

DOM Hub Communications Interface Testing Procedure

Version 0.2

For use with dor-driver release 1.5

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John Jacobsen

John Jacobsen IT Services
for LBNL and the IceCube Collaboration

John Jacobsen
Information Technology Services



1420 W. Edgewater Ave., Suite 3, Chicago, IL 60660
Phone: +1 (773) 769 0522 FAX: +1 (775) 254 5992
E-mail: john@johnj.com
Web Site: it.johnj.com

This document can also be found at <ftp://it.johnj.com/pub/icecube/domhub/driver/doc>

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Introduction

The test procedure described here represents an integration test of the DOM Hub, exercising the main communications and control functions of the DOR communications interface. It can uncover problems in the DOR driver, firmware, or hardware, or in the DOMs themselves.

While the test does require working DOMs to be attached to the DOM Hub, many DOM functions which are to be tested by the Simple Test Framework (STF) tests are not included here. Also not included is the Java-based DOM Hub application, which provides the higher-level interface of the Hub to applications elsewhere on the network.

During development of the DOR driver and firmware we found several stages at which communications problems could occur. Errors could occur immediately, intermittently, or rarely (leading to failures after exercising the system for a long time). The test procedure is designed to catch the immediate problems right away, and, if those are absent, to launch a longer-term test of communications stability. The long-term test allows one to establish the stability of the system, confidence in which increases the longer the test is allowed to continue.

This document outlines the first version of the test procedure. Comments on the test procedure or the document are welcome. Documentation specifying the purpose, function and design of the DOR driver and firmware can be found in Refs. 1 and 2.

Test Environment

The test requires the following preconditions:

- 1) A working DOM Hub with DOR driver installed, of release 1.5 or greater. Driver must be running, and the driver utilities must be installed (see Ref. 1).
- 2) One or more DOR cards installed. DOR flash programmed with FPGA design appropriate to your driver release (005d or higher). DOR FPGA loaded with this design.
- 3) One or more DOMs plugged into the DOR card. DOM CPLD and flash programmed appropriately (recent or latest Iceboot).
- 4) Power supply attached to the DOR power distribution bus; power supply on, with correct voltage and current limits.

Test Procedure

The test consists of six steps:

- 1) Create a file with inputs specifying which DOMs are to be exercised during the test
- 2) Run the test script
- 3) Verify that the short term tests completed successfully

- 4) Monitor the long term test
- 5) Terminate the long term test when enough time has elapsed or an error has occurred
- 6) Power off the DOMs

Creating the Test Input File

The test inputs specify which DOM Hub channels you want to exercise. The input file should be called `st.in` or given another name and passed as an argument to the test script.

Example `st.in`:

```
# This is an example st.in file, showing
# four DOMs on card 1, wire pairs 0 and 1.
# Comments are ok.
# First number is card ID, second is wire pair num., third is A or B:
1 0 A
1 0 B
1 1 A
1 1 B
DONE
```

Run the Test Script

To run the script, run `/usr/local/bin/stagedtests.pl`. If you called your input file something other than `st.in`, supply that as an argument. You may want to create your input file and run your test in a directory specific to that test session; you can then return to that directory later in order to monitor the long test.

Verify Short Term Tests

The program will proceed through the list of short term tests described below. The user has the option of skipping a particular stage of the test, or automatically performing all the operations. A sample session is given below.

If the short term tests have been passed, the long term communications tests will begin.

Monitor Long Term Tests

Once the long term communications tests have started, and while the main test script is still running, the user can repeatedly monitor the progress of the communications tests by typing the “l” key. When the user quits the test script, the tests continue to run in the background. The user can monitor the tests again at any time:

```
% /usr/local/bin/stagedtests.pl -moni
```

IMPORTANT: The user should be in the same directory he/she was when the test script was started!

The monitoring operation simply displays the last line of the echo test and time calibration output files for each channel. If all is well, statistics for each channel will be shown.

