



ROADMAP FOR RESEARCH INFRASTRUCTURES OF LITHUANIA

2011

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● FOREWORD BY THE MINISTER OF EDUCATION AND SCIENCE



Introducing the *Roadmap for Research Infrastructures of Lithuania*, I note with delight that this is the first successful attempt to identify and enumerate the existing and planned research infrastructures in Lithuania. Almost three years ago I approved a renewed and enlarged working group of researchers and industrial experts that undertook this necessary and important task. I would like to thank them for the time devoted to discussions, for their ideas and insights.

The national roadmap of research infrastructures is essential in order to recognize the research potential we have here in Lithuania and directions it should be developed. From now on research in Lithuania will be associated with well-defined research infrastructures. An important input into the preparation of the roadmap is the participation of outstanding foreign scholars. They assessed

the roadmap project proposals impartially, with an outsider's eye, without being involved in the national research environment. We may agree or disagree with their evaluation but we can be certain of their objectivity.

In a certain sense this roadmap negates old stereotypes concerning research. The traditional viewpoint was that natural, biomedical and technological sciences need the support of strong infrastructures. This roadmap also includes infrastructures for social sciences and humanities. Moreover, the roadmap shows a new direction for those sciences encouraging researchers to outreach the national cultural boundaries and to strengthen historical and contemporary links with European societies and their cultures.

I consider this roadmap as the first step into a better understanding of what we have in Lithuania and what is our base for future integration into the networks and consortia of pan-European research infrastructures. I am certain that publication of the roadmap will invigorate discussions that will give new insights and ideas how to improve and update it. The roadmap will also encourage the monitoring and evaluation of Lithuania's success with respect to the rapid advancement of technological development and scientific knowledge in the world.

Gintaras Steponavičius
Minister of Education and Science



● INTRODUCTION

According to *Council Regulation* No. 723/2009 of 25 June 2009, "... 'research infrastructure' means facilities, resources and related services that are used by the scientific community to conduct top-level research in their respective fields and covers major scientific equipment or sets of instruments; knowledge-based resources such as collections, archives or structures for scientific information; enabling Information and Communications Technology-based infrastructures such as Grid, computing, software and communication, or any other entity of a unique nature essential to achieve excellence in research. Such infrastructures may be 'single-sited' or 'distributed' (an organised network of resources);"* Single sited or centralised RIs such as telescopes, particle accelerators, specialised laboratories, etc. are needed for physical and technological sciences. They require large investments. Distributed or network resources are more typical of social sciences and humanities as well as biomedical sciences (environmental observatories, biobanks, databases, archives, etc.).

Alongside the above mentioned physical infrastructures, virtual RIs emerge and gain popularity since researchers can access them via computer networks. The virtual elements are being integrated into physical infrastructures. Systems of remote control for conducting phys-

ical experiments that allow researchers to receive data from instruments and facilities can be located in other countries or even continents. Such systems are becoming widely accessible. According to the fields of research the RIs can be either specialised, meant for one or a few similar fields, e.g. astronomical or environmental observatories, or they can serve as interdisciplinary enterprises that can be used by diverse research communities. The latter include libraries, museums and other information and communication infrastructures.

* Council Regulation (EC) No. 723/2009 of 25 June 2009 on the Community legal framework for a European Research Infrastructure Consortium (ERIC). Official Journal of the European Union, 2009 8 8, p. 4.

● THE PURPOSE AND OBJECTIVES OF THE ROADMAP

The new smart, sustainable and inclusive economic growth strategy of the European Union for the coming decade *Europe 2020* encourages investment into research and technology; it also has the ambitious goal to complete the European Research Area and to re-focus R&D and innovation policy on the challenges facing our societies. The European Research Area will involve global RIs that foster innovation that will increase resource efficiency, will improve competitiveness and reinforce economic and social cohesion in the European Union. Global competition in the fields of science, technologies and innovations and the increasing costs of RIs make long-term public sector investments into the development of RI not only desirable but also inevitable. It takes many years if not decades to design and establish national RIs, especially those (like biobanks, archives, and large databases) meant for biomedicine, environmental and social sciences and humanities. However, the national budget can supply RIs with only limited funding, therefore it is important to determine long-term priorities.

At present the necessity to design and create new national RIs has become as urgent as never before. There is a large need for such RIs that satisfy increasing demands to use modern research tools and facilities, physical and virtual resources, means of computation and communication. The national RIs should provide open access and serve researchers from the entire country. Since ambitious demands of advanced researchers outreach financial possibilities of their in-

stitutions and the state in general, participation in the pan-European research infrastructures is highly desirable.

In the year 2009 the Ministry of Education and Science of the Republic of Lithuania responded to the urgent needs of researchers and initiated the development of the *Roadmap for Research Infrastructures of Lithuania* (hence Roadmap). Considering the developing trends of research in Lithuania and worldwide the Roadmap seeks to:

- overview the present situation of RIs in Lithuania;
- evaluate prospective national projects of RIs;
- present proposals for the incorporation of the national RIs into respective pan-European consortia.

This Roadmap is a long-term (10–15 years) planning instrument that lists research infrastructures of national importance, either new or in need of upgrading, therefore it will be periodically updated. The inclusion of a research infrastructure in the Roadmap does not assure its funding. Nevertheless, the Roadmap will serve as a guideline/aid to the decision-making process.

● INTEGRATED SCIENCE, STUDIES AND BUSINESS CENTERS (VALLEYS)

In April 2007 the Government of the Republic of Lithuania passed a document proposing the initiation and development of research, education and business/industrial enterprises, called *General Concept of Initiation and Development of Integrated Research, Education and Business/Industrial Centers (Valleys)*. Representatives from academic institutions and private enterprises concerned with research generated programmes for five valleys that were approved by the Government in 2008.

These programmes enabled the consolidation of human and physical resources of related academic and research institutions. In the period of 2009 – 2013 activities foreseen in the programmes are funded by the Structural Funds of European Union and state budget. The amount of money provided (more than 1.3 billion litas) has no precedent in the funding of research in Lithuania. It is assumed that when the programmes of the valleys are carried out, they will create highly improved conditions for research in biomedicine, physical sciences and technologies and enable close cooperation between academic research institutions and industry.

