Report on the theme "Information and Computing Infrastructure of JINR"

and proposal for its extension

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The purpose of the theme is to ensure the further development of the network, information and computing infrastructure of JINR for the research and production activities of the Institute and its Member States on the basis of state-of-the-art information technologies in accordance with the JINR Seven-Year Plan of development. In frames of the theme we provide a full list of IT-services on networking (telecommunication channels, JINR local area network, JINR IXP, JINR LAN remote access, datacenter network, device registration, DHCP, DNS, IPDB, network registration & connection, network monitoring, technical network, WIFI, WLCG network), on basics (account management, JINR certificate authority, computer security controls, security firewall, SSO (Single Sign On), SSH (Secure SHell), E-mail), on collaboration (audio conferencing, Eduroam, Indico, video conferencing, Webcast and recording, project management, GIT, JINR Disk, JINR Document Server (Invenio)), on databases (administration databases, ADB2, ISS, 1.C EPR, EDS “Dubna”, PIN, etc.), on computing (GRID, CLOUD, НРС), on application software (JINRLIB, software support), etc.

A particular area within the theme is the development of the Multifunctional Information and Computing Complex (MICC) at LIT JINR presented in a Project form.

The main results obtained in 2017-2019 are presented.

* **MICC Project**

The implementation of the MICC project in 2017-2019 laid foundation for its further development and evolution taking into account new requirements to the computing infrastructure for JINR scientific research. The rapid development of information technologies and new user requirements stimulate the development of all MICC components and platforms. Multi-functionality, high reliability and availability in a 24x7 mode, scalability and high performance, a reliable data storage system, information security and a customized software environment for different user groups are the main requirements that the MICC should meet as a modern scientific computing complex.

During the project realization in the 2017-2019 time period, the projects related to increasing the bandwidth of the Moscow-JINR telecommunication channel to 2 x 100 Gbit/s, installing and configuring the equipment of the Institute backbone computing network to 2 x 100 Gbit/s and the distributed multisite computing cluster network to 400 Gbit/s were carried out. The organization of an additional fiber-optic channel Dubna-Moscow with a capacity of 2 x 100 Gbit/s gives a new direct channel to CERN.

The modernization of the MICC engineering infrastructure including uninterruptible power supply systems, the conditioning and ventilating system was performed. In frames of the MICC development plan, the modernization of the JINR LIT power supply system, together with the replacement of the transformers with a nominal value of 1000 kVA with new transformers of 2500kVA, was performed. The modernization of the external power supply system allowed proceeding to the next stage, i.e. the creation of the MICC guaranteed power supply system. Two diesel-generator sets with a total capacity of 3300 kVA were installed and put into operation.

The modernization of the MICC air-conditioning system was performed. A multi-stage cooling system is used for this purpose. It includes the following: a system of inter-row cooling of racks; special cooling units, which provide excess pressure of cold air under the raised floor; specialized engineering devices operating from cooling towers; exhaust ventilation, which ensures the outflow of the remaining hot air out of the hall; a specialized engineering infrastructure to provide the highly efficient technology of liquid cooling of the GOVORUN supercomputer with hot water.

The JINR MICC consisting of four key computing components, namely, the grid infrastructure, the central information and computing complex, the computing cloud and the high-performance platform HybriLIT with the “GOVORUN” supercomputer, ensures the implementation of a whole range of competitive studies conducted at the world level at JINR in the experiments: MPD, BM@N, Alice, ATLAS, CMS, NOvA, BESIII, STAR, COMPASS, etc.

It should be marked out that within the report period the “GOVORUN” supercomputer being a natural development of the heterogeneous cluster HybriLIT was put into operation. The creation of the supercomputer was not initially implied in the MICC project and the JINR Seven-Year Plan of development, however, it was the result of requests from scientific groups of JINR Laboratories, primarily BLTP, with the aim of cardinally accelerating complex theoretical and experimental studies in nuclear physics and condensed matter physics underway at the Institute as well as for the development of computing for the NICA megaproject. It became possible due to the significant support of the JINR Directorate. The introduction of the “GOVORUN” supercomputer into the MICC was based on the accumulated successful experience in operating the HybriLIT cluster, which supports novel computing architectures, as well as on the enormous work of the heterogeneous computing team on the implementation of parallel calculations to solve challenges facing the Institute and to train specialists in high-performance computing.

The Tier1 level grid center is the only one in the JINR Member States and one of the seven world data storage and processing centers of the CMS experiment. Our Tier1 has demonstrated stable work through the entire period since its launch into full operation. Since the beginning of 2017 16 506 640 tasks have been completed, 371 617 million events have been processed, which accounts for 19,11% of the total number of the CMS experiment events processed by all Tier1 sites. The JINR site is ranked second in its performance in the world. The JINR Tier1 and Tier2 grid sites are the elements of the global grid infrastructure used in the WLCG project for processing data from the LHC experiments and other grid applications.

