3 OBJECTIVES

3.1 RESEARCH OBJECTIVES

The first global GRID infrastructure is currently under construction - *LHC Computing GRID (LCG),* with major role of CERN and European sites. Russian High Energy Physics Institutes actively participate in the LCG project with a valuable contribution to the first phase, LCG-1. This pioneering program requires a number of researches to tune the middleware already created in different R&D projects. The main goals of this project are a theoretical analysis (computer modeling), development of advanced algorithms and tools, study of optimization problems, methods of testing, evaluation of emerging soft/middleware for the LCG infrastructure and as well deployment of this infrastructure in the Russian Grid segment.

The computer modeling provides a better understanding of LCG-infrastructure functionality and operability while implementation of more sophisticated algorithms for its key components (e.g., the Resource Broker) may improve these characteristics. Development of the infrastructure-state and data-migration monitoring tools as well as optimization of data access and transfer (including optimization of data flow migration between different end users and Tier-levels) aim at improving the LCG usability, performance, quality of service, etc. A special test suite to be constructed in the framework of this project is intended for comprehensive testing of new implementations of data services. Evaluation of emerging OGSA-based middleware as well as emerging and existing software (e.g., VMWare) is very important for further development of LCG. Installation and tests of components of the LCG infrastructure in the Russian segment aim at achieving its full-scale functionality. This will provide a basis for the integration of Russian GRID segment into the whole LCG infrastructure and, eventually, for full-scale participation of Russian scientists in the LHC experiments.

3.2 Background and Justification

The project team has a good experience in applications of the advanced technology of distributed computations in High Energy Physics (HEP), with emphasis on intensive operations with huge amounts of data globally distributed over computing centers all over the world. Team members were involved (and are currently involved) in various Grid-related projects including the preceding INTAS-CERN project No. 00-0440 "Research of GRID Technology for Data Intensive LHC experiments in Heterogeneous Environment" (2000 -2003) as well as European project, EU DataGRID (cf. http://eu-datagrid.web.cern.ch/eu-datagrid/EU), with successful deployment of the EDG middleware (version 1.3.2) and participation in EDG testbeds (cf. http://lhc.sinp.msu.ru/DataGRID/). In the framework of the latter activity, the Russian EU DataGrid Certification Authority center was established (cf. http://lhc.sinp.msu.ru/CA) for providing users from Russia with this service. In addition, a prototype of a GRID Operation Center was created (including such basic services as Resource Broker and GRID monitoring). In addition, team members actively participate in modeling the event production for LHC Collaborations (cf., e.g.,

http://lhc.sinp.msu.ru/sinp-farm/, http://lhcb-comp.web.cern.ch/lhcb-comp/ComputingModel/production/score_table.htm).

The preceding INTAS-CERN (No. 00-0440) project was devoted to preliminary study of Grid data intensive infrastructure. Now this research serves as main background for more advanced and practical activity to be carried out in the framework of the current project, which is in tight correspondence with the general LCG-project plans and scheduling.

Basic references, shown the team experiences, one can find in the "Team Information» section of this proposal. It is reasonable to add the reference on the *VIII International Workshop on Advanced Computing and Analysis Techniques in Physics Research* (ACAT'002, Moscow, Russia, June 24-28, 2002), http://acat03.sinp.msu.ru, organized by SINP-MSU and JINR teams. One of the main topic of this workshop was "Very Large-Scale Computing and GRID"0. The Proceedings of this workshop was published in the journal *Nuclear Instruments and Methods A502 (2003)*. One can find there a number of presentations made by members of teams (Russian and INTAS ones) of this proposal, as well reports of major GRID projects around the world.

The justification of the project tasks reads as follows.

Development of advanced mathematical techniques for LCG aims at improving functionality of some key components of the Grid system, in particular the Resource Broker. Current realization of scheduling algorithm is straightforward and not effective in the situation of submitting a large amount of jobs. We propose to realize much more sophisticated algorithm which takes into account on-line information about resource loading and data traffic as well as to study schemes predicting the status of GRID for optimization of scheduling policy. However, to enhance effectiveness of a Grid system as a whole, it is desirable to have adequate mathematical models describing it. Unfortunately, because of complicated internal structure of LCG, such models are likely to be complicated and by pure analytical methods it is hard to achieve detailed predictions. Hence, computer modeling, which should reproduce the LCG functioning in detail, is necessary. MONARC is an example of software, which addresses this problem. Still, it may require to extend it, or to develop new software to achieve the goal.

Under conditions of a distributed Tier2 cluster in Russia it is important to optimize the usage of communication channels both between sites of this clusters and with external centers (Tier(s)1). The existing and being under development LCG algorithms do not yet include this kind of optimization. We propose to develop a set of algorithms and tools to optimize data migration paths and data replications inside the Russian Tier2 Cluster.

A necessary condition for full-scale functionality of the distributed Russian cluster is the deployment of the global Grid components (e.g., Resource Broker). Only all resources of the Russian HEP Institutes, integrated together by means of global Grid services, may serve as a regional center at the level asked by Russian physicists participated in LHC. One more possible way for improving the functionality of the LCG segment is to use the emerging OGSA-based technologies: the investigation under project should reveal advantage (or disadvantage) of the OGSA approach and its realizations (such as Globus Toolkit 3) for data intensive and, more generally, for scientific Grids. A solid background

for this activity is the good experience of the team members in currently working Grid middleware (such as Globus Toolkit 2 and EDG).

Use of other types of new software also may considerably enhance effectiveness and interoperability of the LCG infrastructure. In particular, VMware emulates several virtual computers at the same hardware base and thus it provides decreasing expenses on the hardware. A set of Active X components, which development is planned in the project, encapsulates connectivity to the GRID systems and therefore provides the facilities for the end-users to develop their own programs with the interface desired (e.g., to work on Windows platform with Microsoft Visual Basic or Borland Delphi).

An important part of LCG infrastructure development is testing of the software used. Unit testing suites developed by EDG exist for initial testing. However, these are usable only by developers themselves in their development environment. We propose to write a test suite executable by users in the production environment, which would allow testing of LCG components, for example information and data management services, under the real user conditions.

