NEWS from ITER Controls

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A Status Report

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Outline

- Progress of the ITER project
- Major challenges for the ITER control system
  - Standards
  - Control system framework
- Architecture
- Some numbers
- Technology decisions taken in the last two years
- Some pilot projects
- Conclusions

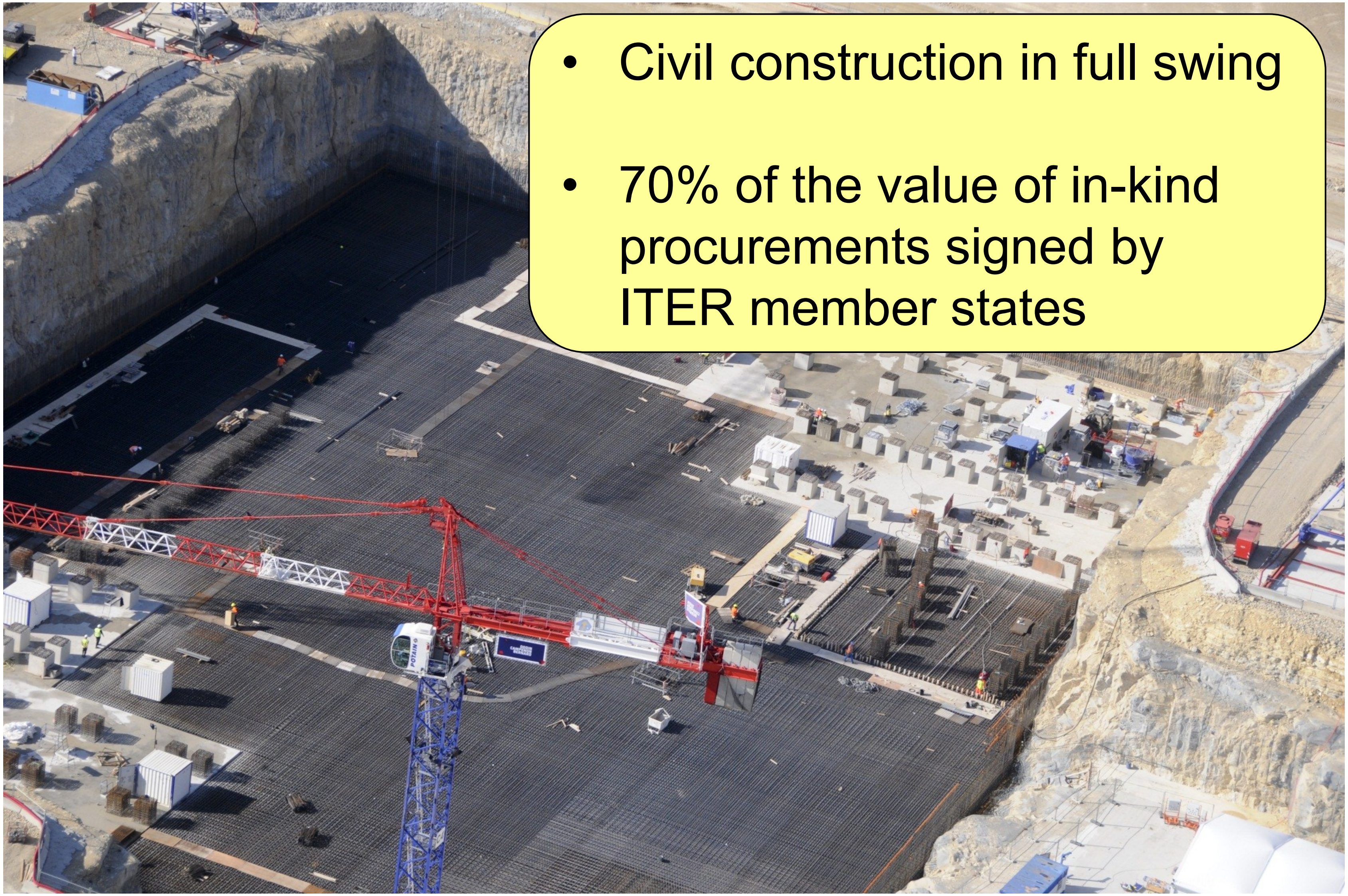
http://www.iter.org/org/team/chd/cid/codac

ITER platform September 2011

ITER office building September 2011

Poloidal Field Coil Winding Building September 2011

Tokamak foundation and seismic pit September 2011



- Civil construction in full swing
- 70% of the value of in-kind procurements signed by ITER member states

Main challenge for the ITER control system

- The components, or plant systems, of ITER are procured “in-kind” from the seven ITER member states. These components come with their own local control system.
- The value of the “in-kind” procurement is more than 90% of the total project cost.
- The central control system is one of the few example of “in-fund” procurement, i.e. under responsibility of ITER Organization in Cadarache. The central control system must integrate all local control systems to allow integrated and automated operation of the full ITER plant.

