ITER Operation Application Systems for Plant System Integration and Commissioning

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13-17 May 2019

Daejeon, Republic of KOREA

12th LAEA Technical Meeting on Control, Data Acquisition and Remote Participation for Fusion Research



- Overview of ITER CODAC (Control, Data Access and Communication)
- Progresses of CODAC Operation Application System
- CODAC for 1st Plant System Commissioning
- Future Plan

ITER CODAC

Is the central control system in charge to monitor/control all ITER plant systems and to orchestrate ITER operation and shall deliver;

- 1. Control Software toolkits/suites for
 - Plant Control System : CODAC Core System (CCS)
 - Operation Support : Operation Application System (OP App)
- 2. Data Handling (Access/Service) (ITERDB)
- 3. Control Infrastructure
 - Network Infrastructures
 - Main/Back-up Control Rooms and Main/Back-up Server Rooms
 - Temporary Services (for early plant systems): TCR, T-MCR, T-MSR
- 4. Supports for Plant System I&Cs
 - Mini-CODAC and I&C Integration Kits (for Plant I&C developments)
 - Control environment for software development and distributions
 - Control System Simulator

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CODAC Core System

- The base software on all CODAC computers <u>for</u> <u>developments of plant control systems</u>
 - 154 distributed to 63 organizations (excl. IO-CT)
 - Statistics of CODAC software as of Feb-2018

Number of software units	196
Total number of Software Line of Codes (SLOC)	3,770,910
Total time to develop (year)	7.77
Total cost of development (in 2000's USD)	153,783,627



Infra	2013		2014		2015		20	16	2017	2018	2019	2020	2021
RHEL 6.3 MRG-R 2.1	4.0	4.1	4.2	4.3	Support								
RHEL 6.5													
MRG-R 2.5					5.0	5.1	5.2	5.3	5.4	Support			
EPICS 3.15													
RHEL 7.x										C O	6.4	<u> </u>	6.2
EPICS 3.16										0.0	0.7	0.2	0.3

1. IPFN-IST: Lisboa, Portu 2. CIEMAT: Madrid, Spain 3. UPM: Madrid, Spain 4. GMV: Madrid, Spain 5. Procon: Badalona. Spain 6. F4E: Barcelona, Spain 7. GTD: Barcelona, Spain 8. CCFE: Abingdon, UK 9. Tessella: Abingdon, UK 10. Oxford Technologies: Abingdon, UK 11. Arcadis: London, UK 12. CEA Saclay: Saclay, France 13. NI France: Nanterre, France 14. ECRIN: Paris, France 15. EADS: Paris, France 16. ITER IO: Cadarache, France 17. CEA Cadarache: Cadarache, France 18. Bertin Technologies: Aix-en-Provence, France 19. Intermodalics: Leuven, Belgium 20. ITER-NL: Eindhoven, Netherlands 21. ESS: Lund, Sweden 22. NAT: Bonn, Germany

23. EICSYS: Hamburg, Germany 24. MP-IPP: Garching, Germany 25. DMCS-TUL: Lodz, Poland 26. Wigner RCP: Budapest, Hungary 27. INFN-LNL: Legnaro, Italy 28. Consorzio RFX: Padova, Italy 29. ENEA Brasimone: Brasimone, Italy 30. ENEA Frascati: Frascati, Italy 31. Vitrociset: Rome, Italy 32. Cosylab: Ljubljana, Sloveni 33. NIIEFA: Saint Petersburg, Russi 34. IOFFE-RF: Saint Petersburg, Russia 35. ITER-Russia: Moscow, Russia 36. MIT: Cambridge, USA 37. Carcassi LLC: Ann Arbor, USA 38. PPPL: Princeton, USA 39. HDF Group: Champaign, USA 40. ITER-US: Oak Ridge, USA 41. General Atomics: San Diego, USA 42. nHance: Lynchburg, USA 43. MOBILS: Seoul, Korea

4. Dawonsys: Siheung, K 45. NFRI: Daejeon, Korea 46. KSTAR: Daejeon, Korea 47. KAERI: Daejeon, Korea 48. IFMIF: Obuchi, Japan 49. JAEA: Tokaimura, Japan 0. A-Tech: Tokaimura, Japan 51. Toshiba: Yokohama, Japan 52. NIFS: Toki, Japan 53. MHI: Kobe, Japan 54. IPP: Hefei, China 55. RXPE: Anshan, China 56. ITER-China: Suzhou, China 57. HUST: Wuhan, China 58. SWIP: Chengdu, China 59. ITER-India: Gandhinagar, India 60. IPR: Gandhinagar, India 61. OSPL: Ahmedabad, India 62. TCS: Pune. India 63. Siemens India: Thane, India 64. Actemium India: Bangalore, India

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The software suite for supporting plant system commissioning, tokamak operation and plasma experiments by delivering the following tools;

- Support of plant I&C test & commissioning,
 Configuration Editor
- Pulse configuration, validation & verification,
 'PSPS'
- Supervision & Automation, 'SUP & AUTO'
- Real-time Feedback Control, 'PCS' on 'RTF'
- Data Access and Services, 'UDA' 1st implementation of UDA in service for plant commissioning
- Remote participation, 'ORG/ODG'

Operation Application System



CODAC Tools for Diagnostic I&C

Localization in the Production System



ITER Real-Time Framework



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Remote Participation (RP)



ITER Data System

ITER Data Types

- PON Data: EPICS traffic, conventional control/monitoring data, 25-50MB/s, archiving in RDB
- DAN Data : data with high throughput (scientific data), a few MB/s to 50GB/s, archiving to HDF5 file

Data Access Workflow - POZ ("small POZ")

Data Access Workflow - XPOZ



Plugins to various existing vizualisation tools: CSS databrowser (for continuous data), MDS+ Jscope, Matlab, Uda-itool (Python/Matplotlib), ThermaVip

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ITER Data System

Implementing Data Service for Plant System Commissioning

- Complete 1st implementation of UDA (Unified Data Access) at IT for plant data service, 1st client is UTIL connected to B36 TCR. Plant commissioning data backed up in a storage at IT
- Working on the design of ITER Data System alongside Remote Participation in terms of infrastructure (with IT) : data evolution, data center & disaster center, security, etc



Temporary Solutions for Integration and Commissioning

TCR (Temporary Control Room)

- To allow integration of plant I&Cs before the availability of B71N
 - Temporary central services and temporary control rooms in strategic buildings
 - Included plant configuration, data archiving, alarm handling, logging, HMI, gateway and data access together with operator terminals
 - 1st TCR B36 delivered in May-2018 for UTIL-HV and B36 BMS SAT and commissioning

T-MCR (Temporary Main Control Room)

- Functions
 - Supervision and monitoring : at least, 6 plant systems in operation until 2023
 - Plant commissioning and testing
 - Individual and/or multiple plant systems commissioning
 - Remote Participation
 - Tests with multiple DAs on-going and under planning (RF-DA,QST in JA, GA, others)
 - Operator Training
 - Plant simulator
 - Construction complete by end of May 2019

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Delivery of TCRs



Architecture of TCR



B36 and SSEN SAT/Commissioning

Energization as seen from central data archive



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Control System Ready for Integrated Commissioning

Scientific Data Center (SDC), Disaster Recovery Backup, High-Performance Computing under design

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