

Network Data Analysis Server (NDAS)

Prototype Development

Szabolcs Márka¹

LIGO Laboratory, California Institute of Technology, Pasadena, CA 91125, USA

Benoit Mours²

LAPP Chemin de Bellevue - BP 110 74941 Annecy-le-Vieux CEDEX – FRANCE

LIGO Laboratory, California Institute of Technology, Pasadena, CA 91125, USA

Roy Williams³

CACR, California Institute of Technology, Pasadena, CA 91125, USA

We developed a simple and robust system based on standard UNIX tools and frame library code to transfer and merge data from multiple gravitational wave detectors distributed worldwide. The transfer and merge takes place with less than 20 minutes delay and the output frames are available for all participants. Presently VIRGO and LIGO participate in the exchange and only environmental data is shared. The system is modular to allow future improvements and the use of new tools like Grid.

¹ Electronic address: smarka@ligo.caltech.edu

² Electronic address: mours@lapp.in2p3.fr

³ Electronic address: roy@cacr.caltech.edu

1. Introduction

Interferometric gravitational wave detectors⁴, capable to detect various sources at cosmological distances, are in advanced stages of their construction worldwide. The clear long time goal of the international gravitational wave community is to operate these detectors in unison and share data freely and rapidly. Besides logistics, it is also extremely important from the viewpoint of achievable science: to extract the most information from the possible observations, conduct efficient coincidence analysis, determine source direction with the ultimate goal to provide this information to other detectors with pointing capability, etc. Sharing the large amount of sensitive data in near real time is not a trivial task even when considering only the technical difficulties and neglecting the organizational ones. It is mandatory to have a well tested and robust prototype system by the time the real gravitational wave data is available from multiple observatories. It is very likely that the evolution of this system will take a considerable amount of time and effort, therefore it is advisable to start this endeavor as soon as possible.

⁴ LIGO - <http://www.ligo.caltech.edu/>
VIRGO - <http://www.virgo.infn.it/>
TAMA - <http://tamago.mtk.nao.ac.jp/tama.html>
GEO - <http://www.geo600.uni-hannover.de/>
ACIGA - <http://www.anu.edu.au/Physics/ACIGA/>

2. Overview

Inspired by the above arguments we developed a very simple, portable, secure, robust, stable and scalable system based on freely available UNIX tools. Due to the standardized nature of the software components, this system can function under all flavors of UNIX and these different implementations can be mixed and still can work well together. The system incorporates multiple buffering to eliminate possible data loss due to network problems. Since none of the observatories will provide high duty cycle gravity wave data on the short term, we decided to use environmental data for our prototype system. Besides allowing a first look at correlated noises, environmental data has several advantages at the moment. It is available from most of the gravitational wave observatories worldwide. The data is produced by well-characterized commercial sensors. Modest data rate is acceptable and will spoil neither the initial bandwidth available for the observatories nor the value of the scientific analysis. Environmental data is also less sensitive and can be shared internationally much easier than the gravity wave data. These arguments strongly support our decision to limit the amount of shared data to 10Kb/sec for each node (observatory) and only share the scientifically interesting channels. Presently we are exchanging power line monitor, seismic and magnetometer data, since they are the most likely channels to indicate real or accidental intersite coincidence of environmental artifacts.

3. System anatomy

Figure 1. shows the block diagram of the NDAS system when configured for communication between the LIGO and Virgo observatories.