Main challenge is integration

MOCAULT02, Dave Gurd, after lunch

Plant Control Design Handbook

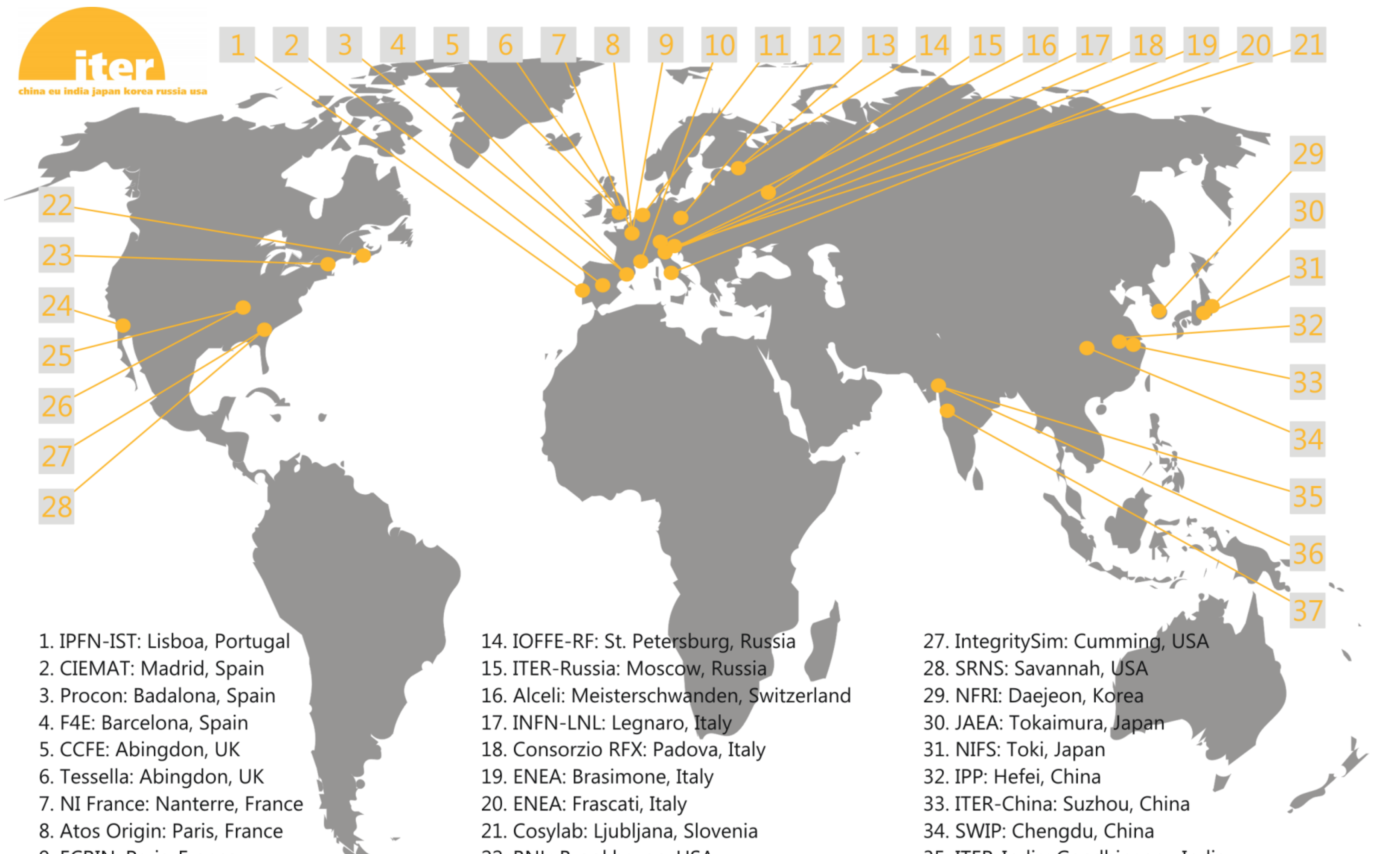
- Plant Control Design Handbook (PCDH) is a set of documents that defines mandatory rules, recommended guidelines, methodologies and catalogue of supported products.
- It is contractually binding to all in-kind procurements.
- Latest edition was issued in February 2011