According to the programmes of the valleys, five integrated centers are planned: two each in Vilnius and Kaunas and one in Klaipėda. Saulėtekis (Sunrise) Valley in the Antakalnis neighbourhood of Vilnius will host researchers from the following fields: life and materials sciences, laser, light and nano technologies, semiconductor physics, electronics,

and civil engineering. The major institutions affiliated with the Saulėtekis Valley are the Center of Physical Sciences and Technologies of Vilnius University and Vilnius Gediminas Technical University.

Another valley is situated in the neighbourhoods of Visoriai and Santariškės in Vilnius. It will concentrate human resources and physical infrastructure for research in biotechnologies, biopharmacy, molecular medicine and innovative medical technologies, ecosystems, safe environment research and computer science. The programme of Kaunas Santaka (Confluence) Valley is intended for research in chemistry and biopharmacy, mechatronics, energy and environmental engineering, information and telecommunication technologies. The second valley of Kaunas, called Nemunas, will specialise in agricultural sciences and forestry, specifically in agrobiotechnologies and bioenergetics, as well as in food processing technologies. In the seaport of Klaipėda, the Marine Valley will specialise on the issues of marine studies and marine industries (sea-craft, ports and their infrastructure, industries of shore zone resources, etc.).

● DEVELOPMENT OF PAN-EUROPEAN RESEARCH INFRASTRUCTURES

During the past decade, the European Union Member States, reacting to the increasing needs of resources for research as well as global tendencies, increased their attention to the development of RIs. In 2001, the Council of Ministers recognised the benefits of an integrated European approach on research infrastructures within the context of the European Research Area (ERA) and invited the Commission, in close collaboration with the Member States, to explore the need for new arrangements to support policies related to research infrastructures.

An expert group, set up to examine the issue, concluded that policy-making on research infrastructures of European significance had steadily become more complex and less effective. Therefore, a more integrated approach was needed to guide policy-making in the Member States.

This directly led to the creation of a European Strategy Forum on Research Infrastructures (ESFRI), with the following mandates:

- to support a coherent and strategy-guided approach to policy-making on research infrastructures in Europe;
- to facilitate multilateral initiatives leading to a better use and development of research infrastructures.

The inaugural meeting of ESFRI took place in Brussels on 25 April 2002. Immediately after joining the European Union in 2004 Lithuania delegated its representatives to this forum.

The emergence of ESFRI was caused by objective reasons. Costs of implementing, upgrading and functioning of research facilities are high and can be reasonably managed with the help of transnational cooperation.

In 2006, the first *ESFRI Roadmap* was issued that contained the list of 35 European RIs embracing all fields of science and technology. An update of the ESFRI Roadmap was published in 2008. It presented new facilities, while at the same time endorsing almost all previous projects in the first edition. There were altogether 44 projects of RIs. Implementation of these projects would require 20 billion Euros, while the yearly costs of their maintenance would be about 10 percent of the initial investments. The last issue of ESFRI, called *ESFRI Strategy Report and Roadmap Update 2010*, presents 48 pan-European Research Infrastructures or major upgrades, corresponding to the needs of European Union research communities in the next 10 to 20 years.

According to the legislation of the European Union, RIs belong to the sphere of national regulation. However, the *ESFRI Roadmap* and activities around it indicate that in the near future an increasing amount of the common European Union funds will be dedicated to the building, renewal and support of the European RIs. A proof for that is the 7th Framework Programme of the European Union that allocates about 1.7 billion Euros for RIs. A major part of these funds goes for the integration and assurance of open access to RIs. Part of the funds is devoted for the support of ESFRI projects at their preparatory phases. The largest amount of funds that covers the costs of the design, upgrading and maintenance of the RIs is allocated to the Member States.

In the 2007 study *Guidelines on Coordinating the Research Framework Programme and the Structural Funds to Support Research and Development, a Consortium for Research Excellence, Support and Training (CREST)* working group suggested how to achieve a more coordinated use of Framework Programmes and Structural Funds to support R&D. Recommendations to use both sources to build or upgrade research infrastructures and to connect them at European level as well as to optimise the use and development of the best existing research infrastructures in Europe was part of the plan for strengthening and developing the base of Research, Technological Development and Innovation (RT-DI).

Another study, requested by the European Parliament, *Synergies between the EU 7th Research Framework Programme, the Competitiveness and Innovation Framework Programme and the Structural Funds* (2007) advises how to improve the coordination and synergy effects between three major European Union instruments. It points out that the Capacities strategic programme with its budget allocation of 7.536 billion Euros is of primary interest to regional policy since this programme specifically deals with measures targeted, among others, at RIs of pan-European interest, both existing and new.