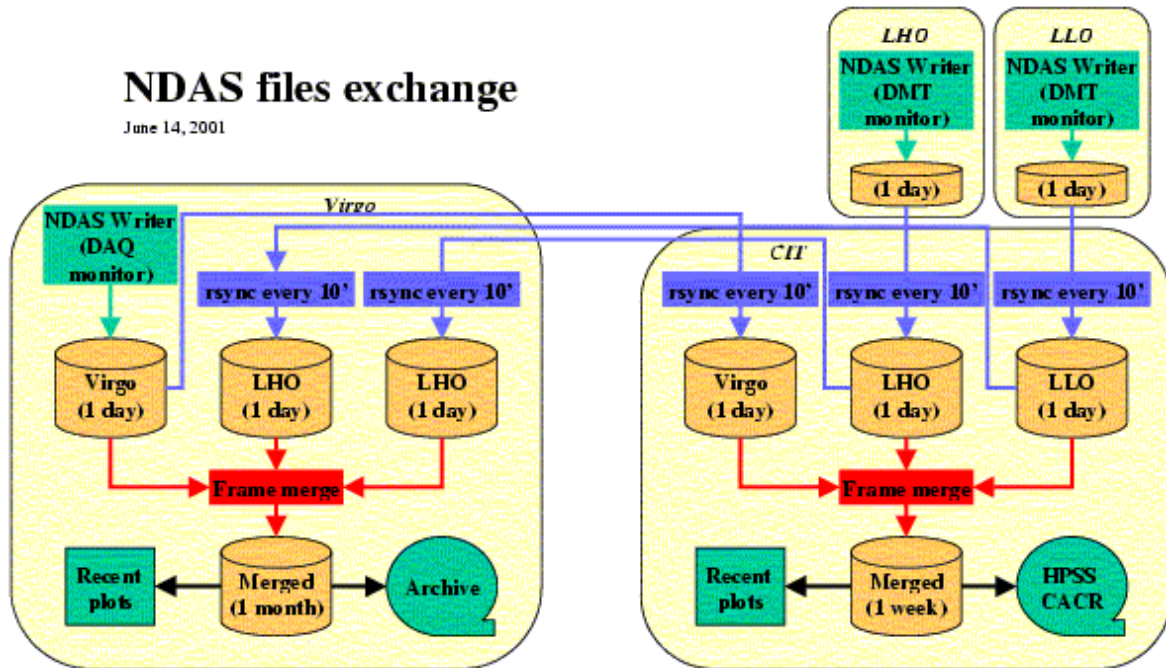


Figure 1 Anatomy of the Network Data Analysis Server prototype configured for the two LIGO and the Virgo observatories

Each node observatory has a semi-custom process (NDASWriter) running on a computer with real time access to the data. The desired channels are resampled to a 2^n rate to ensure compatibility among the sites and saved in a standard frame format on a local disk. The local disk serves as a circular buffer and it is large enough to store data at least for a day. Therefore, short network outages and transient bandwidth problems will not lead to data loss. In the same time, each local buffer is accessible to a single NDAS process running

on a CIT (CalTech) computer. This process reaches out and transfers the recently created data frames to its local disk. This disk also serves as a circular buffer and caters out each data frame to participating observatories. The Virgo and CIT machines presently have the capability to store individual frames for one day. These machines also create a new merged dataset for each time segment, where data is available from all participating observatories. These merged datasets can be stored locally for an interval ranging from couple of days to a month. After that the merged sets must be archived. Following the merging process, a detailed state of health and diagnostic information is generated, which is posted on the web in real time. Presently, CIT and Virgo feature such an active, NDAS diagnostic web page, which are available at: <http://www.ligo.caltech.edu/~ndas/> and <http://wwwcascina.virgo.infn.it/otherDetectors/NdasStatus.html>. The screenshot of a page taken at a typical moment is shown on Figure 2. The transfer rate log for a typical period is shown on Figure 3.

4. Summary

Our system is up and running and we already have significant amount of shared and merged data from the two LIGO and the Italian-French Virgo observatories. The expansion of the network is underway with GEO joining in at the moment and interest is shown from our Australian colleagues. We plan to survey the advantages and implement prototype systems using grid technology in the near future.

Network Data Analysis Server - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Location: http://www.cascina.virgo.infn.it/otherDetectors/NdasStatus.html

Penz LDAS Seismic Engineering Run SupeNova LIGO Utilities Physics Search GDS News Search

NDAS @ Virgo

Network Data Analysis Server

[Go to NDAS @ CIT](#)

[LIGO](#) [VIRGO](#)

Available Data at this NDAS server

- [LHO](#) (951MBytes)
- [LLO](#) (1351 MBytes)
- [Virgo](#) (710 MBytes)
- [Merged](#) (9547MBytes)

(38 % of the disk is used)

[HPSS archive at Caltech](#)

Data diagnostics for the last merged file

- [File Dump](#)
- [Dump of the first frame in file](#)
- Plot for the [seismometer](#), [power line](#) or [magnetometer](#) data
(click on the text to get the postscript file or on the plot to enlarge it)

NDAS files exchange
June 14, 2001

Data Calibration

Timing: The relative time offset between the detectors has not yet been calibrated. A rough estimate gives an upper value of 2ms.

