

Referee's report on the theme "Information and Computing Infrastructure of JINR"

The goal of the theme is the development of the JINR network, information and computing infrastructure for the research and production activities of the Institute on the basis of state-of-the-art information technologies and novel computing architectures in accordance with the Seven-Year Plan for the development of JINR.

The major direction within the theme is the development of the Institute basic facility, i.e. the JINR LIT Multifunctional Information and Computing Complex (MICC), presented as **the Project**. The implementation of the MICC project in 2017-2019 laid foundation for its further development and evolution with regard to new requirements to the computing infrastructure for scientific research at JINR on the basis of modern information technologies in accordance with the Seven-Year Plan for the development of JINR for the 2017-2023 time period. The MICC is a combination of complexes, subsystems and other organizational units, which include data processing centers of the Tier1 and Tier2 levels; the cloud infrastructure, the GOVORUN supercomputer, data storage; the data transmission network; the MICC engineering infrastructure; the monitoring system. 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, which the MICC should meet as a modern scientific computing complex. These requirements relate to all MICC numerous computing components and IT-technologies aimed at solving JINR current tasks, from theoretical studies to experimental data processing, storage and analysis. They are the IT-ecosystem for the NICA project (BM@N, MPD, SPD), Tier-1 of the CMS experiment at JINR, Tier-2/CICC providing support to experiments at the LHC (ATLAS, ALICE, CMS), FAIR (CBM, PANDA) and other large-scale experiments as well as support to users of JINR Laboratories and the JINR Member States (MPD/NICA, BESIII, LRB, FLNR, DLNP, BLTP, LNP); the integrated cloud environment of the JINR Member States for support of JINR users and experiments (NICA, ALICE, BESIII, NOvA, Daya Bay, JUNO, etc.); the HybriLIT platform with the GOVORUN supercomputer as a major resource for high-performance hybrid computing. To fulfill these requirements it is necessary to provide both a high-speed telecommunication and network infrastructure and a reliable engineering infrastructure.

The successful implementation of the MICC project in 2017-2019 laid foundation for its further development and evolution with regard to new requirements to the computing infrastructure. One of the main directions of the MICC development is the development of its grid component, i.e. the Tier1 center for the CMS experiment and the Tier2 center for all experiments at the Large Hadron Collider (LHC). It is noteworthy that JINR LIT actively participates in the WLCG (Worldwide LHC Computing Grid) global project, which aims at providing distributed computing resources for LHC data processing, storage and analysis. The work on the use of the grid infrastructure in frames on the WLCG project is carried out in cooperation with the collaborations such as CMS, ATLAS, Alice and major international centers, in which both Tier1 centers of the CMS experiment (CH-CERN, DE-KIT, ES-PIC, FR-CCIN2P3, IT-INFN-CNAF, US-FNAL-CMS) and Tier2 grid centers, located in more than 170 computing centers of 42 countries worldwide, operate. Since the beginning of 2015, a full-scale WLCG Tier1 site for the CMS experiment has been operating in JINR LIT; it is regularly ranked second in the number of processed events and shows almost 100% level of availability and reliability. The development of the center with regard to the expansion of the computing performance and data storage volumes is dictated by the research program of the CMS experiment, in which JINR physicists take an active part in frames of the RDMS CMS

collaboration.

The MICC project continuation is aimed at upgrading and developing the major hardware and software components of the computing complex taking into account the rapid development of information technologies, computing architectures and user requirements. One of the examples of the MICC development is the GOVORUN supercomputer introduced into the HybriLIT heterogeneous platform in 2018. The supercomputer is a joint project of LIT and BLTP, supported by the JINR Directorate and aimed at a significant speed-up of complex theoretical and experimental studies. At present, the GOVORUN supercomputer is actively used for modeling computing for the NICA megaproject, including for generating data of events from the MPD experiment; by May 2019 over 40 million events have been generated.

Another key direction of the theme is the development of the information provision of and software for the JINR research and production activities based on the Institute corporate information system (CIS). The development of information systems and services included in CIS will be performed taking into account the requests of end users and the recommendations of the coordination group on the development of JINR databases, electronic document management and information security, with the concept of the cloud SaaS platform of a unified administrative and business information system.

One more important direction of the theme is the development of the system for training and retraining IT-specialists based on the MICC educational components. In the framework of this direction, the organization and realization of training courses on modern IT-technologies for both the Institute staff and students and young scientists from the JINR Member States are planned. Special attention in training courses will be given to the directions of IT-specialists' training for solving problems related to data processing and analysis for experiments of megascience projects including the NICA project and the neutrino program.

Based on the above, I recommend supporting the continuation of the theme "Information and Computing Infrastructure of JINR" until 2023 with the first priority.

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