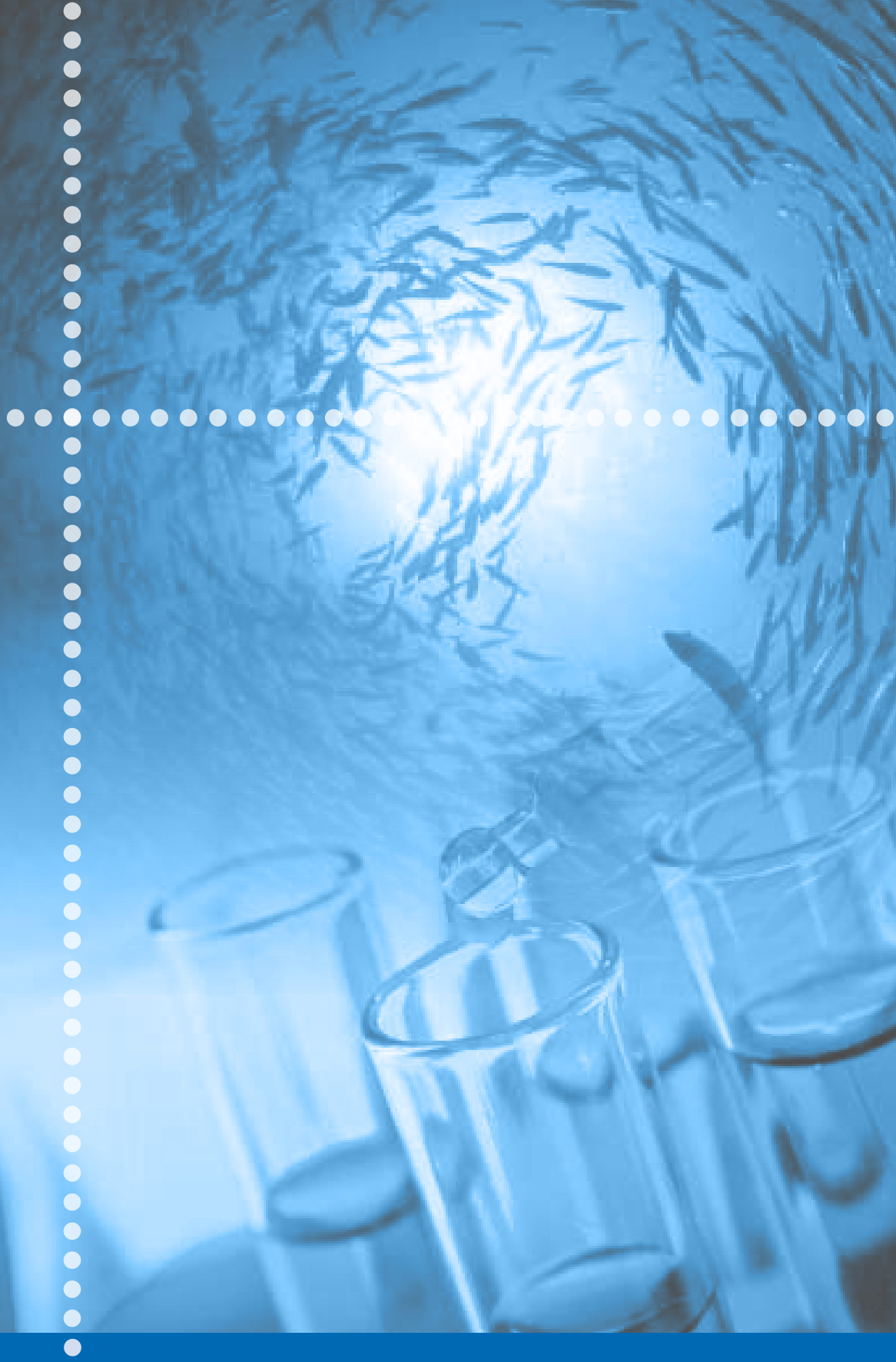
Seeking to promote investment in RIs, the European Commission and the European Investment Bank (EIB) in 2007 joined their efforts to set up the Risk Sharing Finance Facility (RSFF). RSFF is a new European guarantee scheme aimed to improve access to EIB financing for the participants of large-scale European R&D projects initiated by the European Union Member States and associated countries. RSFF is built on the principle of credit risk sharing between the European Community and the EIB. It provides more favourable conditions for borrowing than regular commercial credits.

A major difficulty in setting up such research infrastructures between European Union countries was the lack of an adequate legal framework that allows the creation of appropriate partnerships. Existing legal forms under national law do not fulfill the needs of these new European infrastructures. The same applies to legal forms under international or European Union law. It is in this context that the Euro-

pean Commission proposed a legal framework for a European Research Infrastructure Consortium (ERIC) adapted to the needs of such facilities. The Community legal framework for a European Research Infrastructure Consortium became effective in 2009. This specific legal form is designed to facilitate the joint establishment and operation of research infrastructures of European interest. ESFRI activities and its Roadmap aim to integrate national resources into a common, pan-European effort.

The coordination effort made at European level under the European Strategy Forum for Research Infrastructure aims at creating a European research infrastructure backbone, but also gives orientation on the development trends at European level. Moreover, ESFRI is organising a forum for the exchange and coordination of infrastructure policies. It is of paramount importance for Lithuania to identify its own policy and to decide which ESFRI projects are most relevant for its interests and where to participate as a member or associated partner.

Several countries are now using the ESFRI Roadmap as a model for the development of national roadmaps and setting of national priorities, including existing and new research infrastructures. In many Member States and associated countries national budgets for large research infrastructures are being foreseen. Thirteen countries have already drafted their national roadmaps, fifteen more are under preparation. With this Roadmap Lithuania demonstrates its readiness to keep the country at the rapidly evolving forefront of science and technology and to increase its capacity to meet the needs of the national and international research community.



PROJECTS FOR THE NATIONAL RESEARCH INFRASTRUCTURES IN LITHUANIA

The most important goal of the Roadmap is to identify the directions of RI development for the next 10–15 years. This goal has been achieved considering the present-day situation in Lithuania and European Union, especially how that situation was affected by the appearance of the ES-FRI Roadmap. The building of national RIs should be made with regard to the overall aims and objectives of the research and technology development as well as of social and cultural development of the country.

New or updated RIs must enable internationally competitive high level research and scientific and technological breakthroughs that in their own turn would contribute to the economic, social and cultural advances of the country. National RIs must seek integration into the international and transnational RIs, especially those presented in ESFRI. The assessment of the proposed RIs should be transparent, made by the best national and foreign experts.

The proposals of new RIs were presented to and preliminarily assessed by three sub-groups of the working group, named after their sphere of expertise: Social Sciences and Humanities (SSH), Biomedical Sciences (BS) and Physical Sciences and Technologies (PST). The working group has chosen the most promising projects for RIs based on the criteria of relevance for the country and open access to their services and resources. The latter is a must for all national RIs. All the selected projects had passed four phases of selection.

● SELECTION PROCEDURE OF NATIONAL RESEARCH INFRASTRUCTURES

Preliminary analysis of the status quo in existing RIs was based on the study carried out by the National Development Institute in 2007. It provided a list of RIs that met the above criteria. A call was issued to the academic institutions of the country, inviting them to present the renewed RI proposals. Aiming to assure greater openness and effectiveness the Ministry of Education and Science in 2009 invited academic institutions and high technology enterprises to cooperate with the working group in determining the most important RIs for Lithuania. Up to late 2009 twenty project proposals were received: three from (SSH), seven from (BS) and ten from (PST).

The proposals by individual institutions and their consortia were assessed by foreign experts*. They performed preliminary assessments and categorized the proposals into three groups: mature, promising, and immature. According to the foreign experts, mature projects meet the requirements of the national RI, have the necessary human resources as well as a clear vision for the implementation of the project. Promising proposals meet the requirements of the national RI and could be useful for national research and development. However, they have to be supplemented by feasibility studies that would specify their concept, potential users, partners and stakeholders, funding pos-

sibilities and inter – or transnational cooperation. The final selection of the projects to be included in the Roadmap was made by the members of subgroups and approved by the entire working group. The Roadmap includes only the mature and promising project proposals for national RIs.