The complicated LCG infrastructure requires monitoring of the operational state of computing systems and networks and providing statistic information about the resources used in computing systems (CPU load, disk capacity, etc.) and networks. Statistical study of GRID is important for management of the infrastructure, improving its effectiveness, etc. However, there exists a deficit of tools that can provide a GRID researcher with such information. Thus, the development of monitoring tools is one of the central problems for success of any GRID project and, in particular, the LCG project. For a comprehensive analysis, it is desirable to create a centralized and unified presentation of monitoring data and the statistics for a distributed system. Another task is to collect the requests for resources allocation and to plan the resource usage. Then the standard monitoring facilities in existing GRID middleware allow controlling jobs very roughly. A user is able to inquire only if the job scheduled, started, finished or canceled. We propose to create a tool providing users with essentially more detailed application information in the framework of the GRID paradigm and to test this tool in the LCG.

4 SCIENTIFIC / TECHNICAL DESCRIPTION

4.1 Research Programme

The research program of this proposal is an extension of the work carried out under the preceding INTAS-CERN project No. 00-00440 "Research of GRID Technology for Data Intensive LHC experiments in Heterogeneous Environment" (2000 -2003). It will be carried out by teams from INTAS countries (CERN-IT, FZK, INFN-Padova) and Russia (SINP-MSU, BINP, IHEP, ITEP, JINR, PNPI), which have a good experience in development and applications of the advanced technology of distributed computations in High Energy Physics.

The research program comprises tightly interconnected theoretical, computer engineering and practical (soft/middleware deployment and testing) sets of problems. Thus the theoretical models will serve as a basis for development of soft/middleware tools and program products will be deployed in the LCG infrastructure.

These sets are organized in six tasks:
T1. Advanced mathematical techniques for LCG (task leader - A. Kryukov, SINP-MSU);
T1.1. Advanced algorithms and tools for resource allocation and job scheduling (subtask keader M. Sgaravatto, INFN-Padova, deputy A. Kryukov, SINP-MSU);

T1.2. Large scale data flow simulation in local and GRID environment (subtask leader V. Kolosov, ITEP).
T2. GRID monitoring tools (task leader - Yu. Ryabov, PNPI);
T2.1. Monitoring of application jobs (subtask leader A. Kryukov, SINP-MSU);
T2.2. Monitoring of the GRID infrastructure state (subtask leader Yu. Ryabov, PNPI).
T3. Optimization of data access and transfer in the LCG (task leader - V. Korenkov, JINR).
T4. The development of test suite for new LCG middleware (task leader – I.Bird, CERN-IT, deputy E. Slabospitskaya, IHEP).
T5. The use of the Windows platform for LCG tasks (task leader - M. Kunze, FZK, deputy V. Korenkov, JINR);
T5.1. Use of the VMware for construction of VO's on different platforms and OS versions (subtask leader M. Kunze, FZK, deputy V. Mitsyn, JINR);
T5.2. Porting some of the LCG software on the MS Windows.NET platform (subtask leader D. Oleynik, JINR).
T6. Deployment of LCG infrastructure for creating Russian Grid segment (task leader - V. Ilyin, SINP-MSU);
T6.1. Installing and testing components of the LCG infrastructure to achieve full-scale functionality (subtask leader V. Ilyin, SINP-MSU, , deputy E. Tikhonenko, JINR);
T6.2. OGSA/Globus evaluation for data intensive applications (subtask leader A. Demichev, SINP-MSU);
T6.3. Development of Russian LCG portal (subtask leader E. Nikonov, JINR).

The tasks T1 and T3 have rather theoretical nature, the core of the tasks T2, T4 and T5 is software engineering and the T6 task is devoted to practical deployment of LCG infrastructure. Therefore, a successful accomplishing the T6-task will essentially influence the work on all other tasks in the Program, especially T2 and T3. In one's turn, the work on the T6-task will be in close interconnection with progress and results of the task T4. As concerns T5, if the results of the investigations will show up that the software is highly valuable for the general goals of the project, this also will significantly influence other tasks (especially, T2, T3 and T6). The results of the T2-task will be used in T3 after the testing in the framework of T4.

The work scheduling is shown in the "*Research Information: Planning"* section. For the last months, the program plans the preparation of final report and materials for publications and conference presentations.

4.2 Project Structure

4.2.1 **Task Title : Advanced mathematical techniques for LCG**

Task coordinator : A. Kryukov, belonging to team: SINP-MSU

Objectives :

The main goal of the task is development and implementation of advance algorithms for job scheduling and resource allocation. The investigation of behavior of the algorithms on the real LCG infrastructure permits to evaluate the efficiency of the algorithms and improve the quality of LCG infrastructure.

Methodology :

Statistical investigation of monitoring information about the site resources. Use of elements of queuing theory.

Task Input:

The task is depending on : Deployment of LCG for creating Russian GRID segment Experience in research and development of Recourse Broker in EDG project and tools for submitting application jobs. Experience in deploying EDG middleware in Russian GRID segment.

Result, milestones :

Milestones, results expected and deliverables are defined in the subtasks.

4.2.1.1 **Task Title : Advanced algorithms and tools for resource allocation and job scheduling**

Subtask coordinator : M. Sgaravatto, belonging to team: INFN-Padova, deputy A. Kryukov (SINP-MSU)

Other participants: V. Edneral, L. Shamardin and A. Demichev (all SINP-MSU) , U. Gasparini and M. Michelotto (INFN-Padova)

Objectives :

One of the major components of LCG middleware is the Resource Broker (RB). It is responsible for job schedulingand resource allocation. Thus this service is very important for effective the LCG functioning. In current EDG (and therefore LCG-1) realization, rather straightforward algorithm is implemented: jobs are sent to resources which matches the job requirements, and which are "close" to the needed data.

We propose to study and implement more sophisticated algorithms, allowing better performance of the overall system for the considered set of applications. In particular we propose to analyze and exploit in the Resource Broker statistical investigation of monitoring information about resources.

In the same time we are going to test proposed algorithms on real LCG infrastructure, that allows to improve both the algorithms and RB and, as a result, the quality of GRID services.

