Gravitational Wave Network Analysis: *"Data Flow Model"*

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Draft

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Network Data Analysis System Prerequisites

The system design will accommodate the following possibilities as prerequisites:

- There will be two or more gravitational wave detectors within the network.
- Orientation (*polarization sensitivities*) of gravitational wave detectors assumed arbitrary.
- The locations of the gravitational wave detectors will not preclude overlapping coordinates and polarizations.
- All gravitational wave detectors must have some overlapping frequency bands at comparable sensitivities. (*NOTE: comparable will need quantitative definition at some point.*)
- Duty cycles of individual gravitational wave detectors are such that one or more detectors may be either off-line or out of specification for non-trivial periods of time.
- All gravitational wave detectors will acquire and distribute data in a common data format (*FRAMES*).
- All gravitational wave detectors will either use a common timing standard (*GPS*) or through a simple transformation, support an equally accurate timing standard.

Common Network Data Requirements

Each gravitational wave detector participating in the network analysis will be required to provide the following fixed set of Common Network Data (*CND*) as input into the Network Data Analysis System (*NDAS*):

- ***H(t)*** – a channel representing a "best" estimate of gravitational strain within the instrumental noise sensitivity limits.
- ***Q(t)*** – a channel representing the quality of the strain signal ***H(t)*** which is discretely sampled at the same rate as the rate as ***H(t)***.
- ***R(t) or R(f)*** – a data set representing the response function used to take the strain signal ***H(t)*** into physical units, including phase delays associated with the acquisition and calculation of ***H(t)*** at a level of accuracy adequate to support any and all network analyses. Note: The discrete representation of ***R(f)*** , (*or* ***R(t)*** *if represented as a linear filter in the time domain*), must be sufficient to provide compact support for the sample rate of ***H(t)***.
- ***Metadata*** – the input data into the NDAS from each gravitational wave detector will include metadata which at a minimum will consist of geographical location of the detector using a WGS84 (*consistent with GPS standards*) geodetic coordinate system, orientation of the detector, sample rate, and possibly others yet to be defined.
- All common channel data will be provided with the same unit of partitioning (*e.g., one second FRAMES*).

Data Distribution Requirements

Each gravitational wave detector participating in the network analysis will provide the following services using a CND Server:

- Generate the Common Network Data (*CND*) outlined above.
- Record this data onto a standardized persistent media (*i.e., tape, cdrom, dvd*), to support CND archives.
- Provide internet connectivity for distribution of the CND from its source (*detector or laboratory archive*) to NDAS centers using appropriate authentication methods and protocols through the server. (*NOTE: speed of internet connection must accommodate the quantity of the CND generated on server side.*)

Each Network Data Analysis System (*NDAS*) center participating in the analysis will use a standardized Ingestion Application Programmable Interface (*I-API*) supporting the following functions:

Front-End:

- Each NDAS center acts as a client to the CND servers.
- Ability to register with each CND Server requests for data via either the internet or on persistent media.
- Ability to read CND from persistent media.

- Ability to read CND over the internet using appropriate authentication methods and using a standardized protocol.
- Ability to gather search specific epochs of data from each gravitational wave detector and reformat this collection of data into a single FRAME.

Back-End:

- Ability to also reformat the search specific epochs of data into the internal format used by the network analysis software (*e.g., ILWD in the case of LDAS*).
- Ability to gather search specific epochs of data from each gravitational wave detector and distribute this Network Wide Data (*NWD*) to preprocessing engine (*like the LDAS dataCondtionAPI*) which produces a data set optimally conditions for particular type of network search to be preformed outside the dataConditionAPI (*e.g. the LDAS wrapperAPI*) in a high performance computation environment (*e.g. a Beowulf Cluster*).

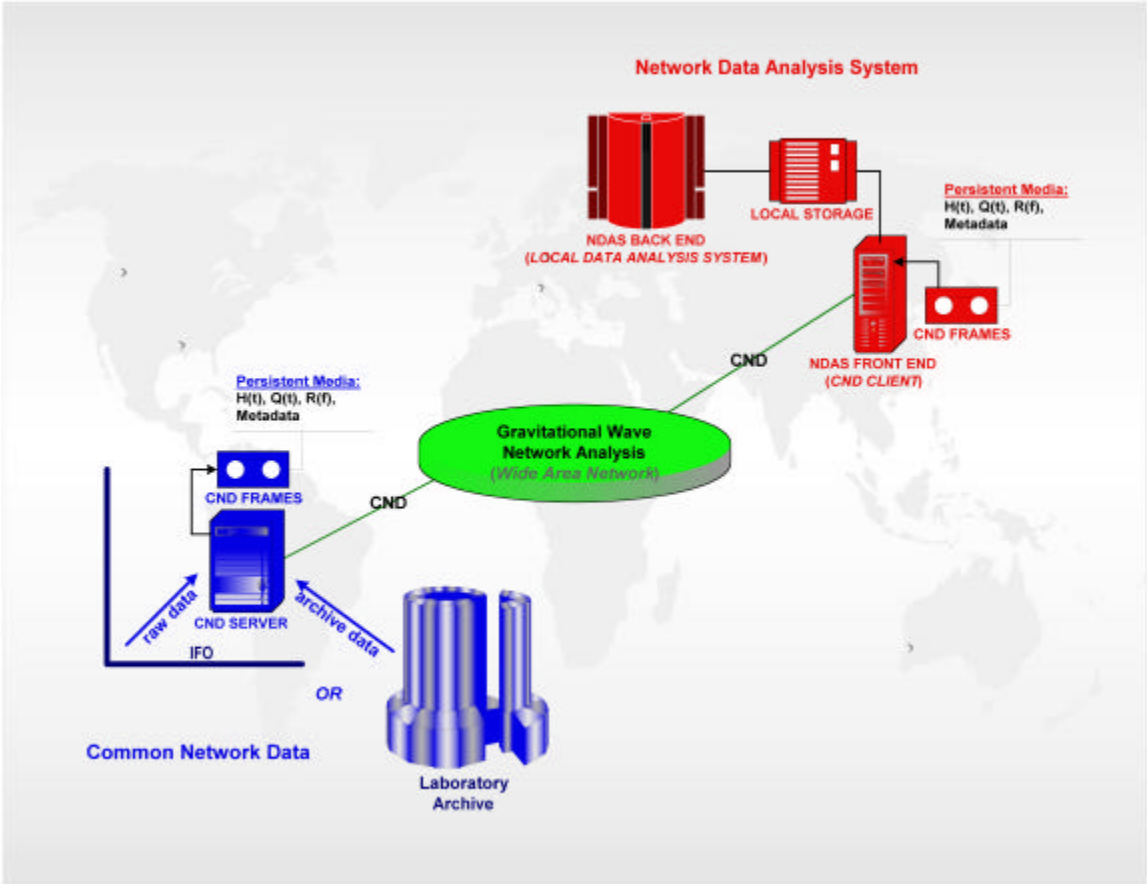

FIGURE 1: Gravitational Wave Network Analysis