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SUBJECT: Mark5C Hardware Test and Acceptance Plan

1. Introduction

The Mark5C hardware test and acceptance plan document will describe how we will test Conduant's new Mark5C hardware to verify that functionally it meets the specifications of the Mark5C Specification document (Haystack Mark5 Memo #5 or the VLBA Sensitivity Upgrade Memo #12)

The format of this document is to: 1) present the test setup that will be used in validating the Mark5C hardware; 2) address any special software tools that will be used in evaluating the hardware; 3) briefly describe the features and the tests that we expect to use in evaluating the hardware, and 4) summarize the tests in a matrix indentifying the section of the requirement, test number, results and comments.

2. Test Setup

Figure 1 shows the assumed test setup that will be used in the evaluation of the Mark5C hardware.

The necessary equipment required for evaluation are:

1. Test Laptop – for control of the tests
2. 1Gbps hub – Computer interconnection
3. 4 Servers – **DBE Emulator** (DBE-E)
 - a. Standard server system with a PCI X8 slot
 - b. 1 Gbps NIC interface

- c. 10 Gbps NIC card with CX4 Interface
- 4. Mark5 Chassis
 - a. Amazon Controller Card
 - b. 10Gbps Ethernet daughter card
- 5. 25 Meters of copper cable to interconnect the 10G NIC card

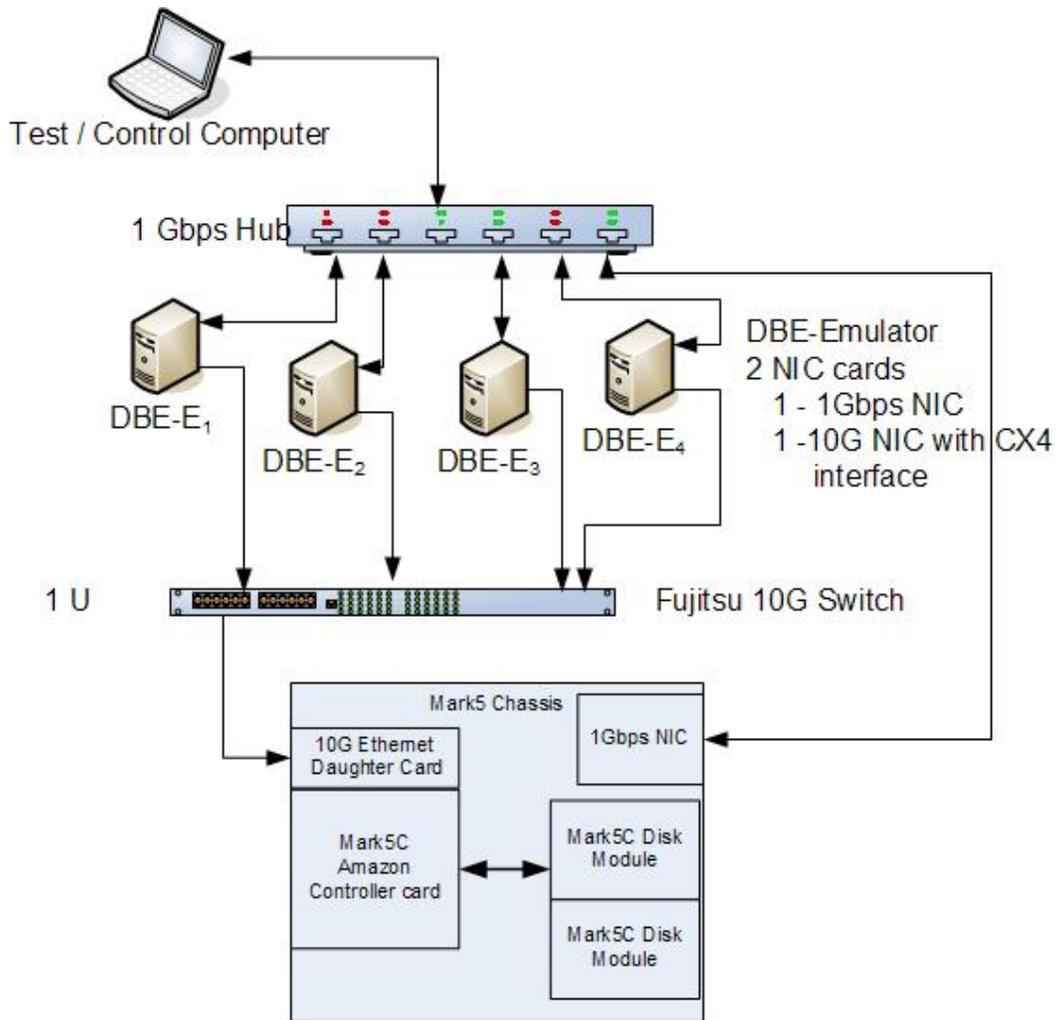


Figure 1: Test and Evaluation Setup

3. Software Tools

It is assumed that the DBE emulator server and the Mark5 systems will be running the latest stable Linux distribution, e.g. Debian Etch, that includes at least a 2.6.22 kernel.

