The DESY MTCA4 AMC Test Stand.

Status, Problems and Improvements

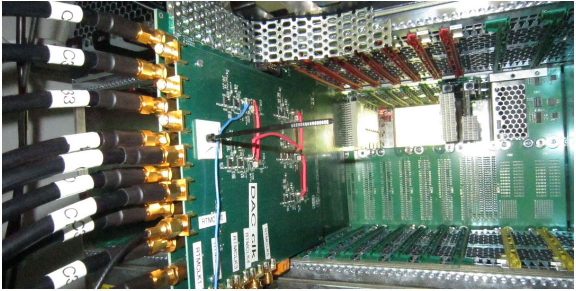
Martin Killenberg
Nadeem Shehzad, Przemyslaw Kownacki

12th June 2015

MSK Collaboration Workshop 2015, Warsaw, Poland

Why Are There So Many Problems?

Typical example: The rear connector. It is working, but. . .



- Wrong form factor
  - Cannot be fixed
    → Fiddling to insert AMC
  - Too long, cables pull it down
    → tilts Zone 3 connector
  - Slightly too small
    → slips out of the rails

- No proper grounding
  - Crate management disturbed when connected
  - Discharges
- Piggy-back board just plugged
  → gets loose, fragile clock signals

This is "proof of concept prototype" quality.
Not suitable for a production system!

Getting To Know the System

- Checkout of the trunk
  - Takes very long
  - All test stands and the framework in the trunk
  - More than 1 GB of data
    (2.2 MB Matlab scripts + 60 kB shell scripts)

- No tags/releases

- No software architecture diagrams
- Few requirements documents
- No design documents
- Scattered information

⇒ difficult to understand and maintain

Improvements

- Tags of relevant directories only
- Software flow charts
- Revived Redmine (not used for two years)
- Wiki page with trouble shooting

Software Design

- System lacks an overall design
- Reusing code: copy and paste
- Library and utility structuring is not applied
- External tools mixed with test stand code in the repository
- Coding is highly coupled

Maintenance and future enhancements are very difficult

Future projects

- Create layout of software design before starting to code
- Define external tools and interfaces
- Proper (Debian) packaging for compiled components
- Common parts → tool kits and libraries

Two Operating Systems

Linux on MTCA CPU

- Access AMC
- Programme FPGA

Windows PC

- Control RF generators and power supplies
- Control of RF switch box (custom)

Implications of having two OS

- Architecture is much more complex
- Maintain two different OS
- Custom devices on both OS → Needs experts for both OS
- Completely underestimated: Client/server communication

How it was implemented

- Send integer to server
- Sleep
- No feedback, just continue

Correct implementation

- Protocol: command↔response
- Send command
- Wait for response with timeout
- Evaluate response: error handling

Improvements

- Response for all commands
- Error handling

Still pending: remove all sleeps

Software Installation

Windows

- One single checkout is used for development, debugging and production

Linux

- Unversioned copy of some state of the trunk
- Local modifications
- Hard coded links to tools/scripts in other user directories

Improvements

- Removed dependencies on external user directories
- Self-contained directories in svn
- Checkouts of the tag for production
- Checkouts of the trunk for development

System Behaviour

- Little or no feedback, especially for errors
- Procedure cannot be interrupted properly
- Designed mainly as expert tool
- Manual written as “reminder for expert” without explanation

Improvements

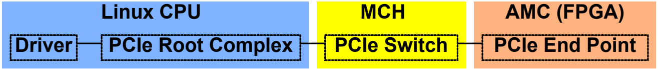
- Typing commands → one click
- All steps have feedback evaluation with error handling
- Pop-up windows with error reports and hints for solutions
- Test procedure is stopped in case of errors
- Manual updated + provides background information

Driver and PCIe Hotplug

Problems

- Frequent reboots because PCIe hangs (hotplug does not work)
- Driver is not available after kernel update

- Script to manually install driver after failure to load
- Kernel 3.02 uses fake hotplug (PCIe switch is not turned off)
- Wrong PCIe hotplug procedure when programming FPGA



Wrong

```
$ programFPGA
$ pcie_downup 6
```

Correct

```
$ pcie_down 6
$ programFPGA
$ pcie_down 6
```

Improvements

- Driver update with working DKMS
- Kernel 3.13 which supports real hotplug
- Fixed PCIe hotplug procedure

Solving Problems

Problem

You cannot run two tests in a row from the GUI

Solution

- Close GUI after each test
- Press <Ctrl><C>
- `>> clear all`
- Get new test stand GUI instance
- `>> teststand.start`

Solving Problems

Problem

You cannot run two tests in a row from the GUI

~~Solution~~ Dirty workaround

- Close GUI after each test
- Press <Ctrl><C>
- `>> clear all`
- Get new test stand GUI instance
- `>> teststand.start`

"Code Smells"

Find what is causing the problem and fix it!
Do not just try to work around the symptoms.

