



**LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY**

*LIGO Laboratory / LIGO Scientific Collaboration*

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**aLIGO Front-End Computer Hardware**

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K. Thorne, R. Bork

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This is an internal working note of the LIGO Laboratory.

**California Institute of Technology**

**LIGO Project – MS 18-34**

**1200 E. California Blvd.**

**Pasadena, CA 91125**

Phone (626) 395-2129

Fax (626) 304-9834

E-mail: [info@ligo.caltech.edu](mailto:info@ligo.caltech.edu)

**Massachusetts Institute of Technology**

**LIGO Project – NW22-295**

**185 Albany St**

**Cambridge, MA 02139**

Phone (617) 253-4824

Fax (617) 253-7014

E-mail: [info@ligo.mit.edu](mailto:info@ligo.mit.edu)

**LIGO Hanford Observatory**

**P.O. Box 1970**

**Mail Stop S9-02**

**Richland WA 99352**

Phone 509-372-8106

Fax 509-372-8137

**LIGO Livingston Observatory**

**P.O. Box 940**

**Livingston, LA 70754**

Phone 225-686-3100

Fax 225-686-7189

<http://www.ligo.caltech.edu/>

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## 1 Overview

The aLIGO CDS front-end computers are used to control the interferometer using digitizers (ADC/DAC) together with real-time software doing digital filtering. They also provide output of these devices to the data acquisition system.

This document details the computer hardware that has been used in this role, specifically motherboards and processors.

## 2 Basic Requirements

These computers had to be compatible with specific PCIe adapters (IRIG-B receivers, PCIe expansion adapters, PCIe reflective memory, Token-ring reflective memory) as well as to support processors with clock speeds over 3 GHz. Additionally, the BIOS has to be able to support a large enough number of PCIe devices to read out the expansion motherboards.

Other features for production use were a separate IPMI processor and support for dual redundant power supplies.

## 3 Front-end Computer Motherboards, Processors

### 3.1 Linux commands to identify motherboards, processors

To assist in identifying the motherboard and processors on existing equipment the following Linux shell commands can be used.

For the motherboard, use the output of the following:

```
cat /sys/devices/virtual/dmi/id/board_{vendor,name,version}
```

For the processor(s), use the output of the following. It will have multiple identical lines for each active CPU core

```
cat /proc/cpuinfo | grep CPU
```

This will be used in the sections below to identify equipment.

## 3.2 Original Equipment (purchased 2011-2013)

These are the computers originally purchases for aLIGO. This model is also used for the original aLIGO DAQ computers. Most of the current computers in the interferometers are of this type.

```
controls@x2seib3 ~ $ cat /sys/devices/virtual/dmi/id/board_{vendor,name,version}
Supermicro
X8DTU
1234567890
```

```
controls@x2seib3 ~ $ cat /proc/cpuinfo | grep CPU
model name      : Intel(R) Xeon(R) CPU           X5680  @ 3.33GHz
```

The X8DTU motherboard specification can be found on the vendor's website at

<http://www.supermicro.com/products/motherboard/QPI/5500/X8DTU.cfm>

This processor has 6 cores for each CPU. Nearly all machines have only one CPU, except for the OAF computers which have 2 CPUs. This motherboard requires an additional PCIe riser card to supply enough PCIe slots. Most computers have a 3-slot riser card, except for machines with additional token-ring RFM adapters, which have 4-slot riser cards. These riser cards supported full-height PCIe adapters.

## 3.3 10-core Intel V2 machines (purchased 2015)

We were finding that the complexity of the LSC (Length-Sensing and Control) and quad SUS (Suspension) real-time controls was requiring more processing power than provided on the original machines. Also, we might need to run more than 5 real-time processes on each machine for LSC control.

After some testing, newer machines using the Intel V2 processors were found. These ran the real-time code almost twice as fast and with less variation.

```
controls@x2susbl23 ~ $ cat
/sys/devices/virtual/dmi/id/board_{vendor,name,version}
Supermicro
X9SRL-F
0123456789
```

```
controls@x2susbl23 ~ $ cat /proc/cpuinfo | grep CPU
model name      : Intel(R) Xeon(R) CPU E5-2690 v2 @ 3.00GHz
```

The X9SRL-F motherboard specification can be found on the vendor's website at

<http://www.supermicro.com/products/motherboard/Xeon/C600/X9SRL-F.cfm>

The processor has 10-cores. The motherboard had several PCIe slots. However, in our standard 2U chassis, this required the use of half-height PCIe adapters, requiring the purchase of new token-ring RFM adapters.

