Operator Access to Acoustically Networked Undersea Systems through the Seaweb Server

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Abstract—The Seaweb server is a suite of software applications for managing the network-layer operations of underwater networks employing acoustic modems [Fletcher, et al., Proc. Oceans 2001]. It resides at manned command centers (ashore, afloat, submerged, aloft, or afar) and handles application-layer telemetry with mobile and stationary underwater nodes. The server communicates with the undersea network through gateway nodes, such as moored buoys, surface vehicles, or submarine sonars.

I. INTRODUCTION
Telesonar is acoustic communications in the undersea environment. Seaweb is an organized network of telesonar modems designed for command, control, communications, and navigation of deployable autonomous undersea systems [1]. A Seaweb server resides at manned command centers and is the operator interface to the undersea network as shown in Figure 1. Data and utility packets travel through the undersea network via routes managed by the server and executed by the undersea network in a distributed fashion. These routes are defined by neighbor and routing tables resident on the networked modems, and may be altered by the server administrator.

The second-generation Seaweb server was developed to provide a seamless operator interface to network undersea systems. It has evolved out of the client’s necessity for a robust server that communicates through transparent I/O to telesonar nodes (mobile and stationary), provides mission-critical information to end-users, and archives data/commands in database tables accessed by a web browser.

II. DEVELOPMENT
The Seaweb server has been transformed from a suite of proprietary software applications to a suite of open-source software applications developed for the Linux operating system. This transformation has significantly increased the robustness, simplicity, and client-server interface compatibility of the second-generation server.

Previously, the Seaweb server’s graphical user interface was a set of Labview virtual instruments [2]. However, due to incompatibility with the MySQL database and a high demand on CPU processing – Labview was replaced by Perl/Tk as a graphical interface. Perl is a script-based programming language, which employs regular expressions for text manipulation, glues several diverse programs together, and provides an interpreter for CGI (Common Gateway Interface) programs that avoids system overhead. Perl/Tk is the Perl graphical front-end toolkit for developing graphical user interfaces.

A MySQL database timestamps, archives and queues all incoming and outgoing data, client information, and network statistics. The database may be accessed/queried using any web browser.

Web integration links the database to the internet with an html form. This permits a client end-user to retrieve and insert telesonar modem data and commands to the undersea network system.
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III. FUNCTIONAL DESCRIPTION

The Seaweb server connects a client end-user to the underwater acoustic network through TCP/IP socket connection. The TCP server, a Perl script, manages the incoming and outgoing message traffic between the Seaweb server and the client as shown in Figure 2.

Client outgoing data are queued in a message queue database table. After the data packet is archived in the modem messages table, it is sent by the server administrator’s message preset prioritization to the acoustic network through a gateway node. The gateway node links the Seaweb server to the undersea network through standard TCP/IP and RS232 serial protocols. Successfully implemented links between the server and the gateway nodes have included FreeWave line-of-sight packet radio, cellular digital packet data (CDPD), Iridium satellite telephone, and US Navy submarine sonar communication systems.

Data packets destined for a client are delivered to the gateway node from a Seaweb of interconnected telesonar modems. After successful delivery from the gateway to the Seaweb server, the data packets are parsed and written to the raw-data, network-statistics, and user-data database tables.

- The raw-data database table receives the unformatted data as it’s sent from the gateway node.
- The network-statistics database table stores the status information of each hop that a data packet completes in the undersea network.
- The user-data database table archives client specific data destined for an end-user.

Acoustic network command and control determines which client to send the user data based on his IP address, port number, and source/destination id numbers of the acoustic telesonar modems and the client’s Seaweb subscription. After setting up a client/server socket to the TCP server the user data packet is sent from the acoustic network command and control to the client end-user.

IV. OPERATIONAL DESCRIPTION

A. Server Administration

A Linux/Unix shell script is executed to start the Seaweb server. This script queries the server administrator to set up the server to utilize his assets: the acoustic undersea network, clients, and the server’s host computer.

The server administrator selects the database location, normally localhost, and the host port number for the TCP server. After these actions, the administrator sets up specific ports (RS232 and TCP/IP) to interface with gateway nodes.

A successful launching of the Seaweb server will display the graphical user interfaces as shown in Figure 3, minus the TcpClient which is shown as an example of a typical client end-user display. All incoming messages are sent to the gateway read-only terminal window and to client displays as they are required. In addition to the graphical gateway display, a time-stamped text log file is initialized for each gateway node as a backup archive to the database.

The heart of the server is the message buffer Perl T/K graphical display – the acoustic network command and control and message queue for outgoing messages. From the message buffer, the administrator prioritizes undersea network activity, selects messages for clients in manual mode or allows FIFO to clients in transparent mode, and views all pertinent information about outgoing messages to the acoustic network.
B. Data Retrieval

Client user data are sent directly to the subscribed clients from the Seaweb server as they arrive from the gateway node from the acoustic network. With permission granted by the server administrator, client end-users may query the database for additional archived information. Clients may submit database queries using any web browser. When the client accesses the Seaweb server’s main web page, a list of available database tables are displayed along with descriptions of the content of the tables, an example of the message queue database table is shown in Figure 4.

An example of a client end-user’s initiated query is shown in Figure 5 with the result posted in Figure 6.
Figure 5. A client query for all user data packets with the word "MINE" coming from node 7 in the undersea network.

Figure 6. The result from the client's query. Note: Destination Id is actually the gateway node to which the data packets were routed.
V. SEA TESTING

For the past two years, the Seaweb server has been the primary data gathering source in experiments involving autonomous systems, including FBE-I, RDS-4, and Q-272.

FBE-I Seaweb (June 2001) demonstrated the successful transmission and reception of Naval messages from and to a submarine at speed and depth via the Seaweb server. In addition, the Seaweb server processed telesonar transmissions from two Deployable Autonomous Distributed System (DADS) ASW sensor nodes.

RDS-4 Seaweb (October 2002) demonstrated a variety of underwater sensors as interoperable nodes of a Seaweb network. The network included the U. S. Hydra and Kelp ASW sensors, and the Canadian UCARA sensors.

Q272 Seaweb (February 2003) demonstrated a fleet of three AUVs operating as mobile nodes with a grid of six fixed Seaweb nodes. When surfaced, the AUVs also functioned as Racom gateways with Iridium, FreeWave, ARGOS, and GPS [3].

VI. FUTURE DEVELOPMENT

Current plans for the server include improved graphical interfaces, routing algorithms, AUV tracking functions, and interoperability with other acoustic modems.

Future plans for the server include implementing node localization, mobile node tracking, optimized routing algorithms, and network initialization. Certain of these functions will ultimately migrate into the water in the form of a Seaweb master node capable of controlling a networked field of telesonar modems. The master node communicates with manned command centers via gateway nodes such as a sea-surface buoy radio-linked with space satellite networks, or a ship’s sonar interfaced to an onboard Seaweb server.

ACKNOWLEDGEMENTS

The development of the Seaweb server is sponsored by ONR 321SS, and its application is sponsored by various sources.

REFERENCES