A Typical Day At The Test Stand After The Stability Improvements

- Starting, 13 board to be tested
- As usual, the first board works
- Test stand fails on the 2nd board
  Problem: Rear board needs delicate expert procedure 0.5 h downtime

A Typical Day At The Test Stand After The Stability Improvements

- Starting, 13 board to be tested
- As usual, the first board works
- Test stand fails on the 2nd board
  Problem: Rear board needs delicate expert procedure 0.5 h downtime
- Failure after 3 boards: always the same board ID
  Power supply broken, does not report "board removed"
  (due to discharge?) 1.5 h downtime

A Typical Day At The Test Stand After The Stability Improvements

- Starting, 13 board to be tested
- As usual, the first board works
- Test stand fails on the 2nd board

  Problem: Rear board needs delicate expert procedure 0.5 h downtime
- Failure after 3 boards: always the same board ID

  Power supply broken, does not report "board removed"
  (due to discharge?) 1.5 h downtime
- Waiting 2 h for a Matlab license

A Typical Day At The Test Stand After The Stability Improvements

- Starting, 13 board to be tested
- As usual, the first board works
- Test stand fails on the 2nd board
  Problem: Rear board needs delicate expert procedure 0.5 h downtime
- Failure after 3 boards: always the same board ID
  Power supply broken, does not report “board removed”
  (due to discharge?) 1.5 h downtime
- Waiting 2 h for a Matlab license
- 9 board in a row successfully tested (all time record!)

A Typical Day At The Test Stand After The Stability Improvements

- Starting, 13 board to be tested
- As usual, the first board works
- Test stand fails on the 2nd board

  Problem: Rear board needs delicate expert procedure 0.5 h downtime
- Failure after 3 boards: always the same board ID

  Power supply broken, does not report "board removed"
  (due to discharge?) 1.5 h downtime
- Waiting 2 h for a Matlab license
- 9 board in a row successfully tested (all time record!)
- Failure 10th board: RTM clock fails → retry

A Typical Day At The Test Stand After The Stability Improvements

- Starting, 13 board to be tested
- As usual, the first board works
- Test stand fails on the 2nd board
  Problem: Rear board needs delicate expert procedure 0.5 h downtime
- Failure after 3 boards: always the same board ID
  Power supply broken, does not report "board removed"
  (due to discharge?) 1.5 h downtime
- Waiting 2 h for a Matlab license
- 9 board in a row successfully tested (all time record!)
- Failure 10th board: RTM clock fails → retry
- New failure, same board: Programming FPGA failed
  PCIe completely hung up, probably due to old programming tool
  → Reboot the whole test stand 0.5 h downtime

A Typical Day At The Test Stand After The Stability Improvements

- Starting, 13 board to be tested
- As usual, the first board works
- Test stand fails on the 2nd board
  Problem: Rear board needs delicate expert procedure 0.5 h downtime
- Failure after 3 boards: always the same board ID
  Power supply broken, does not report "board removed"
  (due to discharge?) 1.5 h downtime
- Waiting 2 h for a Matlab license
- 9 board in a row successfully tested (all time record!)
- Failure 10th board: RTM clock fails → retry
- New failure, same board: Programming FPGA failed
  PCIe completely hung up, probably due to old programming tool
  → Reboot the whole test stand 0.5 h downtime
- RTM clock still fails
  → Piggy-Back board was loose

A Typical Day At The Test Stand After The Stability Improvements

- Starting, 13 board to be tested
- As usual, the first board works
- Test stand fails on the 2nd board
  Problem: Rear board needs delicate expert procedure 0.5 h downtime
- Failure after 3 boards: always the same board ID
  Power supply broken, does not report “board removed”
  (due to discharge?) 1.5 h downtime
- Waiting 2 h for a Matlab license
- 9 board in a row successfully tested (all time record!)
- Failure 10th board: RTM clock fails → retry
- New failure, same board: Programming FPGA failed
  PCIe completely hung up, probably due to old programming tool
  → Reboot the whole test stand 0.5 h downtime
- RTM clock still fails
  → Piggy-Back board was loose

13 boards tested, 4.5 h downtime, 5 failed test runs due to test stand failure

Summary

Status

Operational, but still fragile

- Significant stability improvements
- Improved usability

- Time spend in improvements
  - Nadeem: 6 Weeks
  - Martin: 4 Weeks
  - Przemek: 4 Weeks

What we learned: The test stand is a production system

- Robust (error handling)
- User friendly
- Needs design and planning
- Quality takes time
- Developers need training (svn, Linux, PCIe, MTCA.4)
- Project needs management and guidance
- Solve problems, not symptoms

Room for improvements

- Improve client-server handshake
- New firmware programming tool
- Switch to MTCA4U
  - Packaged external lib
  - Stability improved drivers
  - Matlab remote tools
- Get rid of Linux server