Methodology :

Statistical investigation of monitoring information about the site resources. Use of elements of queuing theory and use of simulation tools, e.g. MONARC.

Task Input:

Experience in research and development of RB in EDG project and tools for submitting application jobs (in CMS). Experience in deploying EDG middleware in Russian GRID segment.

Result, milestones :

MILESTONES:

1) developing of queuing based algorithm for RB, Feb. 2004 - July 2004;

2) programming implementation in RB of this algorithm, Sept. 2004 - March 2005;

3) testing in LCG, Apr. 2005 - Dec. 2005.

RESULTS EXPECTED: Program for job scheduling in LCG.

DELIVERABLES: Preprints, reports, publications in journals. Computer programs and the Program reference manual.

4.2.1.2 **Task Title : Large scale data flow simulation in local and GRID environment**

Subtask coordinator : V. Kolosov, belonging to team: ITEP
Other participants: S. Makarychev, I. Korolko, E. Lyublev and N. Tsvetkov (all ITEP)

Objectives :
Simulation of large scale data flows in the LCG infrastructure, including LAN and GRID aspects, to reveal weaknesses and bottlenecks as concern behaviour of storage servers under critical loads. Work out recommendations for improvement of the operability.

Methodology :
Use of existing (e.g., MONARC) simulation tools and tools under development. Study of data flows to be produced by real applications of LHC experiments.

Task Input:
Experience in scripting Shell and Perl languages, and in using SNMP monitoring toolkits. Experience in design and development of large applications in GRID environment.

Result, milestones :
MILESTONES:
1) Study of requirements on the storage device loading under real applications. Feb. 2004 - Apr. 2004;

2) Design and development of a preliminary version of the simulation tools, May 2004 - Sep. 2004;

3) Simulating a storage server behaviour under critical loads, Nov. 2004 - Nov. 2005;

RESULTS EXPECTED:
Analytic reports, regarding behavior of LCG under moderate and heavy load. New tools for GRID simulation.

DELIVERABLES:
Reports on conferences and publications in preprints and journals.

4.2.2 **Task Title : GRID monitoring tools**

Task coordinator : Yu. Ryabov, belonging to team: PNPI

Objectives :
Creation of a tool providing users with access to detailed application information in the framework of the GRID paradigm and test it in LCG. Thisshould improve the standard monitoring facilities in existing GRID middleware which allow controlling

jobs very roughly. While an application job during its processing records specific information which may be important or even crucial for the user, the delivery of such specific information to users through theGRID is not possible in existing GRIDs.

Development of monitoring tools that produce integrated characteristics by use of statistical information gathered from various GRID elements. This service should improve the LCG usability, performance, quality of service, etc.

Methodology :
Use the knowledge about principles of GRID operation and architecture. Apply the modern programming technique based on Object-Oriented approach and database management.

Knowledge of GRID architecture and interaction of the GRID components is a key point to reach the objectives.

Task Input:

The task is depending on : Deployment of LCG for creating Russian GRID segment Experience in programming C/C++ languages and scripting languages Shell and Perl. Experience in design and development of large program system in GRID environment.

Result, milestones :
RESULTS EXPECTED:

Publication in national and international journals, reports on the conferences.

Milestones of the task research program are indicated in the subtask description.

DELIVERABLES: Program code and User manual.

4.2.2.1 **Task Title : Monitoring of application jobs**

Subtask coordinator : A. Kryukov, belonging to team: SINP-MSU
Other participants: V. Edneral, L. Stepanova and V. Kalyaev (all SINP-MSU), A. Minaenko and A. Filine (both IHEP), A. Soukharev (BINP), N. Smirnov (INFN-Padova)

Objectives :
Standard monitoring facilities in existing GRID middleware allow controlling jobs very roughly. User is able to inquire only if the job is scheduled, started, finished and canceled. However, during processing the application job records specific information, and this information could be important or even crucial for the user. It is not a problem to get this information if the job is started locally. However, the delivery of such specific information to users through the GRID is not possible in existing GRIDs. We propose to create a tool providing users with access to this specific application information in the framework of the GRID paradigm and test it in LCG.

Methodology :
Use the knowledge about principles of GRID operation and architecture. Apply the modern programming technique based on Object-Oriented approach and database management.

Task Input:
Experience in programming C/C++ languages and scripting languages Shell and

Perl. The subtask members have an good experience in design and development of large program system in GRID environment.

Result, milestones :
MILESTONES:

1) Study of requirements of application for their monitoring and design general scheme of tools, Feb. 2004 - June 2004;

2) Development preliminary version of tools, July 2004 - Dec. 2004;

3) Testing and preparing final version of tools, writing User manual, Jan. 2005 - Nov. 2005

RESULTS EXPECTED:
Publication in national and international journals, reports on conferences.

DELIVERABLES: Program code and User manual.

4.2.2.2 **Task Title : Monitoring of the GRID infrastructure state**

Subtask coordinator : Yu. Ryabov, belonging to team: PNPI
Other participants: S. Oleshko and A. Kiryanov (both PNPI), V. Pose (JINR), V. Kolosov (ITEP), Yu. Lazin (IHEP)

Objectives :
Development of monitoring tools that produce integrated characteristics by use of statistical information gathered from various GRID elements.
It will be based on an existing GRID information services and will be added with online databases, web-based interfaces, advanced analysis and prediction algorithms for resource qualification. This service should improve the LCG usability, performance, quality of service, etc.

Methodology :
Investigation of the real time GRID resource attributes changes (the GRID resource 'behavior' in different conditions). Development of the
database structure. Software will be written on highly portable languages (perl, sql). Web-based user interface will be developed. Use of link Russia-CERN and personal visits for communications with IT team.

Task Input:
Initial developments will be made on existing GRID (EDG) testbeds. Later on we shall use Russian segment of the LCG infrastructure.

Result, milestones :
MILESTONES

1) Study of the types of the monitoring information which is needed to be gathered. Development of architecture of monitoring tools, July 2004 - Dec 2004;

2) Development of first version of the tools, Jan. 2005 - May 2005;

3) Testing and preparing final version of the tools. Writing User manual, June 2005 - Dec. 2005.

