LINC-NIRVANA

The **L**BT **IN**terferometric **C**amera and **N**ear-**I**nfra**R**ed / **V**isible **A**daptive i**N**terferometer for **A**stronomy

A collaborative project of the MPIA Heidelberg, INAF-Arcetri, Universität zu Köln, and MPIfR Bonn

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LINC-NIRVANA

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Computer Architecture

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1 Scope

This document describes how the LN computers will be structured and interact with each other, as well as the type of computer currently selected. As the performance of computer increases rapidely, further changes in the choices after the FDR might be done. We only intend to show, that the necessary performance is already available and not a showstopper. The structure presented in this document will also not change with different choices in hardware.

2 Applicable documents

No.	Title	Number & Issue
1	Common Software	LN-MPIA-FDR-ICS-001
2	Adaptive Secondary Basic Computational Unit Design Report	LBT Project 640a009

3 External Interfaces

Item	Short descrition
LBT Network	All computers have to be integrated into the LBT network. This explicitly needs definitions of names, IP, connection points, bandwidth, etc.
ASM	The GWS computers communicate with the Adaptive Secondary Mirror (ASM). The connection as well as the protocol has to be defined.
DM	The MHWS computers communicate with the DM. The connection as well as the protocol has to be defined.
Sensor CCDs	The AO systems communicate with the sensor CCDs. The connection as well as the protocol has to be defined.
Piston mirror	The FFTs system communicates with the piston mirror. The connection as well as the protocol has to be defined.
FFT IR detector	The FFTs system communicates with the FFT IR detector. The connection as well as the protocol has to be defined.

IR science detector	The IRC system communicates with the IR science detector. The connection as well as the protocol has to be defined.
Motors controller	The Instrument control computers have to communicate with the motor controllers. The connection as well as the protocol has to be defined.
Temperature controller	The Instrument control computers have to communicate with the temperature controllers. The connection as well as the protocol has to be defined.

4 Acronyms and abbreviations

ASM	Adaptive Secondary Mirror
BCU	Basic Computational Unit
CCD	Charge Couple Devices
DHC	Data Handling Computer
DM	Deformable Mirror
DRS	Data Reduction Computer
FDR	Final Design Review
FFT	Fringe and Flexure Tracker System
GWS	Ground Layer Wavefront Sensor
ICC	Instrument Control Computer
ICS	Instrument Control Software
IRC	Infrared Camera
IRDC	Infrared Detector Computer
LBT	Large Binocular Telescope
LN	LINC-NIRVANA
MPIA	Max-Planck Institute for Astronomy
MHWS	Mid High Layer Wavefront Sensor
PDR	Preliminary Design Review
RTC	Real-time Computer
SW	Software
WS	Workstation

5 Introduction

LN consists of several sub-systems which are/should be able to run independently. This improves the reliability of the overall system. This approach also makes the instrument fault-tolerant. Therefore, the architecture of the computer system has to be chosen carefully. It also has to be shown that each system can manage the tasks it is supposed to do.

6 Requirements

- Local instrument Ethernet network 1GBit/s (Control room through switch included)
- Dedicated fiber connections between computers and certain hardware. A total of 26 fibers is needed: (number of fibers only 2 DM per arm) [number of fibers 3 DM per arm]
    - (4)[8] multi or single mode fibers; 2[4] pairs Reflective Memory for MHWS DM
    - (4)[8] multi or single mode fibers; 2[4] EDT PCI-RCI Module for MHWS CCD (could be removed if computer close to CCD)
    - (TBD) GWS BCU-ASM (4x high speed ethernet communication, 2x timing reference)
    - GWS CCD camera serial line to N-port server
    - (4) Science detector data link
    - (2) multi or single mode fibers; FFT data link
    - (2) multi or single mode fibers; FFT command
    - (2) multi or single mode fibers; FFT piezo stage (piston mirror)
- Space for 7 computers in 19” racks (≤ 54 RU, 10 RU up to 30 RU in computer room, 44 RU down to 24 RU at the telescope)
- power supply for 4.2kW (7x600W) and cooling/isolation at the telescope
- Space for 2 BCU boards (196mm x 90mm) and 3.3V power supply 15W.

7 Parts

The instrument computer architecture can be divided into instrument sub-systems:

- (1) ICC - Instrument Control Computer (4 CPU LINUX WS)
- (2) GWS BCU r/l – Ground Layer Wavefront Sensor Base Computational Unit

- (2) MHWS RTC r/l (4 CPU LINUX WS) – Mid-High Layer WFS Real-Time Computer
- (1) DHC - Data Handling Computer (4 CPU LINUX WS)
- (1) FFT RTC – Fringe Flexure Tracker Real Time Computer (4 CPU LINUX WS)
- (1) IRDC - IR-Detector Computer (SunSolaris WS or LINUX)
- (1) DRC - Data Reduction Computer (LINUX WS)

8 Layout

The computers are connected through the Ethernet and placed at the telescope as well as in the computer room.

