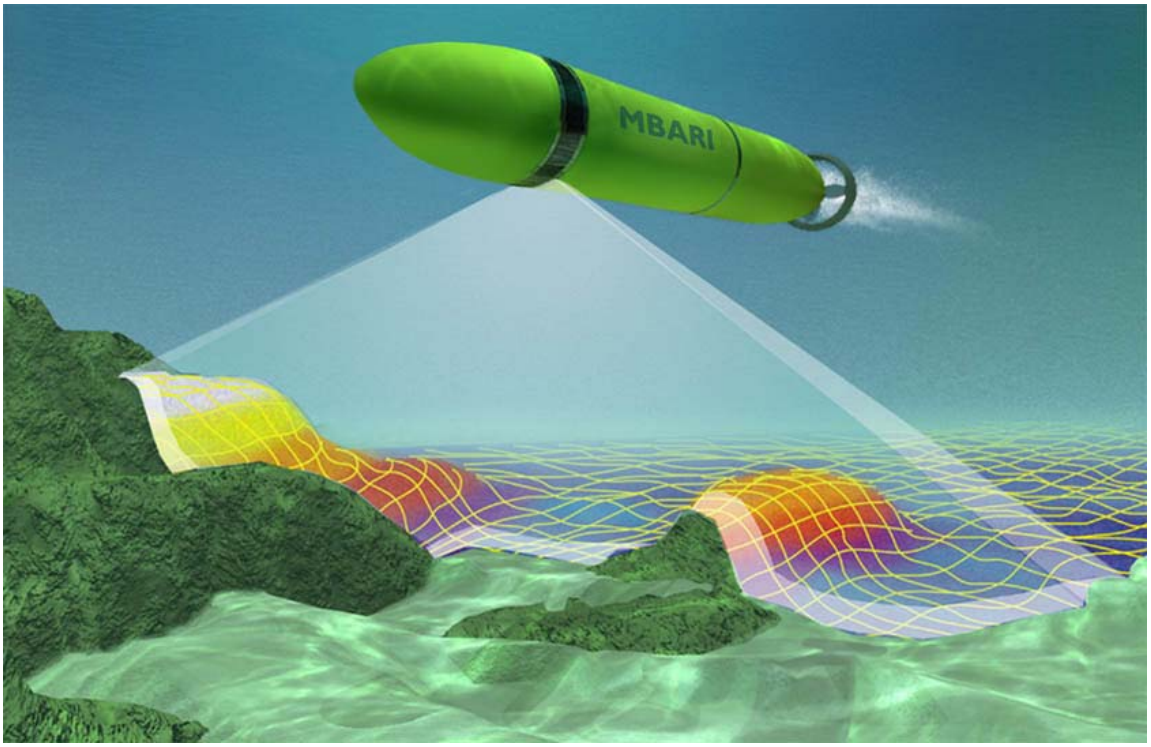
RESON 6046
Payload Controller
and
Data Acquisition System
for
MBARI AUV



Revision 0.02

By

RESON Inc.

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1.0 Introduction

1.1 PURPOSE / SCOPE

This document describes the software features of the RESON 6046 Payload Controller and related Data Visualization Utility for the MBARI AUV project and serves as a statement of work for the development. Furthermore, it serves as a point for further discussion between MBARI and RESON and will be revised as necessary.

1.2 ACRONYMS / DEFINITIONS

PLC	Payload Controller: software component(s) used to coordinate and log an integrated sensor suite and to provide remote control capabilities.
DVU	Data Visualization Utility: a software client of the PLC used to control and optionally display data from the PLC for rudimentary QC purpose.
SeaBat™ 7k	Generic term used to describe the SeaBat™ 7000 series of sonars, related software components and protocols.
7k Format	Record based format defined for data logging and network transmission by SeaBat™ 7k systems, the PLC and other components.
XTF	Extended Triton Format: An open binary data logging format published by Triton Elics International, Inc.
ICD	Interface Control Document.
SSS HF/LF	Side Scan Sonar (High Frequency and Low Frequency).
SBP	Sub-bottom Profiler.
SVP	Sound Velocity Profiler.
DVL	Doppler Velocity Log.
Trigger Controller	A PLC subordinate software component that is used to control or initiate the system triggers.
MVC	Main Vehicle Computer: the AUV's main navigation and system control computer.

1.3 REFERENCES

[1] "RESON SeaBat™ 7k Data Format: Interface Control Document", v0.41, RESON Inc., 2002.

[2] "Interface Control Document for the Integrated DVL INS (SEADeViL)", Kearfott Guidance & Navigation Corporation, Y207A277, Rev A, 8/14/01.