RESULTS EXPECTED:
The result of our activity is the complete
software suite for statistical monitoring which will include the monitoring agents,

database, statistical analysis program and several front-ends (web interface, APIs). Statistical information could be used by GRID
end-users and resource brokers to qualify the elements by durability and accessibility for GRID applications as well as for a long-term estimation of the resource load.

DELIVERABLES:
As deliverables we plan computer programs, database with the monitoring data, report and publications.

4.2.3 **Task Title : Optimization of data access and transfer in LCG**

Task coordinator : V. Korenkov, belonging to team: JINR, deputy V. Mitsyn (JINR)
Other participants: E. Tickhonenko (JINR), V. Motyakov and V. Kotlyar (both IHEP), L. Guy (CERN-IT), M. Kunze (FZK)

Objectives :
The cluster of Tier2 centers will be created in Russia as an operational part of the LCG infrastructure. The corresponding distributed facilities will consist of several computing farms located in different places (Moscow institutes, in Protvino and Dubna, in St-Petersburg and Novosibirsk). These institutes have now (and will have) an access to Tier1 centers (in CERN and/or FZK) with different characteristics. The facilities for permanent data storage will be created in Russian Tier2 Cluster. However they will differ from site to site. Moreover, overall facilities, most probably, will not answer to the requirements of Russian physicists in a full scope. Altogether these conditions require a development of the algorithms and software to optimize the data migration paths between end-users and Russian Tier2 centers, and then with Tier1 sites. In particular, one should determine the locations for data keeping at Russian institutes and getting methods of a quick access to data inside Tier2's in Russia and, if necessary, in Tier1's. It is necessary to take into account current rates of communication channels, a topology of the Tier2 cluster, the time and place of data processing. The main goals are: 1) optimization of the use of Russia-LCG (GEANT) and regional communication links, 2) effective use of permanent storage facilities and CPU resources of Russian Tier2 Cluster; 3) stable and effective access of end-users (physicists) to data stored in the Tier2-Tier1 system.

Methodology :
Analysis of current data transfer rates and prediction of a free space for data keeping. Accounting system on real rates of data transfer via different communication channels. It is supposed to develop a toolkit to optimize data migration paths and to provide a quick access to data with a possible data prefetching to a required place both on user demand and in semi-automatic way. While development the existing GRID/LCG software facilities will be used and it is proposed to develop the additional LCG tools as some kind of sensor sets of a low level for data channel monitoring and monitoring of a free space for data keeping. All this will be considered in a context of peculiarities of a complex hierarchical access from end-users at Russian Tier2 clusters inside a cloud of distributed clusters in Russia and to Tier1(s) in Europe.

Task Input:

The task is depending on : Deployment of LCG for creating Russian GRID segment The current infrastructure of Russian LCG-1 (and the further releases) segment will be used. The statistics on Russia-GEANT channel. The statistics on an available free space for data keeping. The statistics on data access at different nodes of the Russian LCG segment. Replica Location Service, Replica Location Index, Local Replica Catalog for determination of locations of data.

Result, milestones :
MILESTONES:

1) development of algorithms of communication channels monitoring and monitoring of a free space for data keeping, and then development of algorithms of optimization of data migration paths and usage of an available space for data keeping, Feb. 2004 - July 2004;

2) monitoring software development, Aug. 2004 - Dec. 2004;

3) development of software for providing the data migration handling including data prefetching, Jan. 2005 - Dec. 2005.

RESULTS EXPECTED:
The main results of this task are expected to be: 1) the optimization of the usage of communication channels between Russian LCG segment and Tier1 at CERN and FZK, 2) the optimization of the usage of an available space for data keeping and 3) the reduction of data access delays inside Russian Tier2.

DELIVERABLES:
Toolkit and sensor sets for communication channels monitoring and monitoring of a space for data keeping. Tools for optimization of data migration paths. Detailed report on activities.

4.2.4 **Task Title : The development of test suite for new LCG middleware**

Task coordinator : I.Bird, belonging to team: CERN-IT, deputy E. Slabospitskaya (IHEP)
Other participants: Yu. Lazin (IHEP), D.Oleynik (JINR), A. Kiryanov (PNPI), V. Kolosov and S. Makarychev (both ITEP)

Objectives :
The LCG-2 middleware will be based on a number of components developed in various R&D projects (Globus, EDG, iVDGL etc.). A common solution has to be developed to allow the extensive stress testing of the functionality and performance of these middleware via rapid submission of very large number of user or system jobs. We wish to test in particular the correct installation and configuration of main servers, of the information system, data management etc. .

Methodology :
Development of the test suite will use results of the investigation of interrelations between main components of the LCG software. The transparent user interface will be developed. Software will be written in scripting laguages, such as Perl or Python. The link Russia-CERN and personal visits for communications with LCG will be used.

Task Input:
We intend to always use the latest LCG release. Russian sites participating in tests have to be help up-to-date with released software. . The link Russia-GEANT (155 Mbps in beginning of 2004) is also needed.

Result, milestones :
MILESTONES:

1) development of the LCG-2 test suite for install and configuration testing , Feb. 2004 - June 2004;

2) test suite the follow-up to LCG-2 (probably based on web-services), Sept. 2004 - Dec. 2004;

3) test suite for follow-up system (called here LCG-3), Jan. 2005 - July 2005.

RESULTS EXPECTED:
The result of our activity is the creation of a new test suite. The investigation of information system and new data management carried out in this project will allow up to understand the serviceability of such grid infrastructure.

DELIVERABLES:
As deliverables we plan computer programs and the report.

4.2.5 **Task Title : The use of the Windows platform for LCG tasks**

Task coordinator : M. Kunze, belonging to team: FZK , deputy V. Korenkov (JINR)

Objectives :
Study of the VMware as a software for emulation of multi-computer clusters for the LCG purposes. Study of performance fall of such clusters. Study of VMware features to complete distributed computations in a batch mode.

