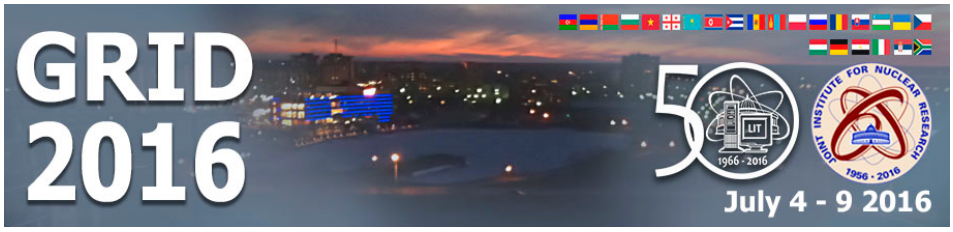

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ONLINE PROCESSING OF LARGE VOLUME OF EXPERIMENTAL DATA IN STRONG ELECTROMAGNETIC AND RADIATION FIELDS IN ITER

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ITER data acquisition and control system consists of CODAC (Control, Data Access and Communication), Plasma control system (PCS), Central Safety System (CSS) and Central Interlock System (CIS). All of them have two tiers of control: global –central supervisor orchestrating the whole plant, and local –subsystem control. Core System (CCS) is the main conventional SCADA system of the ITER based on EPICS. More than 220 diagnostics and technical subsystems are interconnected.
Some plasma diagnostics have tens of measurement channels with frequency band ~500 MHz and more. These multi-channel diagnostics systems (~50 synchronous channels) generate data flow ~200 Gbit/sec. These data arrays have to be measured and sent to CODAC and PCS in real time. Design of diagnostic acquisition systems must satisfy special ITER requirements, which creates problems for designers.
The first problem is in external environment. Some sensors and front-end electronics are located in Port Cells, Galleries close to ITER vacuum vessel and so work in strong magnetic (~0.4 Tesla), neutron (~ 107 n.cm-2.s-1), and Hard X-ray fields. In addition, this equipment located near megawatt radiofrequency oscillators (up to 170 GHz) and must have good electromagnetic shielding.
The second problem is in equipment itself. It cannot be relocated outside operation zone of installation because of long cables induce noise on experimental signals.
The third problem is in electronics parts. In ITER the number of different electronics parts in radiation zone is very large ~500, compared with about 20 different parts in ATLAS detector. Development of special radiation-hard electronics parts for ITER is very expensive and not appropriate for the project.
The fourth problem is in networks. Huge amount of experimental data have to be transmitted into Central systems in real time. Estimations show the required data transmission velocity is more than 10 times exceeds the channel capacity of existing ETHERNET and computer buses (~10 Gb/sec).
The fifth problem is in data network organization. For plasma control system it is necessary to take into account not only data transmission velocity, but also jitter, latency and packets collision between plant system and supervisor and between plant systems.
All above mentioned require optimization of acquisition systems in whole.
Report presents data acquisition system developed for Russian ITER diagnostics, which satisfy requirements for QC3 and QC4 class equipment. Main features of this system are follows. External block with front-end electronics, designed as Faraday casing, placed in ITER Port Cell, in shielded cabinet. It contains minimum electronics components. Main block placed in protected zone at the distance ~100 m. Main and external equipment are connected by multi-channel digital optical lines (10 Gb/sec). Preliminary data processing implemented in smart ADCs (250 -500 MHz step, 14 bit, FPGA). Main data processing is organized inside plant controller (FPGA + CPU) and in local cluster (NvidiaTESLA S1070) connected to plant controller. System uses data compression and fits the size of the data flow to the ITER networks bandwidth

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