CODAC Core System

- CODAC Core System is a control system framework that implements the standards defined in PCDH and guarantees that the local control system can be integrated into the central system.
- CODAC Core System v2 was released in February 2011 and v3 is due in February 2012.
- CODAC Core System is given to the developers of ITER local control system and provides a development environment

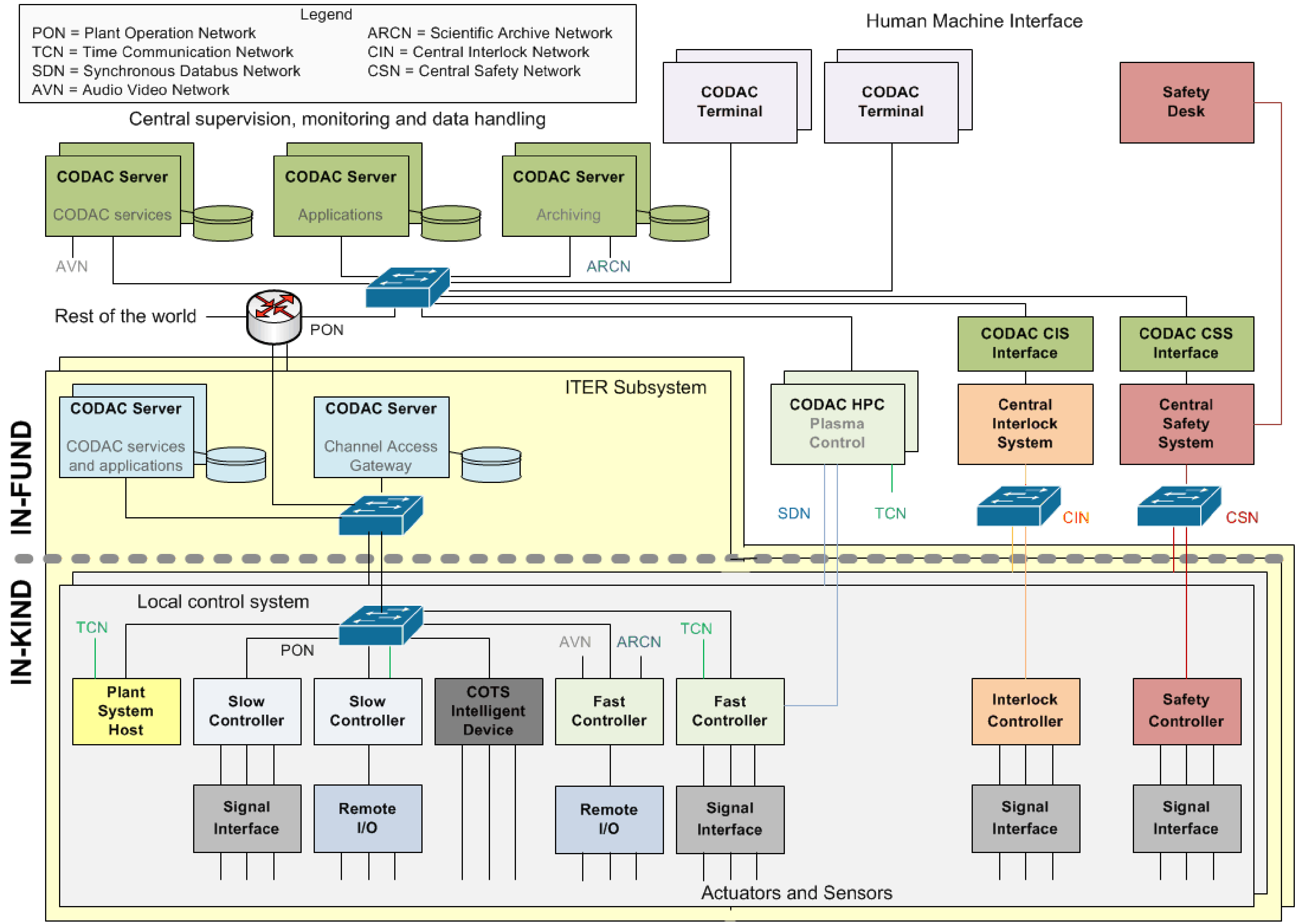
MOPKS029, Di Maio, poster

CODAC Core System registered user organizations



1. IPFN-IST: Lisboa, Portugal
2. CIEMAT: Madrid, Spain
3. Procon: Badalona, Spain
4. F4E: Barcelona, Spain
5. CCFE: Abingdon, UK
6. Tessella: Abingdon, UK
7. NI France: Nanterre, France
8. Atos Origin: Paris, France
9. ECRIN: Paris, France
10. ITER IO: Cadarache, France
11. ITER-NL: Eindhoven, Netherlands
12. DMCS-TUL: Lodz, Poland
13. NIIEFA: St.Petersburg, Russia
14. IOFFE-RF: St. Petersburg, Russia
15. ITER-Russia: Moscow, Russia
16. Alceli: Meisterschwanden, Switzerland
17. INFN-LNL: Legnaro, Italy
18. Consorzio RFX: Padova, Italy
19. ENEA: Brasimone, Italy
20. ENEA: Frascati, Italy
21. Cosylab: Ljubljana, Slovenia
22. BNL: Brookhaven, USA
23. PPPL: Princeton, USA
24. General Atomics: San Diego, USA
25. ITER-U.S.A.: Oak Ridge, USA
26. ORNL: Oak Ridge, USA
27. IntegritySim: Cumming, USA
28. SRNS: Savannah, USA
29. NFRI: Daejeon, Korea
30. JAEA: Tokaimura, Japan
31. NIFS: Toki, Japan
32. IPP: Hefei, China
33. ITER-China: Suzhou, China
34. SWIP: Chengdu, China
35. ITER-India: Gandhinagar, India
36. IPR: Gandhinagar, India
37. TCS: Pune, India

Architecture



ITER controls main parameters

Parameter	Value
Total number of computers	1.000
Total number of signals (wires)	100.000
Total number of process variables	1.000.000
Total number of active operator screens	100
Update rate per screen (200 PVs)	5 Hz
Maximum sustained data flow on PON	50 MB/s