Porting some of the LCG software on the MS Windows .NET platform including a development of a set of ActiveX components. Providing the basic set of operations such as queuing of jobs, tracing the job execution process, requests to the GRID information systems and responding to external information requests, encapsulation of terminal access to different components of GRID under MS Windows.

Methodology :
Installation of the VMware with different operating systems. Installation of software required for distributed computations at computing clusters under VMware. Software development for the Windows users taking into account the peculiarities of the software for GRID systems.

Task Input:
Use of PC cluster in Dubna city and computing environment in Moscow State University. Standard LCG software.

Result, milestones :
Building of Linux computations clusters on a top of Windows computers (under VMware) would be a great benefit for the Russian Tier2 by obtaining an additional power for distributed computations in a batch mode. A set of ActiveX components for using some of LCG software on the MS Windows .NET platform.

Milestones of the task research program are indicated in the subtask description.

DELIVERABLES:
Computer programs; report and a publications (preprints).

4.2.5.1 **Task Title : Use of the VMware for construction of VO's on different platforms and OS versions**

Subtask coordinator : V. Mitsyn , belonging to team: JINR
Other participants: H. Wenske and R. Berlich (both FZK)

Objectives :

Studies of a possibility of the use of the VMware in a context of software testing and development to emulate computer clusters for the LCG purposes. Study of VMware ability to provide cross-platform distributed computations. Study of a performance decrease of computing clusters under the VMware.

Methodology :
Installation of the VMware with different operating systems. Installation of software required for distributed computations at computing clusters under VMware.

Task Input:
A large number of locally connected Windows computing clusters being in a partial use. Plan to use such clusters as PC cluster of the Dubna city and computing environment in Moscow State University.

Result, milestones :
MILESTONES:

1) installation of the software required, Feb.2004 - March 2004;

2) development and testing of software to emulate multi-computer clusters, Apr.2004 - Sept.2004;

3) the usage and analysis of efficiency of clusters under VMware for distributed computations, Sept.2004 - Oct.2005.

RESULTS EXPECTED:
Building of Linux computations clusters on a top of Windows computers (under VMware) would be a great benefit for the Russian Tier2 by obtaining an additional power for distributed computations in a batch mode.

DELIVERABLES:
Report and a publication as a preprint

4.2.5.2 **Task Title : Porting some of the LCG software on the MS Windows .NET platform**

Subtask coordinator : D.Oleynik, belonging to team: JINR
Other participants: M. Kunze (FZK)

Objectives :
Porting some of the LCG software on the MS Windows .NET platform including a development of a set of ActiveX components. The basic set of operations should be provided, such as queuing of jobs, tracing the job execution process, requests to the GRID information systems and responding to external information requests, encapsulation of terminal access to different components of GRID under MS Windows etc.

Methodology :
Software development for the Windows users taking into account the peculiarities of the software for GRID systems.

Task Input:
Standard LCG software.

Result, milestones :
MILESTONES:

1) development and testing, Feb.2004 - Sept.2004;

2) an active usage, Oct.2004 - Sept.2005.

RESULTS EXPECTED:
A set of ActiveX components for using some of LCG software on the MS Windows .NET platform.

DELIVERABLES:
Computer programs; report and a publication (preprint).

4.2.6 **Task Title : Deployment of LCG for creating Russian GRID segment**

Task coordinator : V. Ilyin, belonging to team: SINP-MSU

Objectives :
Installation and test of the key LCG infrastructure components (Resource Broker, Information Service, etc.) in the Russian segment to achieve its full-scale functionality. This upgrading implies preserving full integration of the Russian GRID segment into the LCG infrastructure so that it will serve as a cluster at the Tier2 level.

Evaluation of the new technology based on Web Services Resource Framework (WSRF) considered as a candidate for further stages of LCG.
Testingthe key components of LCG middleware in this new environment.
Investigation of possibility for implementation of WSRF-compliant services at Russian LCG-segment.

Development of Russian LCG web portal (current prototype - http://lcg.jinr.ru) including: information support (current status of tasks, participants, sites, resources etc.); current resource usage and statistics; tools for integration of monitoring data in summary tables and graphical form.

Methodology :
The deployment of the key GRID components in Russian segment will be based on LCG middleware (EDG, GLOBUS, Condor, etc). Implementation of the components will be carried out in such a way that at every step to preserve functionality of the segment in order to match the requirements and obligations within the LCG project.

Available releases of WSRF-compliant middleware will be tested, compaed with OGSA-based Globus Tolkit 3 and evaluated. In the case of positive results, some services will be gradually deployed in Grid system within SINP-MSU, JINR and in Russian LCG-segment. The middleware is planned to be tested in several hosting environments, with different
application servers and types of application problems.

Use of Web forms for giving monitoring information of GRID's, monitoring information from computing units and system, statistic information on utilized capacity and the resource usage. Developing of special software for collecting various information from heterogeneous systems. Storing the information in specialized databases.

Task Input:

The task is depending on : The development of test suite for new LCG middleware Experience in research and development of Grid middleware for EDG, tools for Grid submission application; experience in deploying EDG middleware in Russian GRID segment. The phase-1 Russian LCG segment. Available releases of OGSA- and WSRF-based Globus Toolkits Components of LCG middleware. The documentation

with the description of interfaces to the sensor controls and common structure of description of computing resources. Use of regional links (basically 100 Mbps now).

Result, milestones :
Full-scale integration of the Russian segment into the LCG-2/3 infrastructure as a cluster at the Tier2 level.

Recommendations on use of the OGSA approach for LCG applications, documentation for users as well as publications in journals and conference proceedings. The investigation of functionality of the WSRF-based Globus Toolkit together with components of LCG
middleware in Grid-systems with complicated Trier2 structure may improve effectiveness of Grid calculations and data processing for LHC computing.

Creation of an advanced web site and an additional software to provide LCG users with an uniform interface to the various information services.

Milestones of the task research program are indicated in the subtask description.

DELIVERABLES:

Project report, computer programs, documentation for LCG users in the Russian segment, information materials for developers on OGSA- and WSRF-based Grids, publications in journals and conference proceedings.