Computer room: ICC, DRC

TBD: DHC, FFT RTC, IRDC

Telescope: MHWS RTC, GWS BCU

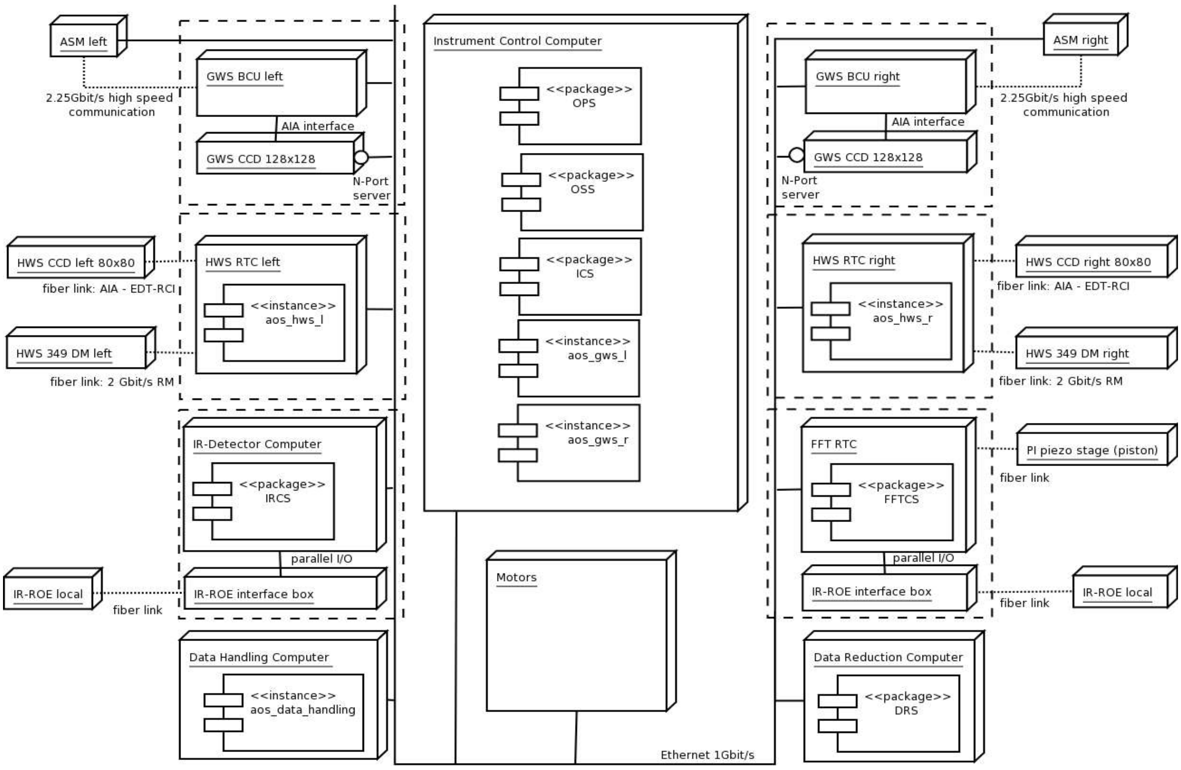

Figure 1 Deployment diagram of the LINC-NIRVANA computer system

9 Standard components

Here, the current selection standard components will be described. Depending on the computers available at the time of purchase, the models might change.

9.1 Themis Computer Slice Modular Architecture

(http://www.themis.com)

Operational Requirements

- Temperature: 0-55 Deg C
- Humidity: 0-85%
- Altitude: 0 – 10000 Feet (0 – 3333m)
- Shock: 60G
- Vibration 2000Hz
- Airflow: 300 liter per minute

Non-Operating Requirements:

- Temperature: 0 – 80 Deg C

Specifications

- CPU: Ultra Sparc and Power PC or Opteron (ideally this should converge to one architecture)
- Operating System: Linux, Solaris
- Gigabit Ethernet
- Power consumption: 600W per computer (1200W power units only)
- 19” rack mountable
- Slices available:
  - Processor slice up to 4 CPU 1RUx17”x17”
  - GPIO Slice with 4 PCI slots 1RUx17”x17”
  - Power/Storage Unit with redundant power supply and removable hard disks/CDRW/DVD 2RUx17”x17”

Availability

The Sparc slice is available, delivery about 1-2 month after order. Opteron and PowerPC versions will be available in the 4th quarter of 2005, the Opteron version in the 3rd quarter of 2005. Delivery about 1-2 month after order.

9.2 Power Edge 6600

(http://www.dell.com)

Operational requirements

- Computer room

Specifications

- CPU: 4x Xeon
- Operation System: Linux, Windows
- Gigabit Ethernet
- Power consumption:
- 19” rack mountable, 10RUx13”x27”

Availability

1-2 months after order.

10 ICC

10.1 Purpose

The ICC runs all the high level software, such as the Observation Support Software (OSS), Instrument Control Software (ICS), Adaptive Optics Control Software (AOS), IR-Camera Control Software (IRCS), etc.

