The Hawaii-2 Observatory

Alan D. Chave (Woods Hole Oceanographic Institution)

The Hawaii-2 (HAW-2) submarine telephone cable was laid in 1964 between San Luis Obispo, CA, and Makaha, Oahu, HI. It was operated continuously by AT&T until 1989, when a cable break off California led to its retirement from commercial service. After the cable system was transferred to a scientific owner, the Hawaii-2 Observatory (H2O) was installed in 1998 close to the midpoint between two repeaters near 28 N, 142 Wat about 5000-m water depth.

The primary scientific motivation for H2O comes from the global geophysics and seismology communities. The H2O site is located at a point on Earth 痴 surface where there is no land for about 2000 km in any direction. For this reason, it is a high priority site for the Ocean Seismic Network (OSN) component of the Global Seismic Network (GSN), and serves as the first operational OSN station. The geomagnetic community has also identified the H2O site as one of eight seafloor locations where permanent observatories are required. Finally, H2O is located at a logistically convenient place for testing permanent seafloor instrumentation and observatory concepts in the deep ocean.

The H2O infrastructure consists of a termination frame which is permanently connected to the HAW-2 cable and a junction box containing communications and power electronics along with a wet-mateable connector manifold to which instruments can be connected. The junction box is designed to be recoverable and deployable from a standard oceanographic research vessel, and this operation has now been completed about six times. The power system consists of a constant current power source in Hawaii and a set of switchable power stacks with a shunt regulator intended to convert the constant current power source to a standard 48 volt supply for the hotel and user loads. The initial communications system for H2O utilized an FDM architecture consistent with the original telecommunications design. This approach was required because the phase characteristics of the SD system are neither well characterized nor constant across the channel, and hence a wideband approach is not tenable. Standard computer modems were utilized along with PC104 stacks designed to multiplex high speed (up to 80 kb/s) instruments onto a set of four modems; four such stacks were contained in the original system. This system has proved to be less than ideal due to the characteristics of the modem.

The H2O system was changed from a circuit-switched to a packet-switched architecture during the 2003 upgrade. Packet switching is the basis for the Internet protocols which provide an automatic and highly reliable way to reassemble packets into the correct order when they arrive at different times (a pervasive problem on the original system), as well as providing a variety of error checking steps. High-speed instruments are connected through the existing signal mux to serial-to-10baseT converters or port servers, which convert the RS422 instrument stream to IP packets. The IP packets are then fed to an Ethernet hub that switches them to a set of Linux-resident PC-104 communications processors which can be programmed dynamically to connect one or more instruments to a bank of modems configured to operate as a pool. This allows one PC-104 to service more than one instrument or multiple PC-104s to service one instrument, and removes the current 80 kb/s upper limit for the data rate of a single instrument. The PC-104s run a multichassis multilink PPP protocol (MLPPP). This protocol allows multiple paths and can dynamically allocate resources. The PC-104s can also run custom code that handles data buffering and modem reconnects. Running TCP/IP over this protocol ensures that all data gets to Makaha and that data streams are fully reconstructed into the instrument 痴 original data format before being delivered to the end user. The re-designed system was constructed and tested prior to the scheduled re-installation in October 2003.

The re-deployment cruise suffered a series of serious problems from the outset. The junction box power supply (designed and built at the University of Hawaii) was delivered to the ship in inoperable condition, with no spare parts, and without engineering support. A significant effort was put into repairing this system for the first week of the cruise, at the end of which the power supply worked with the junction box and all of the planned instruments in the shipboard laboratory. However, as preparations to deploy the junction box were nearing completion, a serious medical emergency aboard ship necessitated a six day roundtrip to Hawaii to evacuate a person to hospital. Upon return, a commercial off the shelf ROV releasable shackle failed during deployment of the junction box, dropping the one ton unit 4000 m to the seafloor. After a three day search, the junction box was located about 450 m laterally from the drop point. It was recovered, found to be undamaged, and successfully deployed. Upon power up, the junction box power supply failed immediately due to serious design deficiencies and poor sytem integration with the power source and cable. Despite significant efforts to patch something together, the system was not operable. The j-box was recovered in mid-2004 and is currently being repaired for re-installation in 2006.