4.2.6.1 **Task Title : Installing and testing components of the LCG infrastructure to achieve full-scale functionality**

Subtask coordinator : V. Ilyin, belonging to team: SINP-MSU, deputy E. Tikhonenko (JINR)
Other participants: A. Kryukov, L. Shamardin and L. Stepanova (all SINP-MSU), V. Korenkov and V. Mitsyn (JINR), V. Gavrilov, V. Kolosov, S. Makarychev and E. Lyublev (all ITEP), Yu. Ryabov and A. Kiryanov (both PNPI), E. Slabospitskya, Yu. Lazin and V. Motyakov (all IHEP), Yu. Tikhonov and A. Zaytsev (BINP), L. Rovertson and I. Bird (both CERN-IT)

Objectives :
The Russian LCG segment is currently being joined to LCG-1 as a set of sites (institutes). From the beginning of 2004, in the framework of the current project, we plan to install and test the key infrastructure components, such as the Resource Broker, Resource Information Service, etc., in order to achieve its full-scale functionality. This upgrading implies preserving full integration of the Russian GRID segment into the LCG infrastructure so that it will serve as a cluster at the Tier2 level.

Methodology :
The deployment of the key GRID components in Russian segment will be based on LCG middleware (EDG, GLOBUS, Condor, etc). Implementation of the components will be carried out in such a way that at every step to preserve functionality of the segment in order to match the requirements and obligations within the LCG project.

Task Input:
Experience in research and development of Grid middleware for EDG, tools for Grid submission application; experience in deploying EDG middleware in Russian GRID segment. The phase-1 Russian LCG segment.

Result, milestones :
MILESTONES:

1) Installation of global Grid services in Russian LCG segment, Feb.2004 - Nov.2004;

2) Testing and debugging the segment with full-scale functionality, Dec.2004 - March 2005;

3) Preparing documentation, Apr.2005-Dec.2005.

RESULTS EXPECTED:
Full-scale integration of the Russian segment into the LCG-2/3 infrastructure as a cluster at the Tier2 level.

DELIVERABLES:
As deliverables we plan the project report, documentation for LCG users in the Russian segment, publications in journals and conference proceedings.

4.2.6.2 **Task Title : OGSA/Globus evaluation for data intensive applications**

Subtask coordinator : A. Demichev, belonging to team: SINP-MSU
Other participants: L. Shamardin and V. Kalyaev (SINP-MSU), V. Pose (JINR), M. Lamanna (CERN IT)

Objectives :

It is widely expected that future architecture of Grid systems will be more clearly aligned with the general evolution of Web services (WS) and will integrate more effectively with WS standards. Currently, a basis for such an evolution of the Grid is provided by the WS-Resource Framework (WSRF; http://www.globus.org/wsrf). The WS-Resource Framework was inspired by the preceding work on the Open Grid Service Architecture/Infrastructure (OGSA/OGSI). Our task will be an evaluation of this new technology considered as a candidate for the further stages of LCG. In particular, we shall study the WSRF-based releases of Globus Toolkit (GT), the first such release (GT4.0-beta) being scheduled by the Globus Alliance and IBM for June 2004. Then we intend to study a possibility for implementation of WSRF-compliant GRID services in the Tier2-structure of the Russian segment.

Methodology :

At the preliminary stage, the latest OGSA-based version of the Globus Toolkit (GT3.2) will be tested to have a reference point for further comparison with the WSRF-based versions of the middleware. A preliminary study of WSRF-based GT-releases will be carried out at PCs in CERN, JINR and SINP MSU. The middleware is planned to be tested in several hosting environments, with different application servers and types of application problems. In the case of successful results of the tests, some WSRF-compliant services may be gradually implemented in a Grid segments within SINP-MSU and JINR. We shall use the link Russia-CERN and personal visits for communications with IT team.

Task Input:

The subtask depends on: OGSA (GT3) and WSRF (GT4) based Globus Toolkit releases. Components of LCG middleware.

Result, milestones :

MILESTONES:

1) Development of testing tools for OGSI-compliant services (GT3.2). Testing basic components of the OGSA-based middleware in different hosting environments and with different application servers. Feb. 2004 - June 2004;

2) Studying and testing WSRF-compliant (presumably GT4.x) middleware. Deployment of WSRF-compliant services in the Russian LCG-segment (within the limits of the possible). Evaluation of the WSRF-based Globus Toolkit as a middleware for data intensive applications. Sept.2004 - March 2005;

3) Working out documentation for users and informative materials for developers on OGSA and WSRF approaches for data intensive applications as well as recommendations on use of WSRF-based systems for LCG. Apr. 2005 - June 2005.

RESULTS EXPECTED:
The result of our activity is expected to be recommendations on use of the WSRF approach for LCG applications, documentation for users. The investigation of functionality of the Globus Toolkit together with components of LCG middleware in Grid-systems with complicated Trier2 structure may improve effectiveness of Grid calculations and data processing for LHC computing.

DELIVERABLES:
As deliverables we plan the report, documentation for users and publications in journals and conference proceedings.

4.2.6.3 **Task Title : Development of Russian LCG portal**

Subtask coordinator : E. Nikonov, belonging to team: JINR
Other participants: D. Oleynik (JINR)

Objectives :
Development of Russian LCG web portal (current prototype - http://lcg.jinr.ru) including: information support (current status of tasks, participants, sites, resources etc.); current resource usage and statistics; tools for integration of monitoring data in summary tables and graphical form.

Methodology :
User-friendly interface to information resources. Use of Web forms for giving monitoring information of GRID's, Monitoring information from computing units and system, statistic information on utilized capacity and the resource usage. Developing of special software for collecting various information from heterogeneous systems. Storing the information in specialized databases.

Task Input:
The documentation with the description of interfaces to the sensor controls and common structure of description of computing resources. Use of regional links (basically 100 Mbps now).

Result, milestones :
MILESTONES:

1) Debugging and improvement of data presentation forms and user interface. Feb. 2004 - April 2004;

2) Development of interfaces to GRID monitoring tools, May 2004 - Oct.2004;

3) A full-scale Russian LCG portal in an active usage, Jan.2005- Jan.2006

RESULTS EXPECTED:
Creation of an advanced web site and additional software to provide LCG users with a uniform interface to the various information services.

