Monitoring the Monitors: Assessing and Visualizing the State-of-Health of Earthscope’s Transportable Array

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1. ABSTRACT

The Earthscope Transportable Array has increased in size over the last three years to over 200 broadband seismic stations. Assessing the state-of-health of the station equipment, collecting data transfer metadata, and providing this information to analysts, station engineers, administrative staff, researchers, and the public is the responsibility of the Array Network Facility (ANF).

2. THE PROBLEM

The Transportable Array (TA) is one component of the Earthscope USArray project. It consists of 400 broadband seismic stations delivering data in real time to the Array Network Facility (ANF), housed at the Scripps Institution of Oceanography. In turn, the data is sent to IRIS for archiving and also stored offsite in a third location. The network is currently ramping up to full capacity. As of December 2, 2006 there are 293 stations operational. The ANF is responsible for data collection and its quality control, and is responsible for data archiving and long-term preservation.

3. THE SOLUTION: WEB-BASED ANALYSIS

To facilitate monitoring of such a large network, and to allow as diverse an audience as possible, we have developed a suite of online-web-based tools (see Box 6 and 7) available from the public ANF website, with further administrative tools located over an encrypted authenticated secure connection. Access to the secure administrative area is limited to station engineers and analysts.

The development of these tools allows any end-user to choose a station(s) of interest and request and/or observe SOH data for any number of components. In addition to monitoring tools that we have written, we have also leveraged pre-existing open-source and proprietary tools. These various tools are the focus of this poster.

4. COMPONENTS TO BE MONITORED

Each TA station has a variety of environmental sensors that are monitored. Data packets along with log messages, status messages, command responses and debug messages are written to a set of output ORBs. A large set of status channels can be generated as regular ORB waveform packets.

5. STATE-OF-HEALTH MONITORING SCHEMATIC

To display and visualize data products are readily accessible via the world-wide-web at http://anf.ucsd.edu, where multiple web-based tools have been developed to display and visualize these products.

6. USER INTERFACE TO STATE-OF-HEALTH MONITORING

7. DETAILED ANALYTICAL TOOL: ON-THE-FLY QUERIES AND RESULTS WITH RRD

Round Robin Database (RRD) tool is an industry standard system to store and display time-series data. It’s origins lie in the network monitoring world, however it can be used to display any time-series data. We have developed a method of populating a RRD Archive (RRA) with data from an ORB, called orb2rrd, that acts as a part of a real-time system. Whenever a new SOH status packet arrives in the ORB the packet is opened and the contents disseminated to a suite of RRD archives.

Database size is determined at creation time. The database server increases in size, even with high sample rates. This is because the RRDs are not linear databases - it helps to think of RRs as the perimeter of a circle; new data gets added along the perimeter. When new data reaches the starting point, it overwrites existing data. Different levels of data decimation are defined at creation time, allowing long time periods to be displayed quickly and with accuracy.

For each station we assign a single variable (such as vault temperature) to its own archive. In this way we can retrieve data from different archives and plot them in a variety of ways, either singularly or in combination with other variables.

The variables monitored cover eight broad areas considered to be the most useful to analysts and station engineers in diagnosing state-of-health problems: clock operations, vault conditions, vault definition, communication with the webserver, real-time waveform trace display and vault condition.