The example `st.in` given above would generate the following output files:

```
echo_results_clw0dA.out
echo_results_clw0dB.out
echo_results_clw1dA.out
echo_results_clw1dB.out
tcal_results_clw0dA.out
tcal_results_clw0dB.out
tcal_results_clw1dA.out
tcal_results_clw1dB.out
```

The following output shows a long term communications test running with no errors (so far):

```
1 0 A: Good ID (00013c629259).
1 0 B: Good ID (00013c62a737).
1 1 A: Good ID (00073c71d2ef).
1 1 B: Good ID (00013c63b045).
/dev/dhclw0dA: 176000 msgs (last 256B, 67.26 MB tot, 1825 sec, 37.74 kB/sec, avg_rd_retries 2
/dev/dhclw0dB: 159000 msgs (last 128B, 60.92 MB tot, 1825 sec, 34.18 kB/sec, avg_rd_retries 2
/dev/dhclw1dA: 175000 msgs (last 95B, 67.03 MB tot, 1823 sec, 37.65 kB/sec, avg_rd_retries 2
/dev/dhclw1dB: 159000 msgs (last 182B, 60.88 MB tot, 1822 sec, 34.22 kB/sec, avg_rd_retries 2
/proc/driver/domhub/card1/pair0/domA/tcalib: 133000 successfull time calibrations.
/proc/driver/domhub/card1/pair0/domB/tcalib: 133000 successfull time calibrations.
/proc/driver/domhub/card1/pair1/domA/tcalib: 133000 successfull time calibrations.
/proc/driver/domhub/card1/pair1/domB/tcalib: 133000 successfull time calibrations.
```

There are three sets of lines. The first four consist of the DOM IDs, followed by the communications statistics, followed by the time calibration statistics. Anything deviating from this format indicates an error.

Terminate Long Term Tests

Once the user is satisfied that the long term tests have run long enough (or sees an error), he/she can stop them as follows:

```
% /usr/local/bin/stagedtests.pl -kill
```

or, alternatively,

```
% killall readwrite
% killall tcaltest
```

Power off the DOMs

The test leaves the DOMs powered on. To power off so that the DOMs can be safely disconnected,

```
% /usr/local/bin/off all
```

The DOMs can then be immediately disconnected or powered on and tested again.

Description of Short Term Tests

The short term test sequence verifies that the DOMs are communicating and that the basic control functions work. It also puts the DOMs in the correct state for the long term test.

Current sequence of operations:

- 1) Verify that the driver is running
- 2) Make sure that a long term test isn't already running. Allow the user to terminate test if it is.
- 3) Load input file. Verify that DOR cards are present for all requested channels.
- 4) Power off all modules.
- 5) Power on all modules. Make sure all requested DOMs are communicating.
- 6) Get and show DOM IDs.
- 7) Put the DOM boot program Iceboot in echo-back mode.
- 8) Make sure each DOM can echo a single packet.
- 9) Make sure a single time calibration can be performed on each DOM.
- 10) Start the long term test.

Description of the Long Term Test

The long term test exercises the two tasks which the DOR interface must perform continuously, namely time calibration and the exchange of messages with the DOMs. The long term test exercises these functions as intensively as possible, to best ascertain the stability and performance of the system.

Two programs are launched for each DOM. The first, `tcaltest`, performs time calibration requests and fetches time calibration data as quickly as possible. The resulting rate of calibrations, about 70 Hz, is much more extreme than the expected rate of 1/sec. The following requirements apply for a successful time calibration:

- 1) The driver successfully initiates time calibration and retrieves data.
- 2) The difference between received and transmitted DOR timestamp values is between 0 and 500 DOR clock counts.
- 3) The difference between received and transmitted DOM timestamp values is between 0 and 1000 DOM clock counts.
- 4) The waveform measured in the DOR card exceeds a threshold of 400 counts above baseline (defined as the average of the first four samples).
- 5) The waveform measured in the DOM exceeds a threshold of 500 counts above baseline (same definition).

Any failure of these requirements causes the time calibration job to terminate with an error condition.

The second program, `readwrite`, sends packets to the DOM and retrieves the echoed return packets as quickly as possible. Failure to read or write a packet, or any difference between sent and received packets is flagged

immediately in the output file. If such an event occurs, the test is considered to have failed. Packets are of variable lengths, distributed uniformly between 1 and 400 bytes.