DELIVERABLES:
Computer programs. Report as a preprint and a publication in journal.

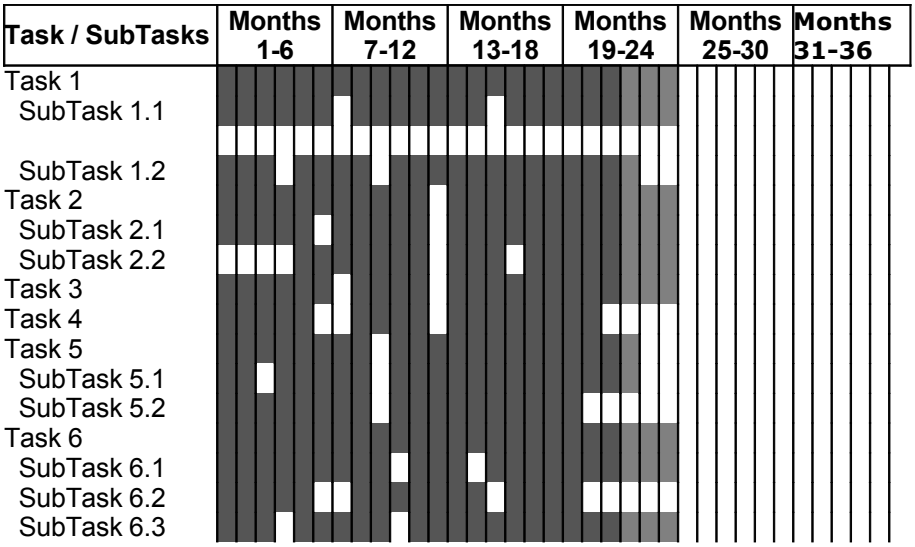
4.3 Management

4.3.1 Planning & Task allocation

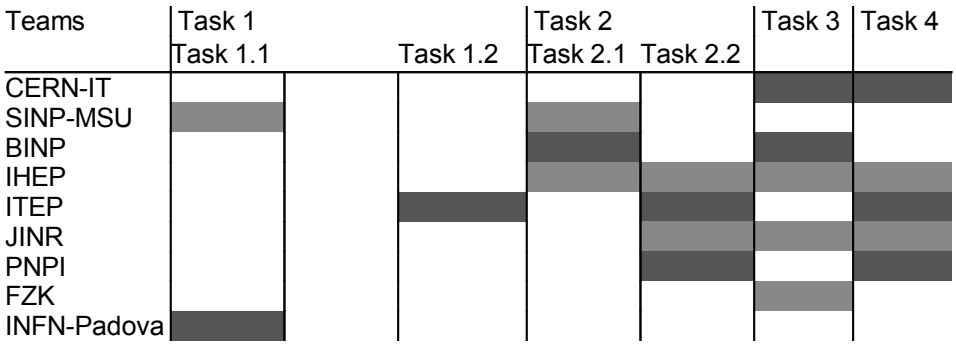
4.3.1.1 List of Task Titles

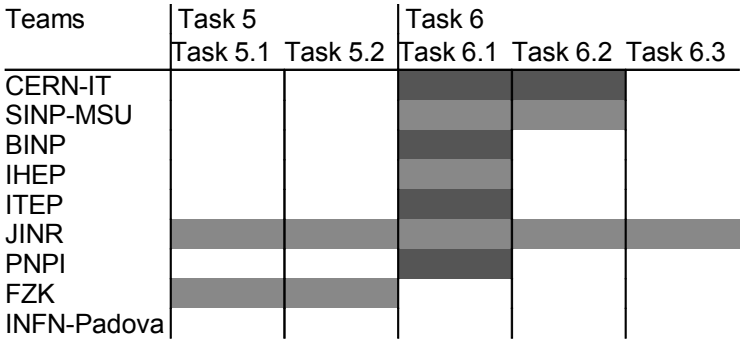
1. Advanced mathematical techniques for LCG
   - 1.1 Advanced algorithms and tools for resource allocation and job scheduling
   - 1.2 Large scale data flow simulation in local and GRID environment
2. GRID monitoring tools
   - 2.1 Monitoring of application jobs
   - 2.2 Monitoring of the GRID infrastructure state
3. Optimization of data access and transfer in LCG
4. The development of test suite for new LCG middleware
5. The use of the Windows platform for LCG tasks
   - 5.1 Use of the VMware for construction of VO's on different platforms and OS versions
   - 5.2 Porting some of the LCG software on the MS Windows .NET platform
6. Deployment of LCG for creating Russian GRID segment
   - 6.1 Installing and testing components of the LCG infrastructure to achieve full-scale functionality
   - 6.2 OGSA/Globus evaluation for data intensive applications
   - 6.3 Development of Russian LCG portal

4.3.1.2 **The project will last 24 months with the activities as indicated in the diagram below**



4.3.1.3 **Team occupation**





4.3.2 **Project Management Description**

The key persons in the management of the project are

Project coordinator (and CERN-IT team leader): Leslie Robertson(CERN)
Deputy project coordinator: Vyatcheslav Ilyin (SINP MSU)

and the team leaders: Alexandre Kryukov (SINP-MSU), Yuri Tikhonov (BINP), Andrey Minaenko (IHEP), Vladimir Gavrilov (ITEP), Vladimir Korenkov (JINR), Yuri Ryabov (PNPI), Marcel Kunze (FZK), Mirco Mazzucato (INFN-Padova).

The project is subdivided into six tasks. Some tasks (T1, T2, T5, T6) are subdivided into few subtasks. For the project management:

- For each subtask the working group (subtask team) is organized by the teams participated in this subtask. The subtask leader coordinates the work process.

- Exchange of e-mails is assumed for current discussions. The face-to-face meetings of the subtask teams and the tasks T3 and T4 with availability to participate via videoconferencing (VRVS) to be organized by the (sub)task leaders each quarter. Participation of members of other (depending) subtasks is assumed according to the working process.

- The intermediate results will be summarized in six-month reports and sent by the task leaders to the project coordinator and the deputy project coordinator.