The other main achievement within last years of the report period was the work on creating a common data storage system (JINR Data Lake) based on the EOS system, which was put into operation at the beginning of 2019. This system should become the major one for all MICC components and later for all JINR computing resources.

The other key objectives of the theme are:

* **Information and software environment for the research and production activities of JINR**.

One of the major goals of the theme is the implementation and development of the JINR corporate information system (CIS). CIS consists of the following services: the system 1C: Manufacturing Enterprise Management (1С: MEM) is aimed at providing a solution to the problems of accounting and management accounting, payroll, personnel records; the corporate system of project management (PMIS (APT EVM for NICA)) allows one to carry out high-level monitoring and management of JINR large-scale projects such as the NICA project in VBLHEP; the information search system (ISS) provides various reports on personnel and financial information; the system of electronic signing, storage and search of documents of the JINR main office administration as well as documents of MES&CC (Management of Economic Services and Capital Construction) and PLS (Procurement and Logistics Service) (Document Base); the institutional open access repository of articles, preprints and other documents (JINR Document Server (JDS)) reflecting and contributing to research activities underway at JINR; the information system of scientific event management Indico provides the full cycle management of conferences, seminars, workshops, meetings, lectures, etc.; the information system for storing and managing data on the results of research activities of JINR employees (Personal Information System (PIN)); the system of management accounting (ADB2); the JINR electronic document system (JINR EDS). The development of this direction is aimed at simplifying and optimizing scientific and administrative activities of the Institute.

* Development of the system for training and retraining IT-specialists on the basis of the JINR MICC and its educational components.

This section of the theme is aimed at creating a system for training and retraining IT-specialists based on the MICC cloud, heterogeneous and grid infrastructures. In particular, the HybriLIT platform is used not only for parallel calculations on novel computing architectures, but also as a polygon for training students, post-graduate students and young scientists.

In the framework of this theme section, the following training courses are held:

* regular training courses and tutorials for JINR employees, students and young scientists from the JINR Member States on advanced information technologies, including Big Data, distributed, cloud and parallel programming technologies, tools and means of application development for computations on hybrid computing architectures on the basis of the education and research grid-cloud infrastructure and the education and test polygon HybriLIT;
* special courses from leading software developers;
* special courses and seminars in frames of conferences and schools organized by JINR;
* special courses organized in the JINR Member States in frames of international cooperation programs.

**The theme "Information and Computing Infrastructure of JINR" and the MICC project prolongation** are aimed at the modernization and development of major hardware and software components of the computing complex, the creation of a state-of-the-art software platform in order to develop methods and algorithms of machine and deep learning for the solution of a wide range of tasks. The MICC project extension presupposes the work in the following directions:

1. Development and improvement of the JINR telecommunication and network infrastructure.

2. Stage-by-stage modernization of the JINR MICC engineering infrastructure.

3. Modernization and development of the IT-infrastructure of the NICA project.

4. Extension of the performance and capacity of storage systems of the Tier1 data processing center for the CMS experiment.

5. Modernization and development of the resources being part of the Tier-2/CICC integral component, which provides support for the experiments using the grid environment and cooperating with physical groups in JINR as well as for non-grid JINR users and its Member States (MPD/NICA, BESIII, LRB, FLNR, DLNP, BLTP, FLNP, VBLHEP).

6. Extension of the cloud component in order to enlarge a range of services provided to users as well as to create an integrated cloud environment for experiments of JINR (NICA, ALICE, BESIII, NOvA, Daya Bay, JUNO, etc.) and its Member States using the containerization technology.

7. Enlargement of the HybriLIT heterogeneous platform with the GOVORUN supercomputer.

8. Significant extension of resources of the MICC components to meet requirements of neutrino experiments.

9. Development of a unified system for computing resource management aimed at big data processing.

10. Development of a unified data management system for all MICC components (JINR Data Lake).

The other key objectives of the theme are:

* Information and software environment for the research and production activities of JINR.

Maintenance and further development of the JINR integrated corporate information system (CIS) including subsystems of accounting, financial and personnel records, electronic document management, interconnected through a universal data exchange gateway and providing access to reliable management information. Development of the NICA project management information system. Upgrade of the PIN subsystem. Implementation of the system “My account” providing the end user with access to his personal information and simplifying access to JINR CIS. Development of electronic libraries and video portals.

* Development of the system for training and retraining IT-specialists on the basis of the JINR MICC and its educational components**.**
* Creation of a special polygon based on the MICC and a developed ecosystem for training IT-specialists capable of solving tasks in projects underway at JINR, the projects of a megascience level including the NICA megaproject, the neutrino program, etc.