Interface Design Definition

FS-3DT, Argos 350, Argos 500, and Argos 1000 Navigation Sonar Systems

FarSounder, Inc.
151 Lavan Street
Warwick, RI 02888
United States

phone: +1 401 784 6700
info@farsounder.com
www.farsounder.com

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Table 1. Definitions

Term	Definitions
FSS	FarSounder SonaSoft™ Software
FS-3DT	FarSounder's 3D dual transmission forward-looking sonar designed for surface ships. Operates in two modes: 90 degree field of view with a range of up to 330 meters and 60 degree field of view with a range of 440 meters. Note that this is an legacy model of sonar that is supported, but no longer available for sale. It has been replaced by the Argos 500 system
Argos 350	FarSounder's 3D medium range forward-looking sonar designed for surface ships. Operates at ranges of 100, 200, and 350 meters with a 90 degree field of view.
Argos 500	FarSounder's 3D extended range forward-looking sonar designed for surface ships. Operates at ranges of 100 and 200 meters with a 120 degree field of view and at 500 meters range with a 90 degree field of view.
Argos 1000	FarSounder's 3D long range forward-looking sonar designed for surface ships. Operates at ranges of 100 and 200 meters with a 120 degree field of view, at 500 meters range with a 90 degree field of view, and at 1000 meters range with a 60 degree field of view.
ZMQ	ZeroMQ Library: http://zeromq.org/
Protobuf	Protocol Buffers: https://code.google.com/p/protobuf/

2. Introduction

This document provides an overview of the network interface to FarSounder's FS-3DT, Argos 350, Argos 500, and Argos 1000 Navigation Systems. The intended audience is software developers who would like to interface with FarSounder's navigation products in order to integrate its live 3D forward looking data into their system.

3. Overview of Interface

FSS uses ZMQ to send Protobuf encoded data through the network. Clients may connect to any data channels they need. FSS typically provides two types of ZMQ connections for clients:

1. ZMQ_SUB for streaming data.
2. ZMQ_REQ for configuring FSS via Remote Procedure Calls and/or requesting certain types of data.

All sockets operate entirely independently. A client may connect and disconnect to each socket as needed. For example, a client that is only interested in Target Data and Control information only needs to connect to the Target Data and Control data sockets. If that client later decides it also wants Hydrophone Data, it can then connect to the Hydrophone Data socket at that time.

In general, streaming data messages (ZMQ_SUB) will be sent at approximately .5 Hz to 3 Hz, with the exact rate depending on the sonar and system configuration in use at the time.

Please see the accompanying .proto files for details on the socket type and default port number for each message provided by FSS. In particular, `nav_api.proto` describes all the messages that are provided by FSS. The other .proto files describe sub-messages of the primary data types.

A basic example implementation in C++ of both the publish/subscribe and the request/reply methods is available for download on our SDK page.

4. FarSounder's Coordinate System Convention

The 3-dimensional data generated by FSS conforms to FarSounder's coordinate space convention. The coordinate space's origin is the center of the Transducer Module array face as shown in figure 1. Positive Cross Range is to Port. Negative Depth is Down. Cross Range and Down Range are constant relative to the earth and do not change as the vessel rolls and pitches.