The communications data rate is shown in the output of `readwrite`. This rate will be about 25% less than the maximum driver rate of 47 kB/sec due to the overhead of the intensive, concurrent time calibrations.

If there are N channels being tested, there are $2N$ processes running simultaneously on the dual-CPU DOM Hub. The multi-process nature of the test provides a thorough, asynchronous test of the driver which can help expose any race conditions in the code or the DOR firmware. Since the Hub must eventually support at least 60 channels, any significant processor load when running small numbers of channels should be seen as a cause for concern.

Note that if one of the $2N$ programs encounters an error, it will stop, but the other programs will keep running. To kill all the test programs, `stagetests.pl -kill`.

Problems which have caused the long term test to fail in the past have included: driver bugs, firmware bugs, faulty DOM hardware, and outdated DOM software / firmware. Channels passing the short term tests have at times failed the long term test after a matter of hours.

Example Test Session

In the session that follows, the user's choice is indicated in bold face. The user's path contains `/usr/local/bin`, which is the location of the test script.

```
% stagedtests.pl
DOR-driver testing script by John Jacobsen (john@johnj.com) for LBNL/IceCube.
Will test:
Card 1 pair 0 dom B.
Card 1 pair 1 dom B.
Card 1 pair 0 dom A.
Card 1 pair 1 dom A.
Firmware versions:
Driver $Revision: 1.124 $
/proc/driver/domhub/card1 -- 005d


[p]ower off modules (s)kip (A)ll (q)uit...
Switching off ALL modules...
power [o]n modules (s)kip (A)ll (q)uit...
Switching on ALL modules...
Card 1 Pair 0 DOM B is communicating
Card 1 Pair 1 DOM B is communicating
Card 1 Pair 0 DOM A is communicating
Card 1 Pair 1 DOM A is communicating
Show DOM (i)d numbers (s)kip (A)ll (q)uit...
1 0 A: Good ID (00013c629259).
1 0 B: Good ID (00013c62a737).
1 1 A: Good ID (00073c71d2ef).
1 1 B: Good ID (00013c63b045).
Put DOMs in echo [m]ode (s)kip (A)ll (q)uit...
Echo /dev/dhclw0dA ok.
Echo /dev/dhclw0dB ok.
Echo /dev/dhclw1dA ok.
Echo /dev/dhclw1dB ok.
[e]cho-test individual channels (1 msg) (s)kip (A)ll (q)uit...
/dev/dhclw0dA passes single-message echo test.
/dev/dhclw0dB passes single-message echo test.
/dev/dhclw1dA passes single-message echo test.
/dev/dhclw1dB passes single-message echo test.
Do single [t]ime calib on each channel (s)kip (A)ll (q)uit...
/proc/driver/domhub/card1/pair0/domA/tcalib PASSED.