In order to support this Conduant must have released an official SDK version 8.X or a beta version of SDK that is to be used specifically with the 10G daughter card. If an earlier version

of SDK is made available for testing, the kernel and Linux distribution should be chosen to match.

The required software and software tools needed for the tests are:

1. Mark5C packet generator server (being developed at Haystack)
2. either an application with the capability to make XLR calls to query the Mark5 Amazon card of status information that is supposed to be supported for the 10G Ethernet daughter card, or a Conduant application to get the appropriate information.

4. Functional Tests

This section provides an overview of the functional tests that will be used to verify that the Mark5C hardware meets the specification.

There are three main modes for packet processing, PSN Monitor Mode 0/1/2. These modes go from basic testing to more advanced testing to verify the packet processing capabilities of the hardware.

1. PSN Monitor Mode 0 - data are recorded to disk in the order that packets are received; no checks are made for out-of-order or missing packets.
2. PSN Monitor Mode 1 - monitors for out of order, missing, or bad packets using the *Packet Serial Number* (PSN) for guaranteeing the correct order of data and fill pattern packet replacement for missing or bad data. This mode is used primarily with the Mark5B compatibility data frame format.
3. PSN Monitor Mode 2 - uses the PSN *most significant bit* (MSB) to indicate whether a packet should be recorded or discarded.

4.1. Basic Test

The basic test suite will use the PSN Monitor Mode 0 to verify that the card can be configured, receive data via the Conduant 10GEthernet Daughter card, and write it to disk.

This test will use the Mark5C packet generator on the DBE-E₁ to send a short burst of Mark5 data at a low data rate, ~ 32 Mbps, to the Mark5C. The payload will be tvg data with a Mark5C header encapsulated in a layer 2 Ethernet Frame.

The Mark5C 10G Ethernet daughter card will be initially set into promiscuous mode. Ethernet promiscuous mode means the 10G card accepts all of the data it sees on the Cx4 interface. All of the data from the interface will then be written to disk. To verify the successful completion of this test, the data written to disk will be read from the disk and compared against the header and payload of the sending packet generator.

If the basic test passes, then other restrictions, described in section 4.1.2, will be placed on the packet processing engine of the daughter card when these features are available.

4.1.1 Packet length test

Repeat the above basic test to verify that the Mark5C can handle the following packet lengths:

1. 64 bytes - the minimum standard Ethernet frame length
2. 1512 bytes - the standard Ethernet maximum frame length
3. 5000 bytes – intermediate jumbo frame length
4. 9000 bytes - maximum length jumbo frame

4.1.2 Basic Packet Filtering

The basic packet filtering test will configure the Mark5C daughter card with a single source MAC address. This test is to verify whether the Mark5C is filtering and accepting only valid data.

The DBE packet generator will send a specified number of packets in a short burst to the Mark5C. We will then use MAC spoofing on the DBE emulator to change the source MAC address and send another short burst of data with a different payload value. The MAC spoofing will be disabled and another predetermined short burst of data will be sent with the original payload to the Mark5C.

To verify if this test passes, inspection and verification of: 1) the number of data packets written to disk must be performed, 2) the contents of the data payload will be inspected and compared, and 3) the status registers of the 10G Ethernet pertaining to number of packets received / rejected / bad must be performed.

4.2 Packet Processing

After successful completion of the basic tests, other features and modes of the 10G Ethernet daughter card will be verified. The main features to be examined are the basic PSN Monitor Mode 1 and 2 general features.

Following the successful testing of the basic of the PSN Monitor Mode 1 and 2, additional finer tuning features will be tested, e.g. *Data Payload Offset* (DPOFST).

4.2.1 PSN Monitor Mode 1

The PSN Monitor mode 1 testing can be separated into two main areas: 1) the ability of the Mark5C to handle out of order packets, and; 2) the ability to fill in missing packets with the proper fill pattern.