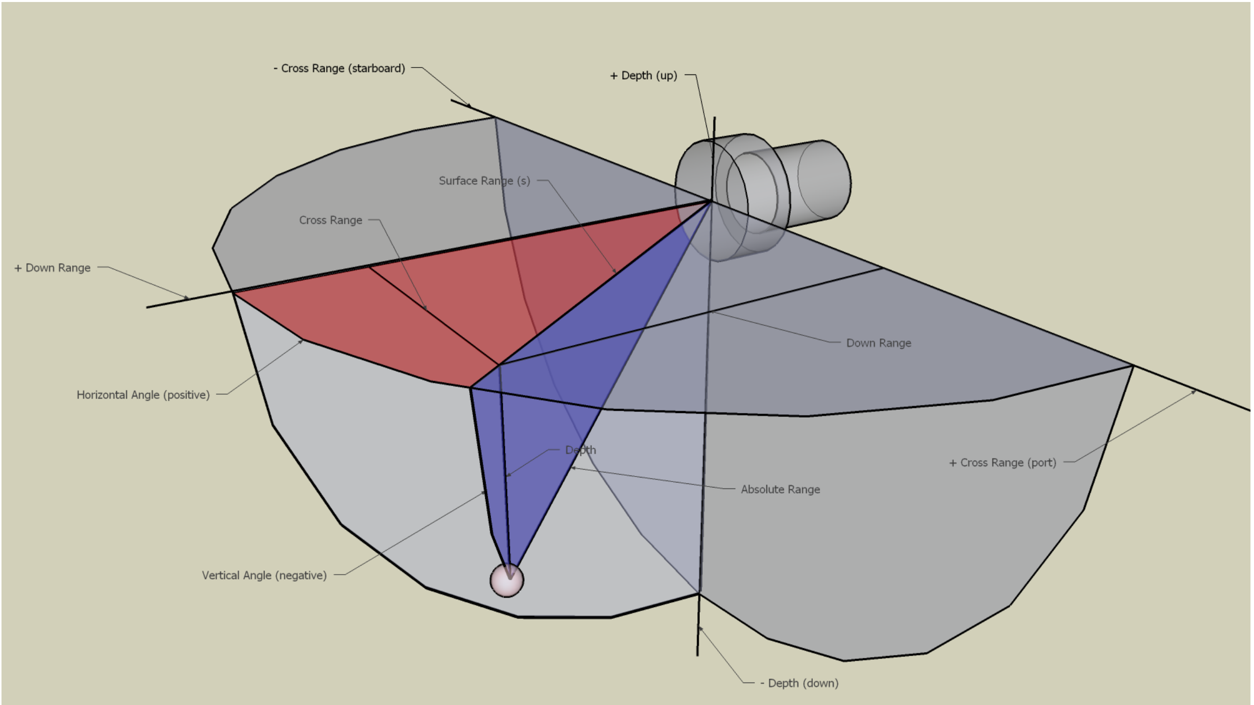

Figure 1. Coordinate System for FarSounder sonars.

5. Hydrophone Data Explained

Hydrophone Data is the filtered receiver signal produced by a sonar's Transducer Module. As each receiver is generally composed of multiple receiver elements arranged into a receiver array, hydrophone data includes the raw signals for all the elements in the array. This data is produced every time the sonar completes a transmit/receive cycle.

FarSounder's user interface display uses hydrophone data in its status viewer. This data type is included so that 3rd party systems can replicate a similar display if desired. This display is used for troubleshooting and checking that the system is transmitting and/or receiving. The FarSounder display shows a "checker board" indicating the geometric layout of the receiver array. Each square in the "checker board" represents a single receiver element. The color of each square is related to total energy received by that receiver. This lets the user quickly see if a single channel is not operating well. The FarSounder display also allows a user to select a specific channel and display the time series of that single channel in an O-scope like display.

Figure 2 shows the Status Viewer from FSS. In the center panel, labeled "Hydrophone Data", is a channel of hydrophone data (shown on the left), as well as a depiction of the relative intensity of each individual hydrophone (shown on the right). Note that the hydrophone intensities on the right hand side are arranged into a grid sized [`number of Horizontal hydrophone elements`] by [`number of vertical hydrophone elements`].