Total engineering archive rate	5 MB/s
Total scientific archive rate (initial)	1 GB/s
Total scientific archive rate (final)	20 GB/s
Total scientific archive capacity	Few PB/year
Accuracy of time synchronization	50 ns RMS
Number of nodes on SDN	100
Maximum latency asynchronous events	1 ms
Maximum latency sensor to actuator (SDN)	500 µs
Maximum jitter sensor to actuator (SDN)	50 µs
Maximum sustained data flow on SDN	25 MB/s

Selected Technologies 1

EPICS

- Control system framework implementing communication, live database etc.
- Selected because open source, proven track record and successful deployment in almost all ITER member states including Tokamaks (KSTAR, NSTX)

Red Hat Enterprise Linux 64b and MRG-R

- Market leader commercial provider of Linux providing the longest support
- Real-time extensions in MRG-R

Control System Studio

- Eclipse based collection of tools running on top of EPICS including BOY (Best ever Operating Interface Yet), BEAST (Best Ever Alarm System Toolkit), BEAUTY (Best Ever Archive Utility Yet) and SNL Editor

Selected Technologies 2

Configuration

MOMAU005, Stepanov, mini oral

- SDD Toolkit (Self Description Data)
- In-house development to unify all configuration data.
- Capture design data (process variables, input/output configuration, alarm definition etc.) in a relational database (postgreSQL). Auto-generate configuration files (EPICS db files, BEAST and BEAUTY configuration files, BOY engineering screens etc.)
- Using Hibernate, Spring, Eclipse and web technologies

Development Environment and Distribution

WEPMU040, Zagar, poster

- Subversion for version control
- Apache Maven as build tool
- Red Hat package management (RPM) for packaging and dependencies management
- Bugzilla for issue tracking
- Jenkins for continuous integration and automated tests
- Red Hat Network Satellite Server for software distribution