4.2.1.1 Basic Test

The Mark5C will be configured into PSN Monitor Mode 1, with a specific source MAC address for acceptance criteria and the *PSN Offset* (PSNOFST) and DPOFST both set to zero. Using this mode, the PSN will be considered as part of the VLBI data payload and written to disk.

The DBE Packet Generator will insert a monotonically increasing PSN value into the first 4 bytes of the VLBI data payload immediately before the data frame. The packet format for this mode is the Mark5B Compatibility mode. The payload will be tvg data with a Mark5B emulation header plus the PSN encapsulated in a layer 2 Ethernet Frame.

This initial test will verify that the Mark5C can process the PSN header.

The recorded data will be verified by reading it from the Mark5 disk module. The first 4 bytes of the payload, where the PSN is inserted, inspected it and verified that the bursts were written in sequential order. The contents of the payload will also be inspected and verified for correctness.

4.2.1.2 Out-of-Order Packets

To test out-of-order packets, the configuration of the Mark5C used in the above basic test will be used again.

The DBE Packet Generator will transmit packets sequentially until a pre-specified PSN is reached. The next two transmitted packets have their order swapped, e.g transmit PSN n first, then PSN n-1, followed by a monotonically increasing PSN from n+1 until a specified PSN is again reached. This will continue until a specified number of packets are transmitted.

To verify that the Mark5C handles out-of-order packets properly, by recording the data in the proper order, the data will be read from the disk module and checked to see that the order of the PSN is monotonically increasing for the specified total number of packets.

If the PSNs are not monotonically increasing, the test will be marked as a fail.

4.2.1.3 Missing Packets

This test will verify that the Mark5C replaces missing packets with the appropriate fill pattern and that the appropriate status registers indicate this.

The Mark5C will be configured as described in Section 4.2.1.1.

The DBE Packet Generator will transmit packets sequentially until a specified PSN is reached, then bypass the specified packet. It will then continue sequentially until the next prescribed PSN is reached. This will continue until a specified number of packets are transmitted.

To verify that the Mark5C handles missing packets properly, the data will be read from the disk module and at predetermined intervals the appropriate fill pattern will be identified along with the monotonically increasing PSN verified for the specified packet length.

The status registers of the controller card will then be queried to confirm that the prescribed number of missing packets were detected.

4.2.2 PSN Monitor Mode 2

The PSN Monitor Mode 2 basic tests will verify that if the most-significant bit is set in the PSN then the Mark5C treats the data as an “invalid” frame, discards it, and updates the appropriate status registers.

Using the same configuration as in Section 4.2.1, except with PSN Monitor Mode2 set, repeat the missing packet test.

The DBE Packet Generator will transmit packets sequentially until a specified PSN is reached, then set the MSB of the specified packet. It will then continue sequentially until the specified PSN is again reached. This will continue until a specified number of packets are transmitted

To verify that the Mark5C discard the appropriate packet properly, the data will be read from the disk module and at periodic intervals the PSN should be two greater than expected and the next monotonically increasing sequence verified.

The status registers will also be read to confirm that the number of discarded packets matches the total number read from the disk module minus those that should have been discarded.

5 Advanced Features

After we test the basic recording capability of the Mark5C for the 3 PSN monitoring modes some of the advanced features of the Mark5C will be verified. The features include the DPOFST, sustained recording rates, and the multiple sources support. It should be noted that in order to test the advanced features of the Mark5C, the ability to support both non-bank mode and bank mode are implied.

5.1 Single Source Performance Test

The single source performance test is a verification that the Mark5C can sustain the prescribed maximum recording data rate, i.e. 2048Mbps in bank mode and 4096 Mbps in non-bank mode.

This test will be initially executed with the Mark5C in PSN Monitor Mode 0, so that no extra packet processing is required.

After the initial test is completed successfully with no buffer overflows or errors, the test will be repeated for PSN Monitor Mode 1 and PSN Monitor Mode 2.

5.2 DPOFST test

The DPOFST test will verify the capability of the Mark5C to skip over a predefined number of bytes of data in the MAC client data payload to the start of the VLBI Data Payload. The payload for this test will be tvg data with a Mark5C header encapsulated in a standard UDP/IP header contained in an Ethernet Frame.

All of the tests which were performed when DPOFST was set to zero, in Section 4.2, should be retested with the DPOFST set to a non-zero value.