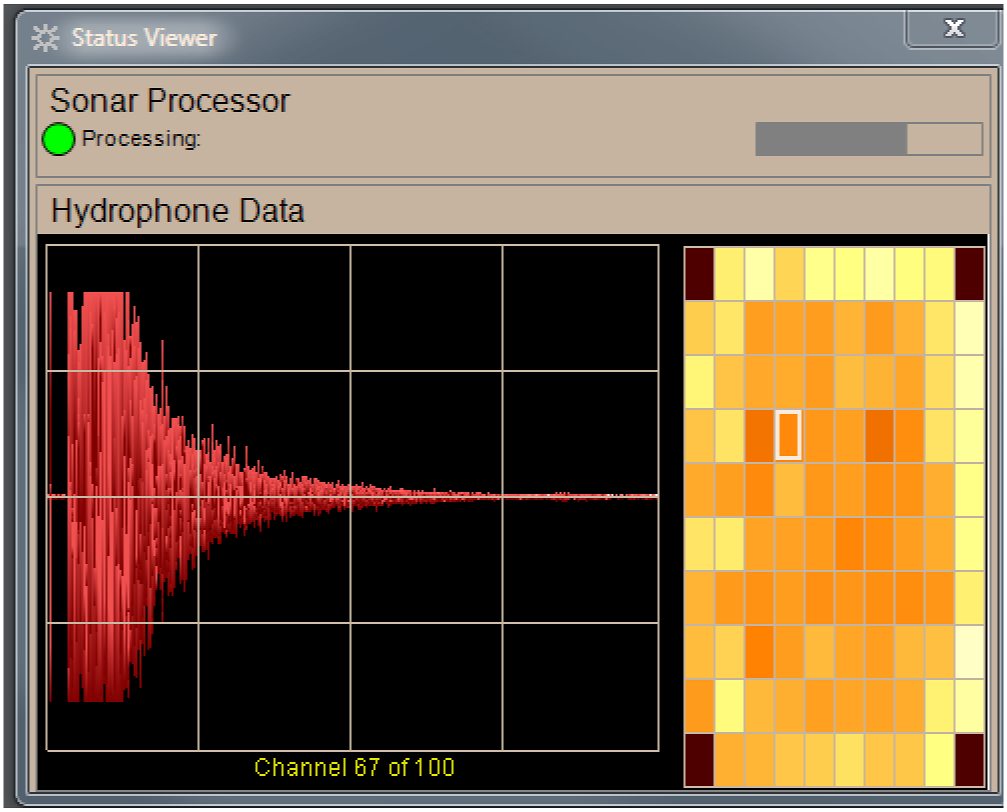

Figure 2. SonaSoft's Hydrophone Data Display

6. Target Data Explained

Target Data is the 3 dimensional data processed from the sonar. The data is split into two primary groups: bottom (sea floor) detections and in-water detections. In FarSounder's display software, the "bottom" is drawn as a smoothed surface. It is generally limited to about 8 times the depth of water below the Transducer Module (see FarSounder's tech blog article "Explaining the Water Depth Limit and Other Unexpected Reflections" for more information). The bottom image can be drawn with color mapped to depth or color mapped to signal strength. This is 3D information and can be displayed in a top down orthographic projection or as a 3D surface with perspective. In-water targets are drawn separate from the sea floor. When these targets are located beyond the water depth limit of the sonar, their depth information is not reliable.

6.1. FarSounder Display Example

Figure 3 shows an example of the 3D sonar display from FSS. It is generated from target data. In this picture, the seafloor is drawn as a smooth surface from the target data's bottom bins. The in-water targets are drawn with a simple sphere representing each in-water target data location. Additional examples of FarSounder's display can be found in FarSounder's screenshots gallery.