* Johanness Andersen (Denmark), Ingmars Eglitis (Latvia), Jacek Gierlinski (Poland), Eeva Ikkonen (Finland), Bente Maegard (Denmark), Karl-Eric Magnusson (Sweden), Andres Metspalu (Estonia), Ekkehard Mochmann (Germany), Taina Pihlajaniemi (Finland), Jan-Eric Solheim (Norway), Dalia Varanka (USA), Richard Wagner (France), John Wood (UK), Kenneth Wärnmark (Sweden).

● SOCIAL SCIENCES AND HUMANITIES

For a long time this field was considered to be able to function without any RIs. Nowadays SSH research is inconceivable without digital resources, databases, software tools and computer networks, therefore modern humanists and social scientists need RIs as much as everybody else. Research in SSH is associated with the development of democracy, civic and knowledge society, social and economic cohesion, cultural identity and encounters and related topics investigated on national and global scale.

Existing national RIs in Humanities form two major groups: Lithuanian language resources and cultural heritage of Lithuania. Language resources consist of speech and lexical databases, digital text archives and corpora, electronic dictionaries, related software tools and services. Digital multimodal resources of cultural heritage include documents and archives of folklore, literature and history.

Social sciences are somewhat less advanced in that respect. They utilise one existing archive, called Lithuanian Data Archive for Social Science and Humanities (LiDA), meant for acquisition, maintenance and dissemination of empirical data of SSH. Multidisciplinary informational RIs consist of the Lithuanian Academic Electronic Library (eLABa) that accumulates academic texts of Lithuanian researchers within the country and

abroad. It serves the need of various researchers and research communities. Another special database, called Lituanistika, contains a selection of outstanding SSH research papers and monographs dealing with the topics of the statehood, society, history, ethnic groups, languages and literatures of Lithuania.

Three project proposals were presented in the field of SSH. Two of them (E-lingua and LiDA) were assessed by foreign experts as mature, one proposal (PITI) was included in the class of promising projects.

Electronic resources of the Lithuanian language (E-lingua) is a new virtual distributed RI based on existing multimodal digital resources. It comprises a variety of text and speech corpora, lexical databases, machine readable dictionaries as well as tools for their processing. The resources are freely accessible on the on-line sites of participating institutions (donelaitis.vdu.lt; www.lki.lt). However, they have to be standardized, aligned and incorporated into national and transnational networks of linguistic resources.

Language resources are of paramount importance for several applications: primarily as a source of knowledge for natural language processing, computational and corpus linguistics, lexicography, artificial intelligence and others. These interdisciplinary fields are of equal importance for linguists and computer scientists who need large amounts of data for their research and research-based language technologies, e.g. automatic language analysis and an-

notation tools (part-of-speech tagger, parser), information retrieval, machine translation systems, etc. In addition, E-lingua is aimed at lexicographers, language teachers, students, and translators, since it provides authentic databases for corpus-driven linguistic research, data driven language learning and teaching. Finally, large corpora are used as a source of various forms of text-based information by researchers of language, literature, folklore, ethnology, anthropology, sociology, politology and social psychology.

E-lingua will be created by a consortium of academic institutions that will merge their resources and jointly make new ones. It will provide data collections, methodological supervision and coordination inside the consortium and outside it on the international level, specifically dealing with the incorporation of Lithuanian language resources into ERIC consortium, called Common Language Resources and Technology Infrastructure (CLARIN). Joining CLARIN is crucial for several reasons: participation in the creation and adoption of standards, acquisition of know-how, adaptation of existing tools for the Lithuanian language, quality control of home-made tools and resources. Lithuanian institutions participated in the preparatory phase of CLARIN still as an ESFRI project since 2006, and they are taking part in its transition phase on an institutional level. Now Lithuania seeks to become a national member of the CLARIN ERIC consortium.

Lithuanian Data Archive for Humanities and Social Sciences (LiDA) is an existing RI that has to be maintained and periodically upgraded (www.lidata.eu).

Currently, LiDA provides virtual digital infrastructure for acquisition, preservation and dissemination of digital SSH data in Lithuania. SSH researchers can deposit, search, browse, make online analyses and download more than 100 quantitative data sets, e.g. Candidate Countries Eurobarometer, New Baltic Barometer, and Socio-economic Barometer. LiDA also serves as a tool to increase methodological competence of researchers by providing methodological assistance and training by means of distance learning solutions and organization of data confrontation seminars and methodologi-

cal training. LiDA as well coordinates international data collection initiatives in Lithuania, e.g. European Social Survey.

LiDA is targeted at the SSH community, both institutional and individual researchers as well as students seeking to support their scientific and educational needs. It is also a useful collection of data for general public and governmental institutions. As the National Member Institution at the Inter-university Consortium for Political and Social Research, Michigan, USA (ICPSR), LiDA provides access to international empirical data resources for Lithuanian SSH researchers at major science institutions. Close institutional cooperation of LiDA was established with German Social Science Infrastructure Service (GESIS), Norwegian Social Science Data Services (NSD), UK Data Archive (UKDA), and Swiss Foundation for Social Research (FORS). LiDA is a national representative in the boards of European Social Survey (ESS) and Council of European Social Science Data Archives-ERIC (CESSDA).

From the very start LiDA was built as a highly interoperable infrastructure. This was achieved by adopting international standards of viable data and metadata storage and dissemination. Data and metadata stored at LiDA are integrated into major national online libraries: Lithuanian Academic Electronic Library (eLABa) and Lithuanian Virtual Library (LVB). Compliance with the international standards will facilitate integration of the LiDA data and metadata into pan-European RIs, such as CESSDA. LiDA has also adopted international standards for subject and topic (UK Data Archive) classification, which again makes it highly integrable into international infrastructures of SSH data search and retrieval. Interoperability and integrability is further facilitated by orientation towards archiving of bilingual (Lithuanian and English) survey data sets.

Heritage and History Research Infrastructure (PITI) is a new RI of digital humanities based on a network model that unites institutions possessing and sharing resources, information and technological facilities that are needed for heritage and history research. The main objective of PITI is to enable the use of digital information in cultural heritage and history research. Other

objectives include inter-institutional and interdisciplinary cooperation, introduction of innovative research methods, digitalization of resources and development of new technological tools, and establishment of common policies and technological standards.