Selected Technologies 3

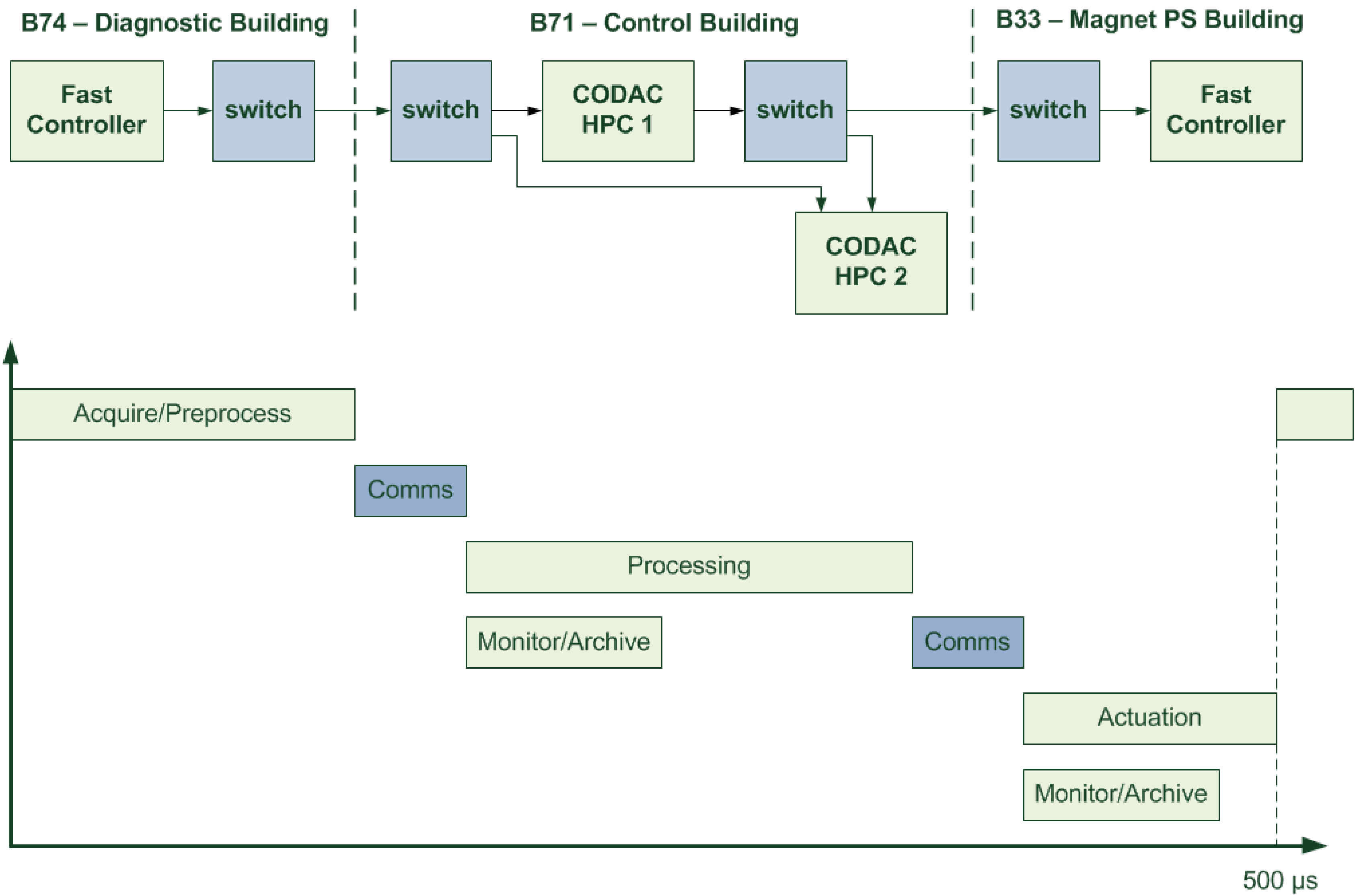
PTPv2 (IEEE 1588-2008) for time synchronization (TCN)

- Driving requirement is off-line correlation of different diagnostics data using time stamps. 50 ns RMS.
- Matching IEEE 1588-2008 spec.
- Proven with Meinberg and Symmetricom grand master clocks, IEEE 1588-2008 compatible switches (CISCO IE3000 and Hirschmann MAR1040) and NI PXI 6682 timing receiver