```

```

/proc/driver/domhub/card1/pair0/domB/tcalib PASSED.
/proc/driver/domhub/card1/pair1/domA/tcalib PASSED.
/proc/driver/domhub/card1/pair1/domB/tcalib PASSED.
Start [l]ong-term echo/tcalib tests (s)kip (A)ll (q)uit...
Running /usr/local/bin/readwrite HUB /dev/dhclw0dA 400000000 >& echo_results_clw0dA.out &...
Running /usr/local/bin/tcaltest /proc/driver/domhub/card1/pair0/domA/tcalib 400000000
noshow >& tcal_results_clw0dA.out &...
Running /usr/local/bin/readwrite HUB /dev/dhclw0dB 400000000 >& echo_results_clw0dB.out &...
Running /usr/local/bin/tcaltest /proc/driver/domhub/card1/pair0/domB/tcalib 400000000
noshow >& tcal_results_clw0dB.out &...
Running /usr/local/bin/readwrite HUB /dev/dhclw1dA 400000000 >& echo_results_clw1dA.out &...
Running /usr/local/bin/tcaltest /proc/driver/domhub/card1/pair1/domA/tcalib 400000000
noshow >& tcal_results_clw1dA.out &...
Running /usr/local/bin/readwrite HUB /dev/dhclw1dB 400000000 >& echo_results_clw1dB.out &...
Running /usr/local/bin/tcaltest /proc/driver/domhub/card1/pair1/domB/tcalib 400000000
noshow >& tcal_results_clw1dB.out &...
Show [l]ast line of long term tests (s)kip (q)uit...
1 0 A: Good ID (00013c629259).
1 0 B: Good ID (00013c62a737).
1 1 A: Good ID (00073c71d2ef).
1 1 B: Good ID (00013c63b045).
/dev/dhclw0dA: 1000 msgs (last 31B, 0.38 MB tot, 10 sec, 38.90 kB/sec, avg_rd_retries 2
/dev/dhclw0dB: 1000 msgs (last 126B, 0.38 MB tot, 11 sec, 35.22 kB/sec, avg_rd_retries 2
/dev/dhclw1dA: 1000 msgs (last 12B, 0.39 MB tot, 10 sec, 39.55 kB/sec, avg_rd_retries 2
/dev/dhclw1dB: 1000 msgs (last 142B, 0.37 MB tot, 11 sec, 34.79 kB/sec, avg_rd_retries 2
/proc/driver/domhub/card1/pair0/domA/tcalib: 1000 successfull time calibrations.
/proc/driver/domhub/card1/pair0/domB/tcalib: 1000 successfull time calibrations.
/proc/driver/domhub/card1/pair1/domA/tcalib: 1000 successfull time calibrations.
/proc/driver/domhub/card1/pair1/domB/tcalib: 1000 successfull time calibrations.
Show [l]ast line of long term tests (s)kip (q)uit...
%
%
% stagedtests.pl -moni
stagedtests.pl
DOR-driver testing script by John Jacobsen (john@johnj.com) for LBNL/IceCube.
Will test:
Card 1 pair 0 dom B.
Card 1 pair 1 dom B.
Card 1 pair 0 dom A.
Card 1 pair 1 dom A.
Show [l]ast line of long term tests (s)kip (q)uit...
1 0 A: Good ID (00013c629259).
1 0 B: Good ID (00013c62a737).
1 1 A: Good ID (00073c71d2ef).
1 1 B: Good ID (00013c63b045).
/dev/dhclw0dA: 3000 msgs (last 369B, 1.14 MB tot, 31 sec, 37.52 kB/sec, avg_rd_retries 2
/dev/dhclw0dB: 3000 msgs (last 288B, 1.15 MB tot, 33 sec, 35.70 kB/sec, avg_rd_retries 2
/dev/dhclw1dA: 3000 msgs (last 309B, 1.15 MB tot, 31 sec, 37.93 kB/sec, avg_rd_retries 2
/dev/dhclw1dB: 3000 msgs (last 256B, 1.13 MB tot, 34 sec, 34.13 kB/sec, avg_rd_retries 2
/proc/driver/domhub/card1/pair0/domA/tcalib: 2000 successfull time calibrations.
/proc/driver/domhub/card1/pair0/domB/tcalib: 2000 successfull time calibrations.
/proc/driver/domhub/card1/pair1/domA/tcalib: 2000 successfull time calibrations.
/proc/driver/domhub/card1/pair1/domB/tcalib: 2000 successfull time calibrations.
Show [l]ast line of long term tests (s)kip (q)uit...
%
%
% stagedtests.pl -kill
stagedtests.pl
DOR-driver testing script by John Jacobsen (john@johnj.com) for LBNL/IceCube.
Will test:
Card 1 pair 0 dom B.
Card 1 pair 1 dom B.
Card 1 pair 0 dom A.
Card 1 pair 1 dom A.
Killing all running test processes...
%
% /usr/local/bin/off all
%

```


References

- 1) J. Jacobsen, *The DOM Hub Device Driver – Function and Design*. Available on the IceCube DocuShare repository or at <ftp://it.johnj.com/pub/icecube/domhub/driver/doc>.
- 2) K. Sulanke, *DOR – API Description*. Private communication, khsulanke@lbl.gov.