10.2 Requirements

- CPU power: medium
- I/O throughput: medium
- Storage media: medium

- Interfaces: Gigabit Ethernet

10.3 Parts

- 1 computer

10.4 Specification

- multiprocessor computer (2 to 4 CPUs)
- >2.8 Ghz
- RAM: >8GB
- Storage: > 70GB
- Operation System: LINUX

10.5 Availability

Already purchased and running in the MPIA lab..

11 MHWS RTC

11.1 Purpose

The MHWS RTC does the loop calculations. The CCD is read and DM voltages applied through PCI card interfaces (reflective memory and PCI RCI).

11.2 Requirements

- CPU power: high
- I/O throughput: high
- Storage media: medium
- Interfaces: Gigabit Ethernet, PCI

11.3 Parts

- 2 computers, on left and on right channel (Themis slice architecture)

- 2 PCI extension, on left and on right channel
- 2 Power/storage units
- TBD: 2 racks

11.4 Specification

- multiprocessor computer (4 CPUs or more)
- Power PC or Opteron
- >2.8 Ghz
- L3 cache >2MB
- RAM: >16GB
- Storage: > 70GB
- Operation System: LINUX (with real-time kernel)

11.5 Availability

See chapter 9.

12 GWS BCU

12.1 Purpose

The GWS BCU calculates the slopes of the ground layer control loop. It also reads the CCD and sends the commands to the ASM. The supervision/control of the GWS is done from the ICC, which is running instances of the AOS for the right and left GWS.

12.2 Requirements

- CPU power: high
- I/O throughput: high
- Storage media: medium
- Interfaces: Gigabit Ethernet

12.3 Parts

- 2 BCU boards (r/l) (from Microgate)
- 2 PCI extension (r/l)

12.4 Specification

- computational power: > 340 million floating point operations per second
- high speed communication: >170MB/s
- AIA interface to SciMeasure cameras
- Gigabit Ethernet to supervisor
- 19” rack mountable
- Cabling from back
- Own power supply

12.5 Availability

Within a few months, depending on the needs of the ASM system itself.

13 FFT RTC

13.1 Purpose

The FFT RTC does the piston loop calculations and runs the FFT control software. The IR-FFT detector is read and signals for the piezo stage to drive the Piston mirror are given. The interface to the devices is through PCI cards.

13.2 Requirements

- CPU power: high
- I/O throughput: high
- Storage media: medium
- Interfaces: Gigabit Ethernet, PCI

13.3 Parts

- 1 computer (currently a Dell 6600 Power Edge but could be changed to a Themis slice architecture)

13.4 Specification

- multiprocessor computer (4 CPUs or more)
- Power PC or Opteron
- >2.8 Ghz
- L3 cache >2MB
- RAM: >16GB
- Storage: > 70GB
- Operation System: LINUX (with real-time kernel)

13.5 Availability

Already purchased and running in the lab at Cologne. Maybe the FFT RTC will be changed to a Themis slice.

14 IRDC

14.1 Purpose

The IRDC takes care of the IR detector readout. The data will be stored locally on this computer and copied to the ICC, DRS, or archive. The IRDC will run the detector control software.

14.2Requirements

- CPU power: high
- I/O throughput: high
- Storage media: high
- Interfaces: Gigabit Ethernet, PCI

14.3 Parts

- 1 computer (currently a SunSparc V480 but could be changed to a Themis slice architecture)

14.4 Specification

- multiprocessor computer (2 - 4 CPUs)
- Processor: SunSparc or Opteron
- >2.8 Ghz
- Cache: >2MB
- RAM: >16GB
- Storage: > 180GB
- Operation system: Solaris or LINUX (not well tested yet)

14.5 Availability

Already purchased and running in the lab at MPIA. Maybe the IRDC will be changed to a Themis slice.

15 DHC

15.1 Purpose

The DHC takes care of the wavefront sensor data. It analyzes the WFS data to optimize the loop performance. The WFS data will also be stored on this machine and forwarded to the archive on request. This machine might be merged with the ICC.

15.2Requirements

- CPU power: medium to high
- I/O throughput: high
- Storage media: high
- Interfaces: Gigabit Ethernet

15.3 Parts

- 1 computer (Themis slice architecture or Dell PowerEdge)

15.4 Specification

- multiprocessor computer (2 - 4 CPUs)
- >2.8 Ghz
- L3 cache >2MB
- RAM: >16GB
- Storage: > 180GB
- Operation system: LINUX

15.5 Availability

See chapter 9.

16 DRC

16.1 Purpose

The DRC will be the computer with whigh the astronomer interacts. The Data Reduction Software as well as the Observation Preparation Software will be installed. The astronomer can use this machine to analyze her/his data and compare it with the predicted performances. He can also create new Observation Blocks. The machine might be merged with the ICC.

16.2 Requirements

- CPU power: medium
- I/O throughput: medium
- Storage media: high
- Interfaces: Gigabit Ethernet

16.3 Parts

- 1 computer (Dell PowerEdge)

16.4 Specification

- multiprocessor computer (2 - 4 CPUs)
- >2.8 Ghz
- L3 cache >2MB
- RAM: >16GB
- Storage: > 180GB
- Operation system: LINUX

16.5 Availability

See chapter 9.