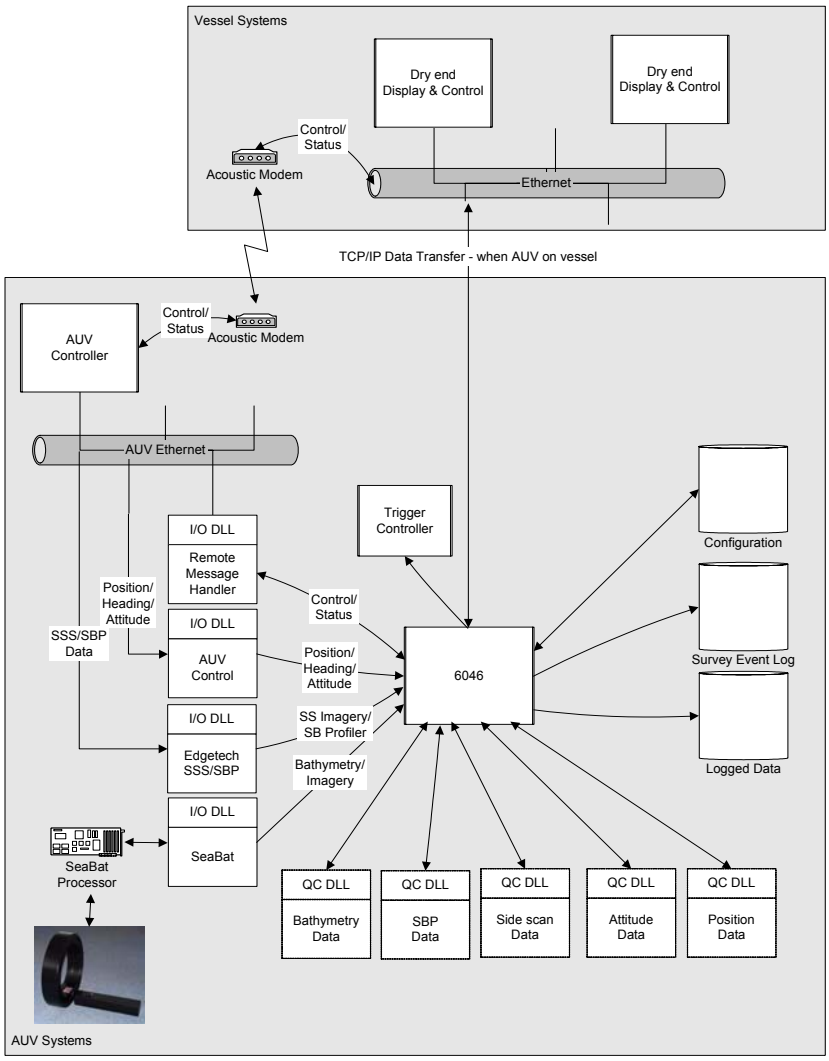
2.0 Description

The 6046 software is designed to collect data and control a variety of sensors in either a manned or unmanned environment. It consists of a Payload Controller (PLC) and zero or more remote control programs. The remote programs may control the PLC and to provided system status monitoring and data visualization.

In development beyond phase II, data specific QC modules will be added to monitor survey data as it is collected along with various aspects of the system performance.

Figure 1 depicts the overall system layout and is described below.

Figure 1 — 6046 System Overview



2.1 PAYLOAD CONTROLLER

The PLC runs as either a NT service or console program under Microsoft's Windows 2000, XP or XP embedded operating systems and is able to be automatically started and shutdown by the operating system.

Each set of related sensors are coordinated by a module that interfaces to the PLC via a standard interface. Modules are responsible for the control and acquisition of data from associated sensors, using a variety of communications types and protocols, as necessary.

The PLC coordinates the acquisition of data from each sensor and is responsible for time tagging and logging the acquired data. System status, alarm reporting and command routing to and from the sensor suite is performed.

Control of the PLC is achieved through a dedicated TCP/IP based stream socket through which one or more clients may connect.

2.1.1 Interface and Protocol

The PLC uses TCP/IP connection oriented sockets to listen for incoming connection requests from remote hosts. By default, socket port number 6046 shall be used for this purpose but shall be pre-survey configurable.

The 7k data format and network protocol shall be used for data logging and transfer purposes. Relevant records are summarized below and defined in [1].

2.1.2 Start-up Configuration

The PLC shall utilize one or more configuration files to restore its significant previous state upon start-up.

2.1.3 Command and Control

The PLC shall be capable of receiving and enacting various remote commands, from one or more connected clients, over the stream socket.

Specific commands are defined in table F.1 of [1] and allow a variable length embedded ASCII command with optional parameter(s) to be specified. Commands may be addressed to the PLC or a subordinate sensor using the generic Payload Controller command (record #11000) also defined in [1]. Various commands, their identifiers and optionally embedded parameter list are also given.