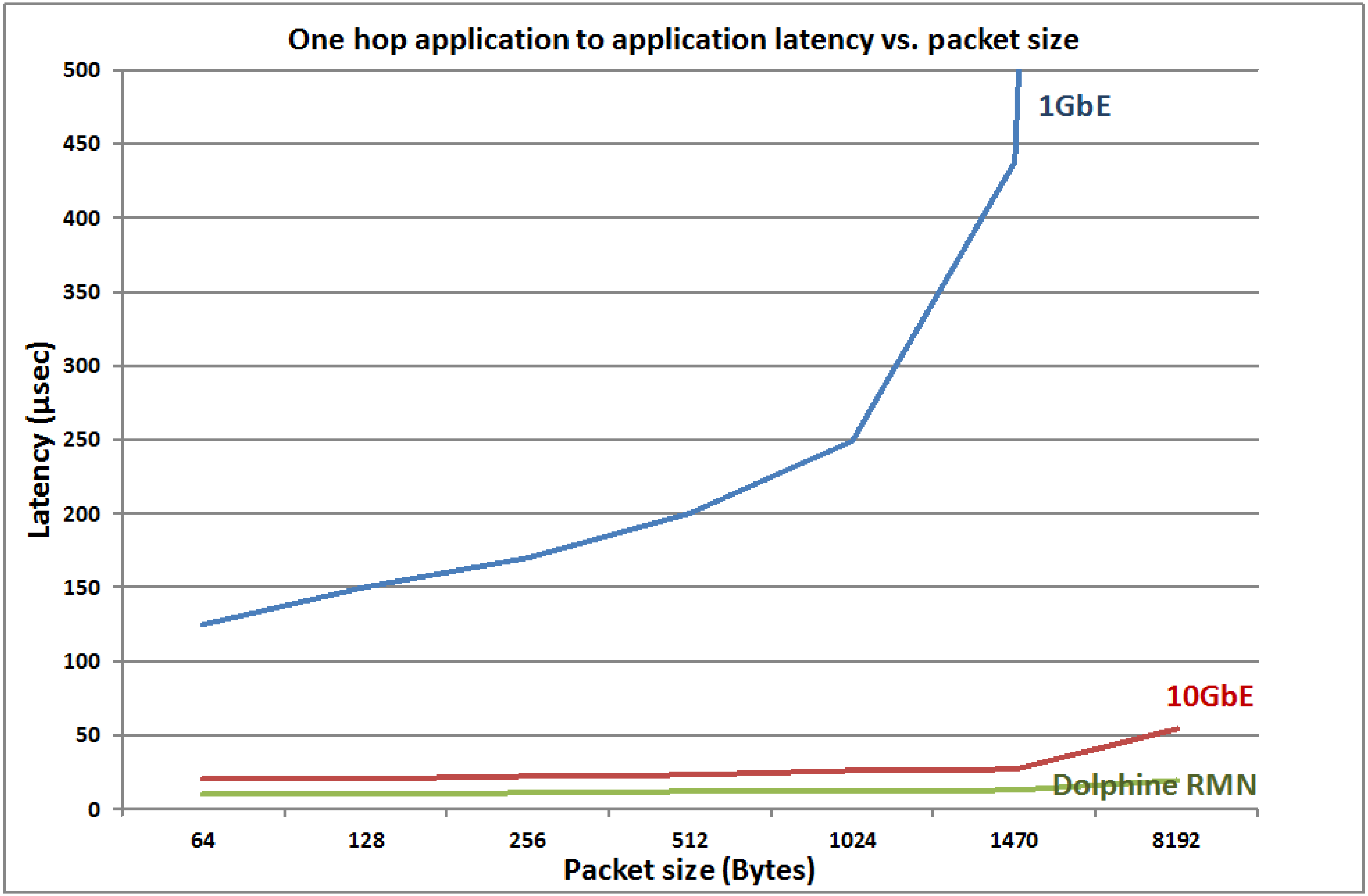
10 GbE multicast UDP for real-time network (SDN)

- Driving requirement is distributed feedback loops in 2 kHz range including acquisition, control law, actuation (two hops).
- Communication latency maximum 10% (one hop 25 μsec).
- Traditionally solved by reflective memory technologies.
- However, 10GbE UDP multicast and cut-through switches is in the same performance region and have a brighter future.