The target group of users comes from any subfield of humanities: ethnology, archeology, literature, cultural and historical studies. This infrastructure is also of importance for the Lithuanian memory institutions: museums, archives, and libraries. In the future PITI is going to provide research resources for a wide range of researchers from public and private sectors, research and educational institutions. The network also will be useful for foreign research centers that carry out comparative studies.

PITI will adhere to the principles and policies of Digital Research Infrastructure for the Arts and Humanities (DARIAH) and will make efforts to join it. Other potential foreign partners are digital resources of European museums, libraries, archives and audio-visual collections, called *Europeana*, the UNESCO Digital Library, as well as RIs such as Art and Humanities Data Service (UK) or Humanities Research Network (USA).

● BIOMEDICAL SCIENCES

Existing research infrastructures of biomedical sciences are concentrated at the universities and research institutions. They comprise three major types of RIs: instruments and equipment, specialised databases, e.g. for structural biology, and experimental animals. At present the RIs are at institutional disposition, and only a minor part is open for outside researchers.

The subgroup of biomedical sciences received seven proposals from universities, research institutes and other enterprises. After expert evaluation three projects (CossyBio, HBRC and MEDWAN) were evaluated as mature, another three (INECOM, RIEA and AEROINFRA) were attributed to the category of promising projects.

Aerobiological Research Infrastructure (AEROINFRA) is a distributed RI meant to secure functioning of the modern system for data storage on the origin, dispersal, assessment and forecasting of air allergens. Its goal is to reach the general European level of public information and to strengthen the use of scientific knowledge for the agricultural and industrial development in the field of aerobiology.

The new RI will satisfy the need for information on bioallergens in the air. It will provide detailed and timely information on airborne bioallergens necessary not only for allergologists, but also other target groups such as allergic people, tourism and sports organisers, etc. The information about airborne pollen and pathogenic fungal spores is potentially relevant for biologists dealing with the

heterogeneity dynamics of plant and fungal populations. Pharmaceutical companies and medicine distributors use pollen and spore data when developing medicines and recommending their use. Moreover, forecasts of dispersal of airborne plant pathogenic fungal spores are of special relevance for Lithuanian farmers. The national aerobiological research network is unique in the country since the problem of airborne particles of biological origin has not been addressed in an integrated way so far.

Biomedicine Data Warehousing, Standardization and Analysis RI (MEDWAN) is a centrally controlled distributed RI that is intended for multiple purposes. They are: increasing the level of health care services, providing new means of diagnostics, therapy, prophylaxis and prediction, securing support measures for clinical decisions at doctor workplaces, contributing to the development of e-Health while creating its data warehousing and processing subsystem. MEDWAN will serve to bind five components of development: research, clinical practice, e-Health system, national and international data networks with powerful GRID network computations, and knowledge resources necessary for large-scale data processing. MEDWAN will provide means to record and exchange information for the structuring and standardization at semantic level. The levels of data records and documents as well as the level of information exchange and technological interfaces and protocols will be created.

MEDWAN naturally integrates into the national e-Health system because the basis of e-Health system is the Electronic Health Record (EHR), i.e. life-long integrated record

warehousing of all information on the patient's health and the services provided, including tests results, history, genetic data, etc. In the future, the RI has to merge with e-Health system, at the same time serving researchers with large amounts of depersonalized medical data and sophisticated tools for its processing and knowledge extraction.

MEDWAN will allow international cooperation by exchange of data and knowledge with foreign partners, carrying out of inter-regional comparative studies, and the participation in joint information warehousing and processing networks foreseen by the *Action Plan for a European e-Health Area* published in 2004. With the establishment of MEDWAN, possibilities will open up to join international knowledge networks, like GEMSS (Grid-infrastructure for Medical Service Provision), neuGRID (a Grid-based e-Infrastructure for Data Archiving Communication and Computationally Intensive Applications in the Medical Sciences), MAMMOGRID (European federated MAMMOgram database implemented on a GRID structure), e-NMRGRID (computational infrastructure for biomolecular Nuclear Magnetic Resonance studies, structure simulation), MEDGRID (Japan, the Philippines and Taiwan network of research institutions for the processing of medical information), OpenMolGrid (GRID network for molecular research and development of medicines), MedPix (medical images database), BRAINLIFE (e-infrastructure for neurooncology and brain tumours), Open EHR (standardized electronic health records development project) and others.

Center for Computational, Structural and Systems Biology (CossyBio) is a distributed RI that will consolidate into one three different centers: Computational Biology Center, Structural Biology Center, and Systems Biology Center. It will provide computational resources, scientific competence and training in their respective fields via open access to research facilities.

The Computational Biology Center will primarily provide computational resources, scientific competence and training in bioinformatics. In addition, the Computational Biology Center could potentially serve as a national node within the proposed pan-

European bioinformatics infrastructure (ELIXIR). It will also provide computational resources and expertise for experimental research projects that include computational components. In addition, the center could be used for training and educating "wet" lab researchers on the use of the current biological data resources and software.

The Structural Biology Center will combine research and educational resources to investigate the three-dimensional structure of biological macromolecules, proteins and nucleic acids, by using several biophysical techniques, in particular X-ray crystallography and NMR. It will serve as a National Research Center within the proposed Integrated pan-European Structural Biology Infrastructure (INSTRUCT). The center will offer consulting, service, courses and collaboration to the Lithuanian biomedical community interested in structural studies of biomolecules in order to understand the role that proteins play in disease pathways and cell function. Currently, the Institute of Biotechnology (Vilnius University) is the only research center in the Baltic countries (Lithuania, Latvia and Estonia) which actively performs crystallographic studies of biomolecules.

The System Biology Center will analyze how proteins, nucleic acids, other biomolecules and cells interact in both healthy and pathological conditions. The center will combine scientific expertise and research resources of Lithuanian scientists in genomics, proteomics, chemical and cell biology as well as in bioimaging and mathematical modeling. It will provide open access to research facilities for high-throughput screening of biomolecules, training and consulting for researchers interested in system biology approaches, genomics, transcriptomics, proteomics. It will also foster collaboration among scientists. The center could serve as a national branch of the European RI network.

