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TECHNICAL REPORT

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AO Software Testing - II
Engineering tests with Arbitrators

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ABSTRACT

This report contains a brief review of the AO Supervisor software testing performed in Arcetri in June 2009.
The testing activity reported here refers to the management of AO System devices under the control of the three Arbitrators.

Contents

Glossary of terms and acronyms

AdSec. The Adaptive Secondary Mirror. In this context usually refers to the group of *AO-Supervisor* components controlling the hardware devices related to the secondary mirror.

ADAM. Ethernet controlled digital output. Used to enable various devices within the AdSec.

AdSec Computer. The workstation running the *AO-Supervisor* components which control the Adaptive Secondary hardware.

Adsec-Arb. The Adaptive Secondary Arbitrator. A component of the *AO-Supervisor* which executes commands related to the *AdSec* coordinating the operations of the hardware devices in the Adaptive Secondary. Commands to *AdSec-Arb* may come either from a specific GUI or from *AO-Arb*.

AO System. The hardware and software components of the LBT first light Adaptive Optics System. Includes the Wavefront Sensor, the Adaptive Secondary Mirror, the *AO Computer* and some auxiliary devices (such as networking hardware) and includes the *AO-Supervisor* and the real-time software.

AO-Arb. The AO Arbitrator. A component of the *AO-Supervisor* which manages the execution of high-level commands, coordinating the operations of *WFS-Arb* and the *AdSec-Arb*. Commands to *AO-Arb* may come either from a specific interface or from *AOS*.

AO Computer. The computer (or farm of computers) running the *AO-Supervisor*.

AO Console. The operator console of the *AO Computer*.

AO-Supervisor. The software system which manages all the components of the *AO System*

BCU. Basic Control Unit. Electronics board used as basic building block for most of the electronics in the AO System (see [1]).

BCU 47. The BCU used as frame grabber for the CCD 47.

C-BCU. Crate BCU. The six BCUs which controls the AdSec.

CCD 39. The CCD used for the Wavefront sensor.

CCD 47. The CCD used for the *TV*.

Copley. Motor driver for the Bayside stages.

Fastlink. The real-time data communication link between the WFS and the AdSec.

FLAO. First Light AO system for the LBT. The whole AO system for the LBT, including both hardware and software components.

Flowerpot. Auxiliary unit to control the calibration source and the related optics (cube beam splitter).

MsgD. Message Dispatcher, the *AO-Supervisor* message dispatching daemon.

RTDB. AO Real Time Database, the *AO-Supervisor* own variable repository. Its functionalities are supported by `MsgD`.

S-BCU. Switch BCU. The BCU operating as inpout source switch for the AdSec.

TTM. Tip-Tilt Mirror. A small mirror used to modulate the pupil image un top of the WFS pyramid.

TV. Technical Viewer. An auxiliary CCD camera used by the Wavefront Sensor to acquire the reference star.

WFS. The Wavefront Sensor. In this context usually refers to the software subsystem controlling the hardware devices related to the wavefront sensor.

WFS CCD. The CCD used in the *WFS* to measure the light wavefront deformation (also: *CCD 39*).

WFS Computer. The workstation running the *AO-Supervisor* components which control the Wavefront Sensor hardware.

WFS-Arb. The WFS Arbitrator. A component of the *AO-Supervisor* which executes commands related to the *WFS* coordinating the operation of the hardware devices of the WFS. Commands to *WFS-Arb* may come either from a specific GUI or from *AO-Arb*.

1 Introduction

This report describes the test activities related to the AO Supervisor software used as a standalone system to control the hardware devices which are part of the FLAO.

The testing activity was aimed to verify that the main components of the AO System (i.e.: the WFS and the AdSec) can be safely and effectively operated by means of the high level arbitrators and that the coordination of operations is properly managed.

1.1 AO System Arbitrators

The AO System Arbitrators are three components of the AO Supervisor which coordinate sequences of elementary operation in order to accomplish a complex task. They come in a two level hierarchy, as shown in figure 1. The two lower level arbitrators are dedicated to the two main parts of the AO System, the WFS (WFS-Arb) and the AdSec (AdSec-Arb), the higher level arbitrator (the AO Arbitrator or AO-Arb) coordinates sequences of operations by controlling the lower arbitrators.