Data flow and timing for simple control loop



Benchmark of communication latency

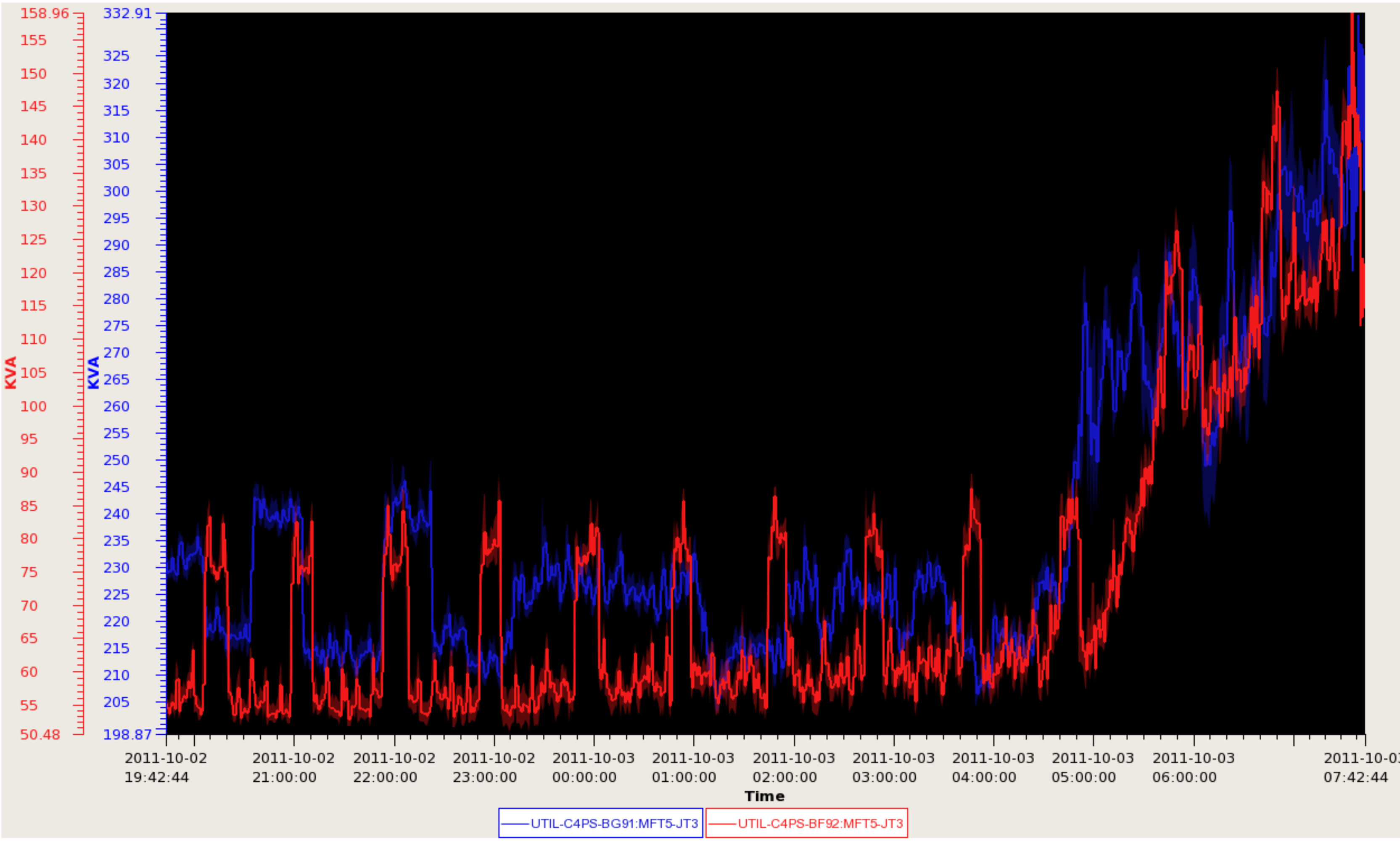


Pilot Projects

Pilot projects have been initiated to confirm technology selections, to prove feasibility of implementing ITER controls using the selected approaches and to identify weak points subject for improvements.

- Monitoring of ITER building site 15kV power substation
- Ion source of neutral beam test bed facility in Padova
- Control of Frascati Tokamak Upgrade (FSU) flywheel generator
- Fuelling control and closed-loop density control at KSTAR, Korea

BEAUTY screen shot: trending of ITER site power consumption



Conclusions

- Design and implementation of the ITER control system is progressing according to plan
- Many technology decisions have been taken during the last two years

Concluding remark

The success or failure of the project will be determined by the acceptance of this work by the ITER member states responsible for providing in-kind local control systems.