Human Biological Resource Center (HBRC) is a distributed RI that aims at collecting and storing of valuable resources of biological information such as tissues from human body, cells, genetic material (DNA, RNA), along with demographic, pathology,

clinical, follow-up and other relevant information. HBRC will follow European and international experiences and guidelines and will function as an open network connecting healthcare and research institutions and collaborating with international networks. Determining common standards nationally and following best practices internationally are important tasks for this infrastructure. The Human Biological Resource Center should be able to provide the following types of samples necessary for diagnosis: samples of human tissues, body fluids, blood, blood components and bone marrow, cells and cell lines, DNA and other biobanks. HBRC infrastructure includes not only storage facilities but also information systems, which individually connect biological samples with hospital and laboratory information systems such as clinical annotations (information about disease manifestations and outcomes, clinical and population registries). Other important components of the HBRC are quality assurance systems to be developed and maintained as well as establishment of legal framework.

The institutions that are planning to participate in the establishment of HBRC infrastructure already have experience and some infrastructure for project-driven biobanking. This includes some freezing equipment and standard operating protocols used at the projects. International contacts have been established with the Tubafröst network managed by the European Organization of Cancer Institutes and with preparatory phase leaders of the 7th Framework Programme for the Biobanking and Biomolecular Resources Research Infrastructure (BBMRI). It is necessary to analyze best practices of functioning biobanks and make optimal investments in equipment and facilities to ensure safe working conditions for the personnel, develop information technologies, legal framework, standard operational procedures, establish maintenance and funding mechanisms, train the staff members in order to transform from project-driven to systematic biobanking infrastructure.

HBRC will be one of the major resources for biomedical, biopharmacy and biotechnology research. The network will allow the Lithu-

anian science community to access biological resources and data of high quality and to participate in national and international research projects. It will employ epidemiologists, medical doctors, geneticists, pathologists and biomolecular researchers and enable collaboration of research institutions, and both pharmaceutical and biotechnological companies. HBRC will also allow integration into international networks such as BBMRI, Tubafröst (The European Human Tumor Frozen Tissue Bank), ISBER (International Society for Biological and Environmental Repositories), etc.

Infrastructure for Ecological Metabolomics (INECOM) is a new distributed RI that aims at developing and applying innovative and ecologically relevant methodologies for studies of information transfer processes between organisms, allelopathic, antipredation, antifouling, antimicrobial, communication and other functions of secondary metabolites, with the aim to reveal their diversity and to better understand environmental factors that are able either to trigger increased emission of these compounds or to suppress their production. For a holistic approach in ecosystem research, the investigators will network with the aim to exchange and integrate information on metabolites and their effect in terms of structure, function, organism community and trophic level. The samples for chemical and biological analyses will be exchanged among the network members to achieve inter-calibration of the methods applied.

The RI will allow training of young scientists in the rapidly growing area of ecological metabolomics, covering such fields as chemical ecology, ecotoxicology and others. In this way INECOM will serve as an advanced training center for a new generation of Lithuanian ecologists promoting application of the ecological data for maintaining a stable environment and biodiversity protection in Lithuania and the entire Baltic region as well. Moreover, INECOM will provide consultation and services in isolation and identification of small metabolites for ecologists and biologists as well as consultations in bioassay arrangement for detection and evaluation of metabolite impact.

INECOM could participate in the preparatory phase of European Marine Biological Resource Center (EMBRC) under the aegis of ESFRI activities as an associated partner, ultimately joining EMBRC as a full member. INECOM could serve as a regional South Eastern Baltic infrastructure node in the EMBRC. Additionally a number of European marine institutions, including partners in the network of the European marine research stations (MARS) have expressed interest in common use of the infrastructure provided by INECOM.

Research Infrastructure of Experimental Animals (RIEA) is a distributed RI that will serve as the national platform to make the best use of laboratory animal models for the understanding of molecular and cellular mechanisms of human and animal health and disease. RIEA animal facilities will meet increasing demands for systemic phenotyping, genetics, physiology, preclinical and clinical studies, surgery, neurology, toxicology, immunology, pathology, gastroenterology, virology, microbiology, parasitology, stem cells, and evaluation of drug candidates. RIEA will be an open access infrastructure of pre-clinical trials with an international certificate ensuring the ethically sustainable use of laboratory animals such as mice and rats, including transgenic rabbits, guinea pigs and larger animals such as Göttingen minipigs and beagle dogs.

Already during the course of the preparatory phase RIEA will participate as observer at the European Infrastructure for Phenotyping and Archiving of Model Mammalian Genomes (INFRAFRONTIER). In addition, RIEA objective is the participation in the Federation of Laboratory Animal Science Associations (FELASA).

Development of new technologies and products in which the modernized breeding-ground will have sufficient material and scientific potential to participate includes: preclinical and clinical trials of new pharmaceuticals, preclinical studies for the immunogenicity of recombinant therapeutic proteins and vaccine components, development of diagnostic systems including nano and visualization technologies, investigations of regeneration potential of stem cells and therapy technologies.

RIEA will provide facilities for scientific partners from European countries to carry out well controlled experiments according to European Union standards, e.g. preclinical studies for evaluation of drug candidates; host-parasite relationships on experimental animal models; therapy of oncological and immunological diseases to meet increasing demands of the European Union market. Main objectives of RIEA are to become a full member of INFRAFRONTIER as well as to join FELASA.

● PHYSICAL AND TECHNOLOGICAL SCIENCES

RIs in physical and technological sciences are concentrated in the largest universities of Lithuania and in specialised research centers. They include facilities for laser equipment that are utilised not only by academic institutions, but also by enterprises that use laser technologies. Other prospective RIs deal with the equipment for material science, ultrasound testing and astronomical observations, serve as the network of academic institutions. Another national network is based on grid technology that creates a distributed and parallel computing network by linking computer clusters of various institutions into a heterogeneous computing system and operating them with the help of middleware. It is a part of BalticGrid, a wider network of the Baltic countries.

During the call for RI projects twelve proposals were received. Two of them did not meet the requirement of national scope and relevance. Foreign experts assessed the remaining ten proposals. Their conclusions were approved by the subgroups, however, all ten proposals were classified only as promising or immature. Six proposals were included into the Roadmap.

Center of Semiconductor Technology (PTC) is foreseen as a single-sited RI, unique in the Baltic region. This center should provide facilities necessary to produce samples for research and development of prototypes for specific applications. PTC will also provide semiconductor material and small scale production for making of semiconductor devices.