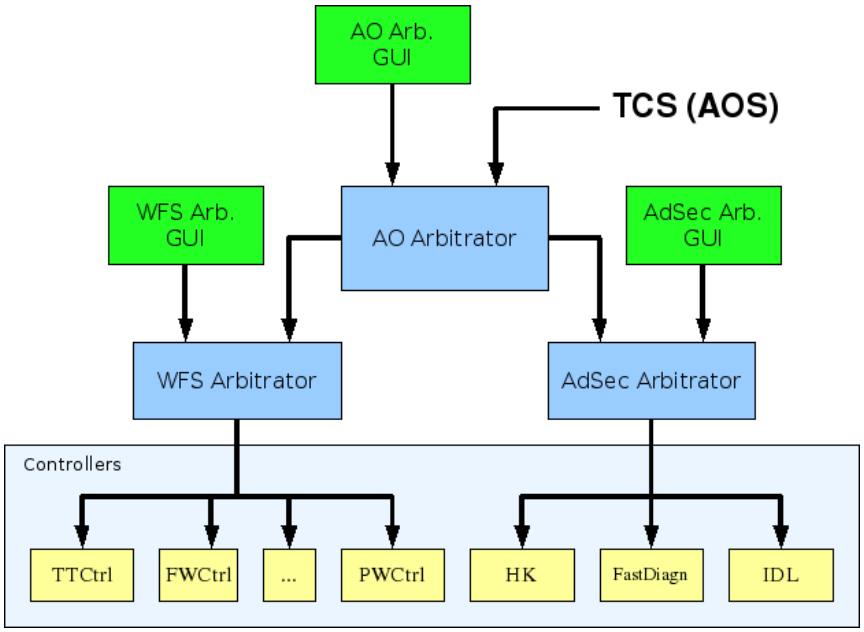

Figure 1: Arbitrators hierarchy

Each arbitrator can receive commands from two sources: a dedicated GUI and another process (either the upper level arbitrator or the TCS). The tests described in the following pages have been performed by means of the dedicated GUIs.

A description of the architecture of Arbitrators and some details about their implementation can be found in [2].

1.2 Test setup

The set of tests described in the following pages has been divided in three steps:

- WFS-Arb test
- AdSec-Arb test
- AO-Arb test

All tests have been performed through the related GUIs. This, anyway, implies that interfacing of the two lower level arbitrators with the AO Arbitrator is also tested when testing the latter. Interfacing with the AOS is the aim of another test task.

The testing procedure essentially consists in verifying that commands issued from the GUIs are correctly executed and result in the expected operations performed by the hardware or in the expected status of devices. The verification methods for each testing procedure depend mostly on the particular set of devices involved and thus they are not described in the following paragraphs. Most test involve the AO Supervisor components whose individual tests have been described in [3]. Complete descriptions of verification procedures for the optical, mechanic and electronics devices can be found in the general reports related to the solar tower test activity.

2 Detailed description of tests

2.1 WFS Arbitrator

The following tests have been performed for the WFS-Arb by using the WFS-Arb GUI.

1. Power on procedure and preliminary setup.
2. Dark calibration
3. Slope null calibration
4. Dark and slope null automatic selection
5. Adaptive loop parameters setup

They are described in the following sections.

2.1.1 Power on procedure and preliminary setup

Testing the preliminary setup of the WFS includes the following steps:

1. Network connection test.
2. Orderly switch on of all devices.
3. The correct status of all devices is verified (including correct homing of all the movable parts).
4. Setup from a configuration file previously saved.
5. CCD 39 autocenter and autofocus procedure (requires that the AdSec is up and running).

2.1.2 CCD dark calibration

Testing the CCD dark calibration includes the following steps (repeated for the CCD 39 and CCD 47):

1. Clear dark arrays in slope computer.
2. Move filter wheels in proper position (mirror for CCD 37 and zero transmission for CCD 47).
3. Bias equalization for the four CCD quadrants (CCD 39 only).
4. Frame acquisition and average of a suitable number of frames (typically 100 for CCD 39 and 10 for CCD 47)
5. Move back filter wheels
6. Start dark selection procedure (see sect. 2.1.4).

