Review of Control Resources for J-PARC Accelerators

• 1) J-PARC Overview
  – Accelerators and 6-year operation
• 2) Control Resources
  – CPU, Network, Disk
• Summary

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J-PARC Facility
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Materials and Life Science Experimental Facility (MLF)

Hadron Beam Facility (HD)

Neutrino to Kamioka (NU)

Linac (330m)

3 GeV RCS (25 Hz, 1MW)

30 GeV MR (0.75 MW)

J-PARC = Japan Proton Accelerator Research Complex
Beam Power History (RCS to MLF)

Stopped by Earthquake

200 kW

Operation for beam delivery to the T2K experiment before summer 2012 was finished on June 9, accumulated $\sim 3 \times 10^{20}$ POT.
Recovery from the Earthquake (on 09.Dec.2011)

Remarkably fast recovery

14:00 Beam went throughout the Linac at 3 MeV with RFQ acceleration.

09:30 Key was on by Nagamiya-san, the Project Leader.

Nov. 2006. The first beam was on at the Linac.
J-PARC is still growing facility

• Beam Performances
  • Design/ LI: 400MeV, RCS: 1MW, MR: 750kW
  • 2012.11/ LI: 181MeV, RCS: 0.3MW, MR: 200kW

• Re-scheduled plan for next 5 years
  – Reach to the design goals in 2017
    • 2013/LI  181-> 400MeV upgrade
    • 2013/LI  IS,RFQ 20mA->50mA
    • 2014/MR replace Magnet Power-supplies
      – And so on ..
  • (1 year delay due to the earthquake in 2011)
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Control System Resources
J-PARC Control – a quick view

• Control by 2 groups
  – JAEA and KEK: 2 control groups
    • JAEA is in charge of Linac and RCS, KEK is MR
  – Both use EPICS, single control room

• Scale of control system
  – EPICS IOCs
    • LI: ~120, RCS: ~30, MR: ~140
  – Number of Applications
    • ~270 in the MR launcher (in 2011)
Control Resources

• Control Resources (for MR, partly for all Accl.s)
  – Focuses on: CPU, Network, Disk
    • They were introduced in 2006-2007
    • 6-year operation
  – Now, good chance to review
  – Troubles during 6-year operation are also shown (to share experiences with you)
**J-PARC CS is growing everyday**

- **Operation**
- **Research**
- **Control System**
  - Add new, modify, replace, ..

- Seeking better operation parameters by research activities

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**1-yr trend**
**MR data archive in 2009**

- **Disk**
  - Disk Server - Traffic
  - Disk

- **CPU**

- **Net**
  - Archiver Server - Traffic
  - Net
CPU – Blade-type server

Blade server (8 blades in)

2007

IBM Blade Center

HS20/21/22

Introduced for MR operation

Blade server (29 blades in 2 racks)

2012

Simulation server (10 customized PCs)

**CPU - Discussion**

**Blade-type server**
- Increase CPU power by adding new blades => **Flexible upgrade**, it is suitable for us
  - For MR loss simulation, we needed customized spec (huge memory, so many cores, ..)
  - => introduced non-blade type machines since 2010

**Re-organize servers with Virtual OS**
- In 2008, 1 server (i.e RDB, ldap, dhcp,) = 1 blade
- In 2012, multiple servers = 1 blade with high spec+large memory
  - Using Virtual OS support (KVM) of Scientific Linux 6
  - Expect easier management server-hardware
**CPU - Trouble**

- **Troubles**
  - no serious trouble
  - A few board stops since 2007
  - Rescue needed when new server rack installed

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Help me, can not escape by myself

Network – Redundant system

• Quick view
  – First install for Linac was in 2004 (MR was 2006)
  – Intelligent core loops to ensure high redundancy
  – Edge Switch/ LI: 80, RCS: 24, MR: 10, CCR: 10
  – Logical VLAN/ sub-networks localize traffic
    li(10.16), rcs(10.32), mr(10.64), ccr(10.8), ..

• Replace to New models
  – Bandwidth/ 1Gbps -> 10Gbps
Network – Core Replace (2011)

Before
(Core 6808)

After
(Core 8906)

Extreme Black-diamond and Summit

Before
(edge 6804)

After
(edge X480-48t x 6)

Before
(edge 6804)
Network – Traffic during Beam-run

Observed network traffic
between MR buildings and CER (Computer room)
Jun. 2012

Bandwidth are occupied by
many (20-30) waveform data (100ks/s x (2-5) seconds)

Network - Troubles

• Edge Switch faults
  – Switch in NU/ 5 times during 20010-2012
    • => Check power-line quality – no fault after 2012.4
  – Switch for CPU&Disk/ once in 2011.10
    • => Replaced to a new model (2011.11)

• Trouble by miss-maintenance
  – A network camera sent broadcast storm (2012.5)
    • Radiation damage in accelerator tunnel
    • => auto port-disable function against abnormal broadcast (2012,summer)
  – Air-cooling unit fault caused network stop (2011.11)
    • One of two units stopped -> room temperature rise ->
      network switches stopped (redundancy didn’t work)
    • => add third cooling unit (not yet)
Disk – Dedicated storage system

Storage disk (9TB)
IBM N3600 (NetApp)
2008

Storage disk (28TB)
IBM N3600 (NetApp)
2012

+Storage disk (30TB)
IBM X3630 (x2)
+Storage disk (11TB)
StoreNext (for LI, RCS)

Disk - Discussion

• Statistics
  – NFS client
    • 40 servers, 150 IOCs, 30 terminals
  – Stored data amount
    • ~50GB/day in Neutrino-mode operation
    • ~110GB/day in Hadron-mode operation
    • Roughly agrees observed network traffic

Long-term maintenance of large data is an open issue

Cadump = waveform_data
Started at 2009-end
**Disk - Trouble**

- **Disk unit fault**
  - a few times in a year (recovered by RAID system)
  - Fault rate seems increasing year by year

- **In 2012.02, a big trouble**
  - Maintenance during beam operation caused system hang-up
    - Maintenance = remove old data-files (~TB order)
    - removing large files made internal CPU very busy
  - => discuss new disk for large data (in 2013)
One more before Summary
Improve after the 2011 Earthquake

On 2011.03.11
J-PARC Control Room

Mid-2011 we add Anti-vibration rubber
Summary
Summary

- **J-PARC Accelerator Facility**
  - Still growing toward the design goal
  - Recovery from the earthquake was made within 1-year

- **Control Resources are reviewed**
  - **CPU** – blade-type servers
    - Blade-type enabled us flexible upgrade
  - **Network** – a redundant system
    - Replaced in 2011-2012
    - Troubles by switch fault and miss-maintenance
  - **Disk** – dedicated disk system
    - In 2012 ~70TB
    - Looking for an idea for long-term large-data storage