This RI would start its work in directions planned in the National Complex Programme which is aimed at R&D on the following topics: light technologies and their applications in the research of ultrafast processes; inorganic and organic semiconductor materials, their characterization and production and application technologies; nanostructures, control and characterization of their optical and electrical properties. In the first direction, the RI would facilitate development of new semiconductor materials and structures for light emitting diodes and laser diodes, photodetectors, novel solar cells, terahertz emitters and detectors, microwave detectors. Currently, approximately 150 researchers in institutions involved in the planned R&D are investigating such materials and structures produced abroad. Availability of the R&D technology would enable development of functional devices and testing these devices in real applications with the final task to create a commercial product in spinoffs or semiconductor companies in Lithuania and abroad. Organic light emitting diodes and solar cells are already being produced in collaboration with researchers from other universities of Lithuania. Further progress in the development of these devices needs new facilities.

Center of Spectroscopic Characterization of Materials and Electronic/Molecular Processes (SPECTROVERSUM) is a distributed RI that seeks to join the fragmental spectroscopic research sites into one open access network. The main objective of SPECTROVERSUM is to provide ability for characterization of materials and electronic/molecular processes by utilizing modern spectroscopic methods in a broad spectral

range, from vacuum ultraviolet to microwave. It will enable cutting-edge spectroscopic experiments performed to unfold subtle structural and compositional features of materials, recognize fragile molecular interactions, and monitor transformations of short-lived derivatives.

Such infrastructure will be able to provide integral spectroscopic research service in the “one window” approach. The strong side of this infrastructure is the variety of spectroscopic techniques, integration of them, and application of theoretical spectroscopy methods for analysis of the results. Expected users of the infrastructure are: academic researchers in physics, material science, biochemistry, and industry researchers in chemistry, pharmaceutical and environmental laboratories, and biotechnology. The center will be involved not only in the application of the spectroscopic methods, but also in the development of the techniques for special applications.

Structurally the infrastructure will consist of six spectroscopic groups composed according to scientific expertise and equipment available. SPECTROVERSUM will consolidate the methods of linear, nonlinear and mass spectroscopy. Due to considerable concentration of technological equipment in one center, this RI could be attractive to research groups and small companies of neighboring countries. Such big technology centers as IMEC in Belgium for nano-electronics, FORTH in Greece and the Optoelectronics Center at Tampere University are models to follow and possible partners in future networking.

High-Intensity and Broad Spectral Range Ultrashort Pulse Laser (Laser RI) is a distributed RI dealing with the topic of generation of ultrashort light pulses in wide spectral range (VUV-IR) and their application in the research of light-matter interactions, ultrafast processes, nano and microtechnologies. The topic is often referred to as ‘Ultrafast science and technology’. It covers many fields, from nuclear physics to astrophysics with applications ranging from telematic communications to medical surgery.

Laser RI is based on the existing infrastructure of two Vilnius-based institutions. It has a rich history of research and cooperation with foreign laser centers. International access has been provided since 2001. Since 2004 the Vilnius University Laser Research Center is the member of LASERLAB-EUROPE and the partner of the new European RI, called Laser Research Facility for Extreme Light Infrastructure (ELI). Another Lithuanian partner of this distributed RI provides facilities for applied research in nonlinear optics. It is expected that nonlinear spectroscopy equipment that is available at RI will allow joining the European Research Infrastructure for advanced spectroscopy, scattering, diffraction and imaging of materials.

For the development of fundamental research in ultrafast science and technology, national and international access to the high-power femtosecond laser system will be created. This will enable the development of multidisciplinary research in Lithuania and ensure membership in the European RIs, such as LASERLAB-EUROPE 2 and the ESFRI research infrastructure, included in the Roadmap in 2006, i.e. ELI.

Molėtai Astronomical Observatory (MAO) is a single-sited RI based on an existing base. It is foreseen that the scientific capacities of the proposed RI will be considerably expanded, by making substantial modifications to the available telescopes and other instruments, also by acquiring several new top-class instruments. The end goal therefore is the creation of a modern RI that would be fully capable to deal with the stringent requirements imposed by modern research programmes in astrophysics.

The proposed expansion of the RI will fully exploit the benefits of the existing infrastructure. The new RI will focus on several long-term research programmes that will allow one to make its truly unique and thus scientifically relevant input on the international level. MAO will operate as an open access RI: 80 % of the telescope time will be allocated on competitive basis between the proposed research projects, 20 % will be reserved for technical service, training courses, and projects of teachers, students, and schoolchildren.

National Grid Infrastructure (LitGrid-HPC) is a distributed virtual RI, based on an existing network of distributed and parallel computing and e-services (LitGrid). It enables comprehensive scientific data maintenance. The renewed RI is meant to create, maintain and develop an e-infrastructure (grid, cloud computing, high-performance computing, virtual repositories, related data sets), to serve the academic environment, public sector, business needs, and requests from foreign partners. It will also provide calculation resources, modelling services, virtual repositories, data sets storage and usage and provide an “on demand” supply: computing, data repositories, related e-services. LitGrid-HPC should deploy the technological innovations or use new technologies in grid and cloud computing, especially via participation in the European Grid Initiative (EGI) activities.

Grid technology creates a distributed/parallel computing network by linking computer clusters of various institutions into heterogeneous computing system and operating them with the help of middleware. LitGrid is now based on gLite operational middleware; however, several other operational systems (such as KnowARC, Globus, UNICORE, CREAM) are under consideration. Some of these systems will be needed to establish successful cooperation between LitGrid and various grids of Europe. The European grid intention is to establish interoperability between such systems to make them compatible to each other.

Ultrasonic Non-destructive Testing, Measurement and Diagnostics Center (ULTRATEST) is a single-sited RI that will cover development and application of combined measurement, electronic, mechanic, embedded control systems and specialised software. It is planned to create the academic e-infrastructure as an international network based on a grid system for non-destructive testing and condition monitoring of remotely located engineering constructions, data acquisition and collection, data processing, appropriate numerical simulations.

Experimental measurement data from places of permanently monitored engineering constructions will be automatically transferred via communication networks, also by Internet, to the Computer Center that will employ neural network processing, expert system decision making and the prediction of future conditions by using sophisticated numerical modelling algorithms.

The condition monitoring of the remotely located engineering constructions will be performed using the appropriate algorithms of ultraconic signal processing and mathematical prediction in order to detect defects as early as possible, before they become critical for the structure reliability and dangerous for the environment. The algorithms include complex time-frequency analysis, prediction by modelling, and identification of condition. This would lead to the development of network database which will be part of the worldwide monitoring and data processing via remote access. Every expert working with this system will receive appropriate access to the control terminal of data analysis and parameterisation opportunity of numerical simulation systems. All distributed units of the network will be connected to the central unit or cluster of network servers by a logical star principle via local and Internet network channels.