5.3 Multiple Source Tests

The Mark5C has the capability to accept data from up to 16 sources. The use of 4 DBE-Es shown in Figure 1 is an example of the configuration to be used with this test suite.

5.3.1 Packet filtering

The packet filtering test of Section 4.1.2 will be repeated for multiple sources. Each DBE-E₁ through DBE-E_n emulator will generate a pre-described number of packets for its source address. Each DBE will generate data at a rate equal to (1Gbps / n). The Mark5C will be configured to accept data from DBE-E₁ through DBE-E_n.

The data payload for this test will be Mark5C packet formats generated by the Mark5C packet generator server for a specific Channel ID.

The verification of this test is that the total number of packets received is correct and that the contents of the disk modules verifying the amount and accuracy of data written.

5.3.1.1 Addition of extraneous source

The above test will be repeated with DBE- E_{n+1} added as a generating source, but without its address provided to the Mark5C.

The verification of this test is the number of total number of packets received, number discarded, and reading the contents of the disk modules verifying the amount of data written was only from valid sources.

5.3.2 Multiple Source Performance Test

After it is verified that the Mark5C can handle packet filtering for greater than 1 data source, the performance test of Section 5.2 will be repeated but with each source generating data at both 2048/n Gbps and 4096/n Gbps to verify non-bank and bank mode functionality.

5.4 Bad Disk Testing

In addition to the specific Mark5C verification, how well the Mark5 system handles bad disks during recording is an additional test of the test suite will verify. Therefore, using a single source generating data at 3.5 Gbps, the Mark5C will be configured for non-bank mode and will attempt to record the data onto the module(s) containing only 7 of 8 discs.

6 Summary of Tests

Please note that the ordering of the tests is based upon a specific feature from the specification and that sequential execution of the tests is not required.

Test	Test No.	Section	Configuration Parameters	Pass / Fail	Comments
Basic Test	1	4.1	PSN Mode 0, promiscuous mode		
Packet Length Test	2	4.1.1	48 bytes		
	3		1512 bytes		
	4		5000 bytes		
	5		9000 bytes		
Basic Packet Filtering	6	4.2.1	Single MAC address		
	7		Two sending stations, Mark5C programmed to accept a single source MAC address		
PSN Mode 1 – Basic test	8	4.2.1.1	PSN Mode 1, PSNOFST = 0 DPOFST = 0		
Out of Order Processing	9	4.2.1.2	“”		
Missing Pkt Handling	10	4.2.1.3	“”		
PSN Mode 2 – Missing Packets	11	4.2.2	PSN Mode 2, PSNOFST = 0 DPOFST = 0		
Single Source Perf. Test (bank)	12	5.1	PSN Mode 0, 2Gbps data rate		

Test	Test No.	Section	Configuration Parameters	Pass / Fail	Comments
	13	5.1	PSN Mode 1, 2 Gbps		
	14	5.1	PSN Mode 2, 2 Gbps		
Single Source Perf. Test (non-bank)	15	5.1	PSN Mode 0, 4Gbps data rate		
	16		PSN Mode 1, 4 Gbps		
	17		PSN Mode 2, 4 Gbps		
DPOFST Test	18	5.2	DPOFST > 0, repeat Test 1		
	19		DPOFST > 0, repeat Test 2		
	20		DPOFST > 0, repeat Test 5		
	21		DPOFST > 0, repeat Test 8		
	22		DPOFST > 0, repeat Test 9		
	23		DPOFST > 0, repeat Test 10		
	24		DPOFST > 0, repeat Test 11		
	25		DPOFST > 0, repeat Test 12		
	26		DPOFST > 0, repeat Test 13		
	27		DPOFST > 0, repeat Test 14		
Multiple Source Packet Filtering	28	5.3.1	Repeat test 6 with number of sending stations (n = 4)		
	29	5.3.1.1	Repeat test 7 with n = 4		
Multiple Source Performance Test (bank)	30	5.3.2	N = 4, PSN Mode 0, 2Gbps aggregate data rate		
	31		N = 4 PSN Mode 1, 2Gbps		
	32		N = 4 PSN Mode 2, 2 Gbps		
Multiple Source Performance Test (non-bank mode)	33	5.3.2	N = 4, PSN Mode 0, 4Gbps aggregate data rate		
Multiple Source Performance Test (non-bank mode)	34		N = 4 PSN Mode 1, 4 Gbps		
	35		N = 4 PSN Mode 2, 4 Gbps		
Bad Disk Test	36	5.4	N = 1, PSN Mode 0, 3.5 Gbps		