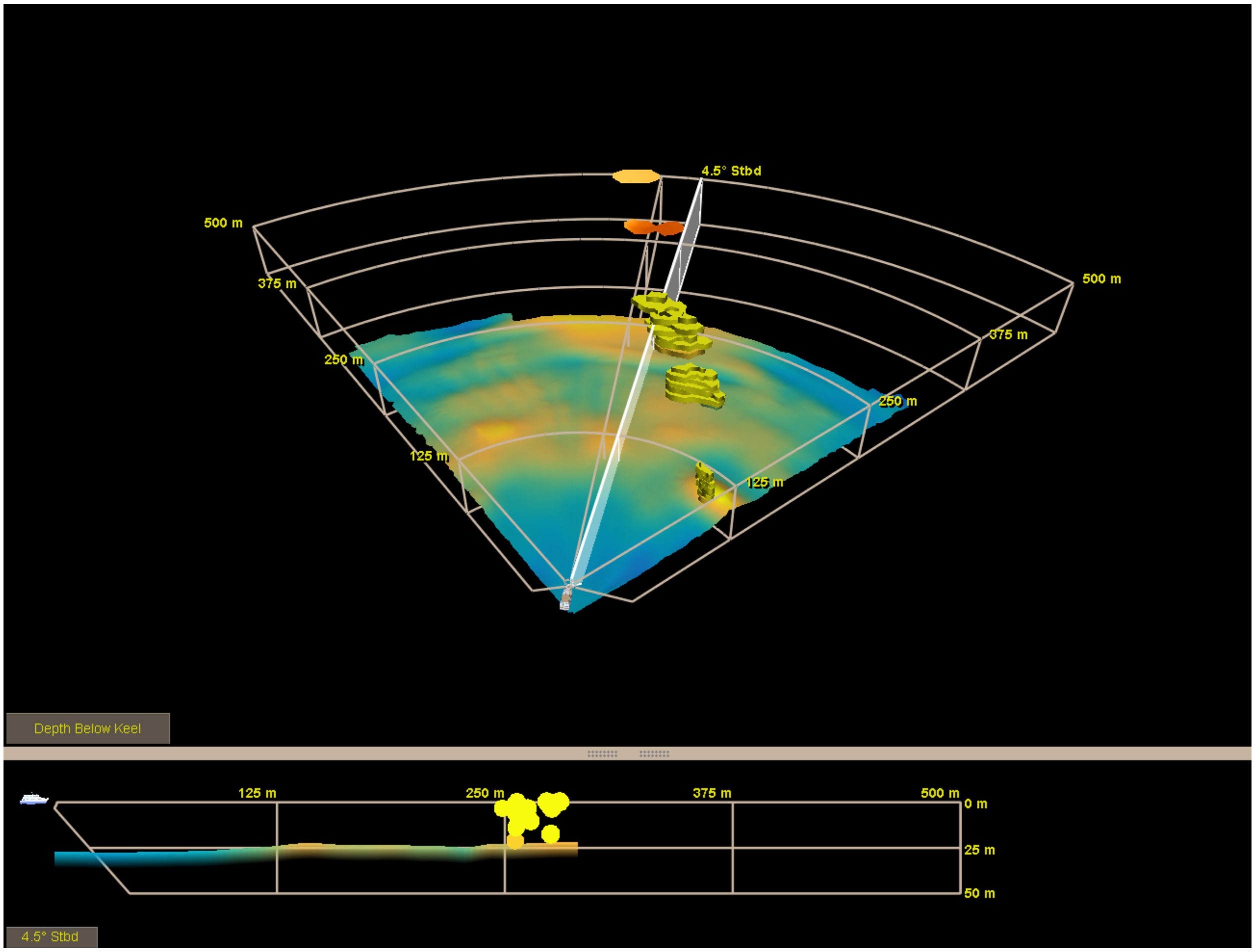

Figure 3. SonaSoft's 3D Sonar Viewer

6.2. Sea Floor Drawing Example

The seafloor data which may be included with each target data consists of multiple bottom bins. Each bin represents a single point that has been detected as part of the seafloor by FarSounder's sonar processing.

Each bin includes information about the particular angle and range indices on which it was detected. Each bin also includes the (x,y,z) location of the bin relative to the sonar. The bottom points provided by the bins can be expected to be ordered by increasing the range index along each angle index.

There are a variety of methods for drawing a surface from a series of sparse points. FSS uses a relatively simple method of generating the 3D surface.

The drawing algorithm first expands the bottom points for every range index along each horizontal angle index. Since the angle and range indices are included in the bins, the drawing algorithm can easily determine the range extents of the bottom bins along each horizontal angle. The algorithm then simply draws triangles between points along two consecutive angle indices as illustrated in Figure 4.

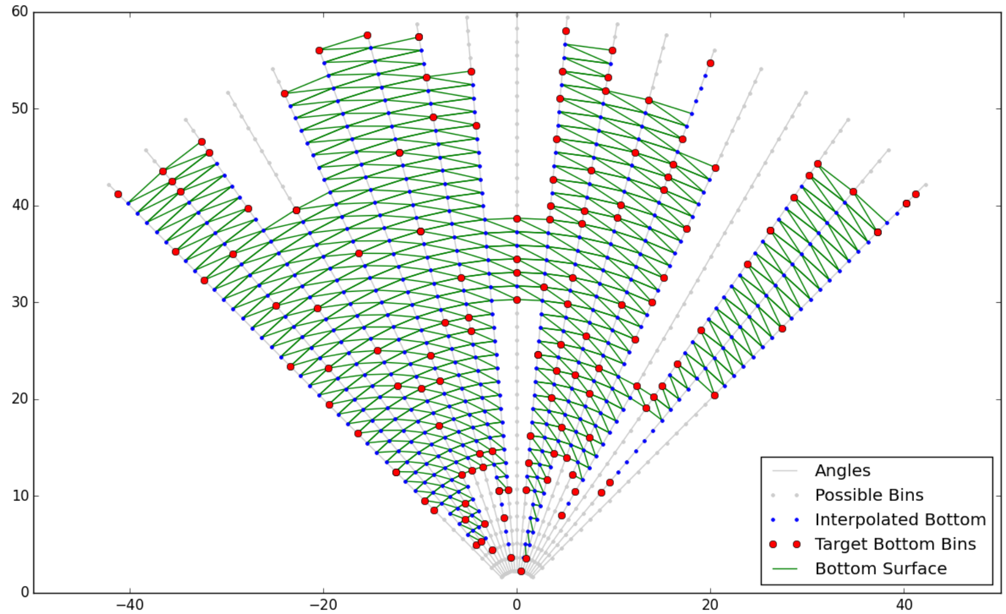

Figure 4. Simple bottom drawing example