LITHUANIA AND THE EUROPEAN RESEARCH INFRASTRUCTURES

The chapter presents the selected list of the European Research Infrastructures to be considered attractive for some national RIs.



BBMRI (*Biobanking and Biomolecular Resources Research* www.bbmri.eu)



CERN (a previous *Conseil Européen pour la Recherche Nucléaire* later renamed as *European Organization for Nuclear Research* www.cern.ch)



CESSDA (*Council of European Social Science Data Archives* www.cessda.org)



CLARIN (*Common Language Resources and Technology Infrastructure* www.clarin.eu)



DARIAH (*Digital Research Infrastructure for the Arts and Humanities* www.dariah.eu)



ELI (*The Extreme Light Infrastructure*
www.extreme-light-infrastructure.eu)



INFRAFRONTIER (*The European Infrastructure for Phenotyping and Archiving of Model Mammalian Genomes* www.infrafrontier.eu)



ELIXIR (*European Life-Science Infrastructure for Biological Information*
www.elixir-europe.org)



INSTRUCT (*An Integrated Structural Biology Infrastructure* www.instruct-fp7.eu)



EMBL (*European Molecular Biology Laboratory* www.embl.org)



ILL (*Institut Laue-Langevin* www.ill.eu)



ESO (*European Southern Observatory*
www.eso.org)



PRACE (*Partnership for Advanced Computing in Europe* www.prace-project.eu)



ESS (*European Social Survey*
www.europeansocialsurvey.org)



ESS (*European Spallation Source*
www.ess-scandinavia.eu)

Correspondence between the Lithuanian and the European Research Infrastructures

LITHUANIAN IR PROJECTS	POSSIBLE MEMBERSHIP IN EU RI
LiDA	CESSDA, European Social Survey
E-lingua	CLARIN
PITI	DARIAH
CossyBio	INSTRUCT, ELIXIR and EMBL
HBRC	BBMRI
RIEA	INFRAFRONTIER
INECOM	EMBRC
Lazeriq MTI	ELI
LitGrid-HPC	EGI and PRACE
MAO	ESO

● TERMS, ACRONYMS AND ABBREVIATIONS

AEROINFRA – Aerobiological Research Infrastructure
BBMRI – Biobanking and Biomolecular Resources Research Infrastructures
BRAINLIFE – E-infrastructure for Neurooncology and Brain Tumours
BS – Biomedical Sciences
CESSDA – Council of European Social Science Data Archives
CLARIN – Common Language Resources and Technology Infrastructure
CossyBio – Center for Computational, Structural and Systems Biology
CREST – Consortium for Research Excellence, Support and Training
DARIAH – Digital Research Infrastructure for the Arts and Humanities
EGI – the European Grid Initiative
EHR – Electronic Health Record
EIB – European Investment Bank
eLABa – Lithuanian Academic Electronic Library
ELI – Laser Research Facility
E-lingua – Electronic Resources of the Lithuanian Language
ELIXIR – European Life Sciences Infrastructure for Biological Information
EMBL – European Molecular Biology Laboratory
EMBRC – European Marine Biological Resource Center
ERA – European Research Area
ERIC – European Research Infrastructure Consortium
ESFRI – European Strategy Forum on Research Infrastructures
ESO – European Southern Observatory
FELASA – the Federation of Laboratory Animal Science Associations
FORS – Swiss Foundation for Social Research
FORTH – Institute of Computer Science of the Foundation for Research and Technology-Hellas
GEMSS – Grid-infrastructure for Medical Service Provision
GESIS – German Social Science Infrastructure Service
GRID – Grid computing is a term referring to the combination of computer resources from multiple administrative domains to reach a common goal

HBRC – Human Biological Resource Center
HPC – high-performance computing
ICPSR – Inter-university Consortium for Political and Social Research, Michigan, USA
IMEC – a company in Belgium for research in nano-electronics
INCOM – Infrastructure for Ecological Metabolomics
INFRAFRONTIER – the European Infrastructure for Phenotyping and Archiving of Model Mammalian Genomes
INSTRUCT – an Integrated Structural Biology Infrastructure
ISBER – International Society for Biological and Environmental Repositories
Laser RI – High-Intensity and Broad Spectral Range Ultrashort Pulse Laser
LASERLAB-EUROPE – the Integrated Initiative of European Laser Research Infrastructures in the 7th Framework Programme of the European Union
LiDA – Lithuanian Data Archive for Humanities and Social Sciences
LitGrid – Lithuanian Network of Distributed and Parallel Computing and E-services
LitGrid-HPC – Lithuanian Grid Infrastructure for High-performance Computing
LitNet – the Information and Communication System of Lithuania
LVB – Lithuanian Virtual Library
MAO – Molėtai Astronomical Observatory
MARS – a Network of the European Marine Research Stations
MEDGRID – a Network of Research Institutions for the Processing of Medical Information
MedPix – Medical Images Database
MEDWAN – Biomedicine Data Warehousing, Standardization and Analysis Research Infrastructure
NeuGRID – a Grid-based e-Infrastructure for Data Archiving Communication and Computationally Intensive Applications in the Medical Sciences
NSD – Norwegian Social Science Data Services
Open EHR – standardized electronic health records development
OpenMolGrid – GRID network for molecular research and development of medicines
PITI – Heritage and History Research Infrastructure
PRACE – Partnership for Advanced Computing in Europe
PST – Physical Sciences and Technologies
PTC – Center of Semiconductor Technology
R&D – Research and Development
RI – Research Infrastructure
RIEA – Research Infrastructure of Experimental Animals
RSFF – Risk Sharing Finance Facility
RTDI – Research, Technological Development and Innovation
SPECTROVERSUM – Center of Spectroscopic Characterization of Materials and Electronic/Molecular Processes
SSH – Social Sciences and Humanities
Tubafrost – the European Human Tumor Frozen Tissue Bank
UKDA – UK Data Archive
ULTRATEST – Ultrasonic Non-destructive Testing, Measurement and Diagnostics Center

NOTES

Handwriting practice lines on the left page.

Handwriting practice lines on the right page.

NOTES

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