The PLC will queue and sequentially execute (serialize) incoming command requests. It is therefore the responsibility of connected clients to coordinate their activity so as to avoid potential command conflicts.

The PLC shall support both verbose and quiet modes. In verbose mode, an acknowledgement message (ACK or NAK) will be sent back to the host upon receiving a command using record #11001. Conversely, no acknowledgement message will be transmitted back to the host in quiet mode.

Note that command acknowledgement in verbose mode is in addition to solicited messages — solicited messages are not affected by this mode.

2.1.4 Notification Messages

Depending on predetermined criteria, the PLC may transmit three (3) unsolicited message types: alarms, system status changes and QC messages as summarized below.

2.1.4.1 Alarms

Record #11002 shall be used to transmit predefined alarm messages to connected remote hosts whenever an alarm condition has been detected or a previous alarm condition cleared. The PLC may emit an alarm message at any time with a corresponding entry being made in the Survey Event Log. Table F.3 of [1] defines the PLC alarm messages.

2.1.4.2 Status Change

The PLC may emit general sensor state or change notification messages to connected hosts whenever a significant event has occurred (as determined by the PLC) or a specific query made by a connected client. Such messages shall use record #11002 with the predefined identifiers and formats as given by table F.2 of [1].

2.1.4.3 Quality Control Messages

No specific quality control messages have been defined at this time, however, record numbers 11200 to 11299 have been reserved for this purpose.

2.1.5 Survey Event Log

The PLC shall maintain a Survey Event Log detailing significant changes to the sensor or internal system state, external command requests or alarm conditions that have occurred during the mission for post-survey review.

Each record in the Survey Event Log will be prefixed with a timestamp and suitable identifier(s) for traceability purposes.

The resulting file shall be of ASCII format and use the nomenclature: YYYYMMDD_HHMMSS.log where YYYYMMDD and HHMMSS respectively represent the UTC date and time.

2.1.6 Trigger Controller

The 6046 Trigger Controller will not be utilized for this deployment as MBARI shall be providing the hardware trigger pulse to trigger the 7k sonar and sundry devices.

2.1.7 Time Synchronization

The PLC shall be capable of accepting external time messages from connected clients in order to grossly discipline its internal clock to UTC. Command identifier 20 of table F.1 (of [1]) is provided for this purpose.

Additionally, the 7k sonar shall allow a 1PPS input to be used to which the time message will be synchronized. Whenever a decoded UTC message has been received by the PLC, and the local system clock determined to be out of tolerance, the system clock will be synchronized to the new time. Message aging of the received message shall be taken into account.

Whenever a time synchronization message has been received by the PLC, all subordinate sensor modules shall be notified so that subordinate subsystems may also be synchronized, as appropriate for the given sensor.

2.1.8 Logging

2.1.8.1 Data Format

Sensor data shall be logged in the 7k data format (c.f. [1]). Individual records used for each sensor are summarized on a per sensor basis in the following sections.

2.1.8.2 Format Conversion

An off-line utility will be provided to convert logged 7k data into eXtended Triton Format (XTF). This utility shall allow multiple 7k files to be chosen and corresponding XTF files generated into a nominated directory on a per subsystem basis.

2.1.8.3 Time Stamping

The PLC shall timestamp all data records with the system time (synchronized to UTC) using the 7KTIME format in the header of each record. Where sensors provide a timestamp, this timestamp shall be preserved and logged along with the embedded sensor data but NOT in the record header.

2.1.8.4 File Nomenclature

The PLC shall create logging file names using the recommended nomenclature of reference [1], namely: YYYYMMDD_HHMMSS.s7k where YYYYMMDD and HHMMSS represent the UTC date and time respectively.

The local logging directory and maximum file size limit will be configurable parameters.

In order to simplify processing, a predetermined overlap shall be maintained across size-based automatically generated files. This overlap shall be 100 records by default but configurable.

2.1.9 Sensor Suite

The following describes the various sensor modules that the PLC shall support and provides a functional description of each sensor module to be developed.

2.1.9.1 RESON 7k Sonar

The SeaBat™ 7k subsystem will be an integrated subordinate sensor within the PLC sensor suite for command, control and data logging purposes. It shall provide general startup and state restoration for its subsystems along with time synchronization.

Full system capabilities shall be supported.

2.1.9.2 Main Vehicle Computer

Vehicle Attitude Data

Vehicle attitude data from a SEADeViL DVL/INS will be sent to the SeaBat™7k sonar i/o module via an RS-232 serial port with the following nominal characteristics: 115200 baud, odd parity, 8 data bits, 1 stop bit. Attitude data shall consist of a single Navigation Data record (message identifier 1) as specified by [2], pp 25 and 43. Moreover, attitude data rates will nominally be 20 Hz — approximately 50 bytes output every 50ms. MBARI will ensure superfluous messages are removed from the serial data stream as all data received on the port will be acquired by the sonar (subject to bandwidth limitations).

