The DESY MTCA4 AMC Test Stand
Status, Problems and Improvements

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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

<table>
<thead>
<tr>
<th>Linux on MTCA CPU</th>
<th>Windows PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access AMC</td>
<td>Control RF generators and power supplies</td>
</tr>
<tr>
<td>Programme FPGA</td>
<td>Control of RF switch box (custom)</td>
</tr>
</tbody>
</table>

### 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

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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 $\rightarrow$ 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

**Diagram:**

```
Linux CPU    PCIe Root Complex    MCH    PCIe Switch    AMC (FPGA)    PCIe End Point
```

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

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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
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Solution Dirty workaround
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“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**

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
  → 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
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## 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