Document: Done

Figure 2 Screenshot of a typical moment of the NDAS diagnostic web page.

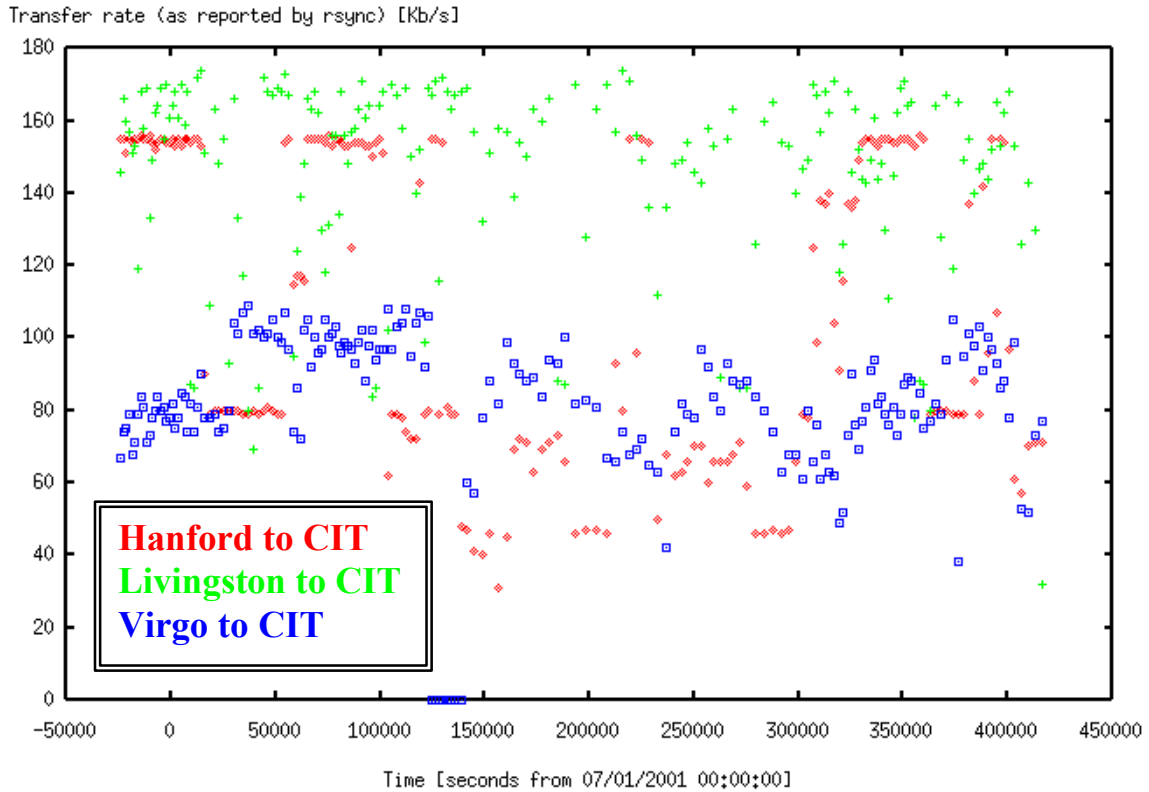


Figure 3 Transfer rate log for a typical period. Note the large daily variation due to uneven load of the network.

5. Acknowledgements

We would like to acknowledge the support of Albert Lazzarini and Barry Barish of LIGO Laboratory, the LIGO laboratory and the Virgo Collaboration, which made it possible to create this system. LIGO is funded by the National Science Foundation under the Cooperative Agreement PHY-9210038.