It is further anticipated that the PLC shall accumulate a single record spanning approximately one (1) second and log an appropriately defined 7k record preserving the sonar's timestamp. Details are TBD.

Sound Velocity Data

A dedicated PLC subordinate module shall be created to acquire oceanic environment data from the Vehicle Control (VC) subsystem. The module shall receive the UDP broadcast Environment Message, as defined in Appendix C of reference [1], on a configurable port.

Data shall be logged by the PLC as record #3100. Multiple message frames shall be used to form a single record spanning approximately one (1) second.

In the event that the VC is extended in future to support other frames defined in Appendix C of [1], record formation shall be on a per frame type basis — that is, one record spanning approximately 1 second for each frame type.

The PLC shall internally route mission critical data to dependent subsystems. Accordingly, vehicle supplied sound speed shall be routed to the SeaBat™ 7k sonar for this deployment.

2.2 DATA VISUALIZATION UTILITY

Top-side clients shall be capable of controlling individual sensors or groups of related sensors at runtime. This will include bringing sensors on-line or taking them off-line, controlling individual parameters of a given sensor and general control of the PLC data logger.

RESON's Data Visualization Utility (DVU) shall provide an interface to visualize collected data for review purposes and to provide an interface to monitor system status and alarm conditions. In the AUV context, the DVU would typically be used only for pre-deployment deck checks with the DVU being replaced by the vehicle controller during survey.

2.2.1 Remote Command and Control

Using the TCP/IP-based socket and messaging interface, it is possible to control the PLC from any computer on the LAN. The PLC is a socket server to which one or more clients may communicate using the SeaBat™ 7k data format defined in [1].

PLC clients shall be capable of sending commands to and receiving data from the PLC — both solicited and unsolicited messages. Messages from the PLC may originate from the PLC itself or be routed to or from individual sensor modules.

2.2.2 Playback

The DVU shall provide a dialog-based user interface to allow files from a given directory to be chosen and replayed for visualization purposes. The replay rate will be selectable from the main user interface.

Note: file transfer between the DVU and the PLC unit will require an operating system function such as shared folders or use of FTP. No UI will be provided for this purpose.

2.2.3 User Interface

2.2.3.1 Configuration Display

The DVU will provide a configuration dialog to allow general parameters to be set up and to set and display the state of the PLC controller once connected.

This display shall include, but not be limited to, the following items:

- Time synchronization (enable/disable)
- Sensors connected
- Sensor status
- Received message statistics

An interface to allow the PLC's acquisition file parameters to be configured will be provided, namely:

- Maximum file size
- Logging directory

2.2.3.2 Sensor Status and Control

Where applicable[1], each sensor module loaded by the PLC shall have a corresponding dialog display on a tabbed panel of the DVU for sensor control purposes.

2.2.3.3 Alarms and Status

A dedicated alarm display and control panel shall be provided to allow historical view of alarms received from the PLC and its subordinate sensor suite.

Most recent alarms will be displayed first, with currently active alarms generating a flashing UI component to notify users of this condition.

Once acknowledged, the active alarm display will cease flashing but the alarm will remain active until the condition is reset by a corresponding alarm clear message from the PLC or it has been canceled by the operator through the UI. Additionally, the UI will provide a method of allowing a given alarm to be suppressed; that is, not transmitted by the PLC.

2.2.3.4 Visualization

The following data displays will be available during replay for visualization purposes and will be provided for phase I. These displays will be extended to real-time operation and otherwise enhanced for phase II.

Waterfall Displays

The system will be capable of displaying side scan, bathymetric and sub-bottom profile data in suitably scrolling re-sizeable waterfall displays.

Time Series Plots

A generic time series plot display will be created to allow various parameters to be displayed on configurable plots. One or more plots with one or more trace per plot will be supported.

It will be possible to display, but not be limited to, the following parameters:

- Altitude
- Speed
- Depth
- Roll
- Pitch
- Yaw
- Velocity components
- Acceleration Components

[1] — The sensor(s) must be remotely controllable.

Navigation Display

Navigation data will initially be viewable as a table of updating values. The position will be displayed with the timestamp for which the position pertains. Most recent position shall be at the top-most of the table. A plan display is anticipated for a release beyond phase II; it will not be present for phase II delivery.

3.0 Revision History

Version	Date	By	Comments
0.01	10/8/01	Wayne Arcus	Initial release
0.02	9/30/02	Wayne Arcus	Moved PLC tables to [2] and general revision.

4.0 Sign-Off

Function	Name	Affiliation	Date	Signature
Software Project Manager	Wayne Arcus	RESON		
Program Manager	Dan Suchman	RESON		
Senior Research Specialist	David Caress	MBARI		