- It is planned to organize two collaboration workshops, where all teams and subtask working groups should participate and present reports. One workshop is planned for the end of 2004 for discussion of the intermediate report. The second workshop is planned in the end of 2005 for discussion of results obtained and preparing the final

report. The workshops locations will be Moscow and CERN (Geneve).

- Exchanges of team members is planned not only for discussions of ideas and intermediate results but also for real joint work on the tasks. These are an important condition for a success of the project. For this aim, we plan to allocate an additional budget from participating institutes for the support of such visits.

The detailed time schedule of the work program is presented in the corresponding tables in the "Research Information: Planning" section.

4.4 Costs

4.4.1 Cost Table

The breakdown of costs of the INTAS contribution (in EURO) is given in the tables below.

INTAS MEMBER STATE TEAMS								
	Team name	Cost categories						TOTAL
		Labour Costs	Overheads	Travel & subs.	Consumables	Equipment	Other	(EURO)
1	CERN-IT	0	500	4500	0	0	0	5000
2	FZK	0	500	4500	0	0	0	5000
3	INFN-Padova	0	500	4500	0	0	0	5000
SUBTOTAL	(EURO)	0	1500	13500	0	0	0	15000

NIS TEAMS								
	Team name	Cost categories						TOTAL
		Labour Costs	Overheads	Travel & subs.	Consumables	Equipment	Other	(EURO)
4	SINP-MSU	21600	2700	2700	0	0	0	27000
5	BINP	7500	0	1500	0	0	0	9000
6	IHEP	15000	0	3000	0	0	0	18000
7	ITEP	16400	0	1600	0	0	0	18000
8	JINR	20100	0	3900	0	0	0	24000
9	PNPI	9000	0	0	0	0	0	9000
SUBTOTAL	(EURO)	89600	2700	12700	0	0	0	105000

TOTAL	(EURO)	89600	4200	26200	0	0	0	120000

4.4.2 **Justification of Costs**

4.4.2.1 **Labour costs (only for NIS teams)**

Team name: SINP-MSU

Number of individual grants		Cost per month	Total number of man months	Total cost (EURO)
Team Leader	1	250	12	3000
Senior Researcher	2	200	36	7200
	1	250	12	3000
Scientist	2	200	33	6600
Engineer	0	0	0	0
Technical or Other	1	100	18	1800
TOTAL				21600

Team name: BINP

Number of individual grants		Cost per month	Total number of man months	Total cost (EURO)
Team Leader	1	250	12	3000
Senior Researcher	0	0	0	0
Scientist	2	150	30	4500
Engineer	0	0	0	0
Technical or Other	0	0	0	0
TOTAL				7500

Team name: IHEP

Number of individual grants		Cost per month	Total number of man months	Total cost (EURO)
Team Leader	1	200	12	2400
Senior Researcher	5	200	42	8400
Scientist	0	0	0	0
Engineer	2	150	28	4200
Technical or Other	0	0	0	0
TOTAL				15000

Team name: ITEP

Number of individual grants		Cost per month	Total number of man months	Total cost (EURO)
Team Leader	1	250	12	3000
Senior Researcher	0	0	0	0
Scientist	2	200	22	4400
Engineer	3	150	60	9000
Technical or Other	0	0	0	0
TOTAL				16400

Team name: JINR

Number of individual grants		Cost per month	Total number of man months	Total cost (EURO)
Team Leader	1	275	12	3300
Senior Researcher	1	200	18	3600

Scientist	2	200	36	7200
Engineer	2	150	40	6000
Technical or Other	0	0	0	0
TOTAL				20100

Team name: PNPI

Number of individual grants		Cost per month	Total number of man months	Total cost (EURO)
Team Leader	1	250	12	3000
Senior Researcher	2	150	40	6000
Scientist / Engineer	0	0	0	0
Technical or Other	0	0	0	0
TOTAL				9000

4.4.2.2 **Travel and subsistence**

Team 1 (CERN-IT)
Visiting NIS teams. Hosting visiters from NIS teams.

Team 2 (FZK)
Visiting NIS teams. Hosting visiters from NIS teams.

Team 3 (INFN-Padova)
Visiting NIS teams. Hosting visiters from NIS teams.

Team 4 (SINP-MSU)
Travel to INTAS teams.

Team 5 (BINP)
Travel to INTAS teams.

Team 6 (IHEP)
Travel to INTAS teams.

Team 7 (ITEP)
Travel to INTAS teams.

Team 8 (JINR)
Travel to INTAS teams.

Team 9 (PNPI)

4.4.2.3 **Consumables**

Team 1 (CERN-IT)

Team 2 (FZK)

Team 3 (INFN-Padova)

Team 4 (SINP-MSU)

Team 5 (BINP)

Team 6 (IHEP)

Team 7 (ITEP)

Team 8 (JINR)

Team 9 (PNPI)

4.4.2.3 **Equipment**

Team 1 (CERN-IT)

Team 2 (FZK)

Team 3 (INFN-Padova)

Team 4 (SINP-MSU)

Team 5 (BINP)

Team 6 (IHEP)

Team 7 (ITEP)

Team 8 (JINR)

Team 9 (PNPI)

4.4.2.4 **Other Costs**

Team 1 (CERN-IT)
No other costs.

Team 2 (FZK)
No other costs.

Team 3 (INFN-Padova)
No other costs.

Team 4 (SINP-MSU)
No other costs.

Team 5 (BINP)

No other costs.

Team 6 (IHEP)
No other costs.

Team 7 (ITEP)
No other costs.

Team 8 (JINR)
No other costs.

Team 9 (PNPI)
No other costs.

4.5 Innovation and dissemination of results

The results of the investigations under this project will be directly applied for enhancement of functional characteristics of the Russian LCG segment. The developed tools, soft- and middleware will be offered for use at future phases of the LCG project.

We plan also to use the results of the investigation for development of multipurpose experimental Grid system in Moscow State University, in the City Computer system in Dubna and other general-purpose projects in science, education, society etc.

The documentation prepared under the project will serve as a basis for tutorials on the Grid technology and lecture courses for students.