2.1.3 Slope null calibration

The slope null calibration test repeats some of the steps used for the dark calibration:

1. Clear slope null array in slope computer.
2. Frame acquisition and average from CCD 39.
3. Start slope null selection procedure (see sect. 2.1.4).

2.1.4 Dark and slope null automatic selection

The correctness of the following steps has been verified:

1. Indexing of file in calibration directory
2. Sorting of files based on creation date
3. Selection of files related to the current setting (frame rate and pupil parameters)
4. Loading of file data onto the slope computer.

2.1.5 Adaptive loop parameters setup

Loop parameter setup includes the following steps:

1. Selection of parameters from the GUI (binning, frame rate, TTM modulation amplitude)
2. Reconfiguration of CCD and slope computer according to given parameters
3. Bias equalization for the four quadrants of CCD 39.
4. Setting of CCD frame rate.
5. Evaluation of amount of decimation for diagnostic frames (to avoid to go over a safe threshold for the diagnostic data rate)
6. Slope computer configuration
7. Setting of TTM modulation (using precalibrated data for the frequency/amplitude relation).

2.2 AdSec Arbitrator

The following tests have been performed on the AdSec-Arb by using the AdSec-Arb GUI.

1. Mirror power-on and flattening.
2. Set up of adaptive loop parameters (reconstructor matrix, time filtering, gain)
3. Setting of mirror in safe position and shut down
4. Error recovering procedure (in some cases after a fault a recovery procedure can be attempted).

2.3 AO Arbitrator

The AO-Arb has the purpose to coordinate the operations between the two lower level arbitrators. It is mainly used to operate as an interface between the AOS and the AO Supervisor. It will also be used (through it's GUI) to perform a few maintenance operations.

> *Because the development of the AO-Arb was not completed at the time of testing, the tests described below are only related to maintenance operations.*
>
> *The testing full functionality of the AO-Arb, including the support for AOS commands have been delayed. This does not affect the global test schedule in that such functionality is required only to support the communication with the AOS.*

The following procedures have been tested:

- Closing the AO loop.
- Opening the AO loop.
- Interaction matrix evaluation

2.3.1 Closing the AO loop

To close the AO loop the following steps must be successfully performed:

1. Verify CCD 39 dark correctness.
2. Set AdSec diagnostic data decimation parameters (in accordance with WFS settings)
3. Set AdSec-Arb in mode "AORunning"
4. Wait acknowledge from the AdSec
5. Send the CloseLoop command to the WFS (enable *fastlink*)

2.3.2 Opening the AO loop

When opening the AO loop the following steps must be successfully performed:

1. Send the StopLoop command (disable *fastlink*)
2. Set the WFS in "Operating" mode
3. Set the AdSec in "AOSet" mode

2.3.3 Interaction matrix evaluation

The evaluation of the interaction matrix is based on the capability of the slope computer to add a command history to the adaptive loop data. This obviously requires that the system is capable of closing the loop, i.e.: the procedures described in sections 2.3.2 and 2.3.1 can be successfully performed.

1. An history of modal commands is generated, based on parameters (Number of modes, number of cycles)[1]
2. The command history is divided into fixed length segments[2]
3. The AO-Arb dispatches commands to the two lower level arbitrators
4. The rest of the procedure is a loop over all data segments:
   (a) Load command segment to AdSec (using AdSec-Arb)
   (b) Load a zero gain vector (AdSec-Arb)
   (c) Close the loop (WFS-Arb)
   (d) Integrate[3]

[1] This step is performed off-line by means of an automated procedure guided by a specific GUI.
[2] Due to the limited amount of memory available on the BCUs, only a data segment of at most about 4000 frames can bu uploaded. The full data set is thus divided into segments of this length.
[3] We have two different procedures for doing that. See details in [4].

(e) Open loop

(f) Store data on disk

5. Compute interaction matrix from stored data[4]

3 conclusions

The tests described in the above pages demonstrate the capabilities of WFS and AdSec Arbitrators to operate the two main sections of the AO System, the WFS and the AdSec from simple and effective GUIs which will be used at the telescope for many maintenance operations. The tests also demonstrate the capability of the AO-Arb to control complex maintenance operations coordinating the two lower level arbitrators.

The testing of the AO-Arb as an interface for the AOS was instead delayed to be performed together with the tests of the AOS.

[4]This step also is performed off-line by a guided procedure.

References

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