Eight(8) of these machines were purchased for each site, four for each production system. No spares were purchased.

### 3.4 6-Core Intel V4 machines (purchased 2017-)

Following work done by Gerrit Kuehn at the AEI in Hannover, Germany, we were able to qualify a new set of hardware. These use Intel V4 processors. They also used more inexpensive Intel processors as they only support single-CPU configurations.

These machines are even faster than the Intel V2 machines. Those also do not have some operational issues with those machines

```
controls@x2seib1 ~ $ cat /sys/devices/virtual/dmi/id/board_{vendor,name,version}
Supermicro
X10SRi-F
1.01B
```

```
controls@x2seib1 ~ $ cat /proc/cpuinfo | grep CPU
model name      : Intel(R) Xeon(R) CPU E5-1650 v4 @ 3.60GHz
```

The X10SRi-F motherboard specification can be found on the vendor's website at

<https://www.supermicro.com/products/motherboard/Xeon/C600/X10SRi-F.cfm>

This is a 6-core processor. As with the Intel V2 machines, this has its own PCIe slots so uses half-height adapters in a 2U chassis.

### 3.5 8-core Intel V4 machines (purchased 2018-)

As we wanted to replace the LSC front-end computers, we had to have more than six cores due to the additional real-time control processors for the Squeezed Light installation. Fortunately, the same motherboard supports an 8-core processor, but at a slightly lower rate.

```
controls@x2lsc0 ~ $ cat /sys/devices/virtual/dmi/id/board_{vendor,name,version}
Supermicro
X10SRi-F
1.01B
```

```
controls@x2lsc0 ~ $ cat /proc/cpuinfo | grep CPU
model name      : Intel(R) Xeon(R) CPU E5-1660 v4 @ 3.20GHz
```

## 4 Other aLIGO CDS computers

We will also document some other hardware used extensively in aLIGO CDS.

The original DAQ computers use the same motherboards, processors as the front-ends. The major change was adding more RAM memory.

### 4.1 Intel V3 DAQ frame-writer (purchased 2015-2016)

The increased data rates for the interferometer required CDS to find more powerful machines to do the most computationally intensive task of frame-writing. They also needed to support more RAM memory than the original equipment.

These machines have two 10-core Intel V3 processors. They also had 128 Gb of RAM

```
controls@x2daqfw0:~$ cat /sys/devices/virtual/dmi/id/board_{vendor,name,version}
Supermicro
X10DRi
1.02B
```

```
controls@x2daqfw0:~$ cat /proc/cpuinfo | grep CPU
model name : Intel(R) Xeon(R) CPU E5-2660 v3 @ 2.60GHz
```

The X10DRi motherboard specification can be found on the vendor's website at

<https://www.supermicro.com/products/motherboard/Xeon/C600/X10DRi.cfm>

There were five of these purchased. Two each for the production systems and a spare on the LLO DAQ test stand.

### 4.2 RFM Router (purchased 2018-)

In 2018, we are replacing the token-ring RFM network with an upgraded PCIe RFM network and a 'router' that is connected to RFM switches at the corner and end stations through the use of PCIe expansion chassis.

We chose an Intel V4 processor, but with more cores (10) at a lower clock speed as real-time processing was not required. The motherboard is also slightly different.

```
controls@x2cdsrfm ~ $ cat
/sys/devices/virtual/dmi/id/board_{vendor,name,version}
Supermicro
X10SRW-F
1.02B
```

```
controls@x2cdsrfm ~ $ cat /proc/cpuinfo | grep CPU
model name : Intel(R) Xeon(R) CPU E5-2640 v4 @ 2.40GHz
```

The X10SRW-F motherboard specification can be found on the vendor's website at

<https://www.supermicro.com/products/motherboard/Xeon/C600/X10SRW-F.cfm>

This motherboard requires a PCIe riser card to provide the slots, so it takes full-height PCIe adapters.

So far three(3) machines have been purchased. One for each production system and a spare on the LLO DAQ test stand.