Feb 28th, 2:15 PM - 2:45 PM

Session 4 Presentation - Comprehensive Software Solution for the Management of Complex Oceanographic and Meta Data

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Comprehensive Software Solution for the Management of Complex Oceanographic and Meta Data

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1. Abstract

The AXYS Data Management System (DMS) [1] software is designed to facilitate WatchMan500™ station configuration and the control of data collection and processing for a WatchMan500™ Network Solution. The DMS is simple enough to be used with a single WatchMan500 station yet robust and scalable enough to interface with many WatchMan500 stations simultaneously. The vertical integration of deployed system network management makes configuration management remote diagnostics and troubleshooting more efficient, effective, and economical.

The DMS data collection and processing features are managed via the DMS Service application. The DMS Service is a Windows service that controls: communications (telemetry), data collection, data processing into a Database Management System (Microsoft SQL Server) and/or ASCII text files and data dissemination to other systems. The DMS is a comprehensive data management software package that allows operators to effectively manage all critical aspects of AXYS products including all Met-Ocean and Directional Wave systems utilizing real-time two-way communications.

2. Introduction

The operation of a remote data acquisition system (e.g. Wave Buoy) with real time telemetry, be it one station or an entire network, will rely on the dependable operation of a supervisorial data management system. Key features of such a system require self-healing capabilities and the ability to avoid being accidently terminated, along with a host of operational features for data IO, data management and data display.

The DMS is software used to communicate with one or more WatchMan500 modules. The DMS enables clients to manage:

- **What** their station network configuration looks like;
- **How** "Station-to-DMS" or "DMS-to-DMS" communication occurs;
- **What** data is being communicated;
- **How** the data being communicated gets stored; and
- **Facilitate** uploading of new Firmware to remote WatchMan 500 systems (advanced feature) via high bandwidth two-way telemetry.

Furthermore, the DMS supports various forms of telemetry to the stations and different modes on how communication is initiated. From the instant you add and configure the first station to the DMS, messages can be sent back and forth from the DMS to the station.

Once the DMS has been configured, it requires minimal user interaction and monitoring as it is designed to recover from any unexpected system/software errors. The DMS Service was designed to run unattended as a self-healing Windows Service which allows users to log on and log off a computer without interrupting its operation or to be installed on a server in a data center. The DMS User Interface can be run on a separate computer allowing interaction with the DMS Service over a LAN or VPN by multiple users. The DMS data collection and processing features are managed via the DMS Service application.

The DMS supports the development of custom plugins to receive and decode data directly from sensors or to provide advanced functionality. As an example, AIS, SMS, Vindicator, and TRIAXYS™ plugins have already been developed to further advance the capabilities of the DMS.

3. DMS System Requirements and Components

The DMS software will operate on any PC or Server operating Windows OS ≥ XP or Windows Server ≥2003, with a 2GHz dual core CPU, >2GB RAM and hard drive capacity >100GB; this by today's standards is an entry level machine. Other required elements of the hardware will be an Ethernet port and serial IO if the system deployed requires this for interfacing.

The DMS components include: DMS Service, DMS User Interface, Microsoft SQL Server Relational Database Management System (RDBMS), SmartView desktop viewing software, and the SmartWeb web-based viewing software. SmartWeb can be installed on a laptop or installed and distributed on a corporate network across different servers and user computers allowing for a flexible and scalable solution.

The **DMS Service** is a Windows service that controls: communications (telemetry), data collection, data processing into a Database Management System (Microsoft SQL Server) and/or ASCII text files and data dissemination to other systems. The benefit of running as Windows service is the freedom for the user not to be logged in to the computer which is running the DMS.

On installation of the DMS application, a public domain **Microsoft SQL Server Relational Database Management System (RDBMS)** is installed on the host PC or Server. This is fully functional, but has a limitation in the number of stations/data that can be accepted.

The **DMS User Interface** presents information and

collects user inputs via a series of dialog boxes. Most of these dialog boxes contain common components to provide you with consistent and logical navigation throughout the entire user interface. Most dialog boxes displayed in the DMS user interface perform validation on the data you enter into the input controls. The validation is completed before the data is saved to the database to prevent errors from entering the system. Once the basic system information has been input, the client will be viewing the DMS Main Window as shown in Fig. 1.

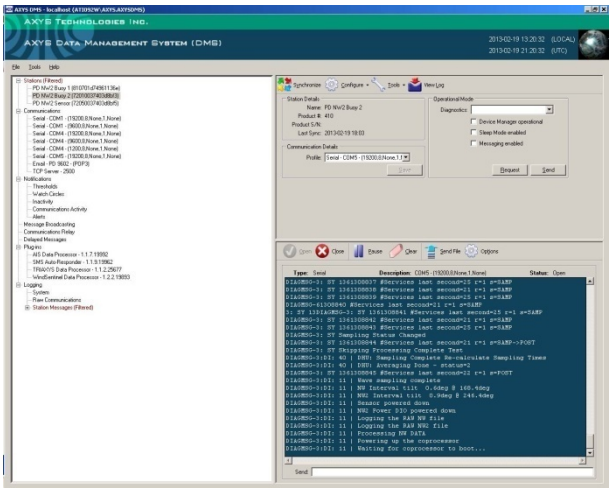

Figure 1. DMS Main Window.

The DMS main window consists of three panels. The panel to the left will be referred to as the **Tree View**. It is used to navigate the major entities in of the DMS. The contents of the *Stations* and *Communications* nodes of the tree view can be filtered by right-clicking on the desired node and entering a filter string in the pop-up box. The filtered node will be displayed in red and suffixed with the text (Filtered). The top right panel will be referred to as the **Data Panel**. It displays details of the item selected in the tree view. The bottom right panel will be referred to as the **Terminal Panel**. It displays a terminal window used to view and send data from the various communications profiles. At the top right of the main window you will also find the current date and time in both local and Coordinated Universal Time (UTC) base on your computers regional settings.

The DMS user interface can be connected to a DMS Service running on any computer within the same Local Area Network (LAN) or connect to a DMS Service running on a different computer than the user interface, Select *File Connect to Service* from the menus in the DMS main window. You will be prompted to enter the host name or IP address for the computer the DMS Service is running on. The DMS Service can handle multiple connections from different DMS user interfaces.

Before any data can be sent or received one or more communications profiles must be set up in the SQL database. Communications profiles define how the DMS will interface with the telemetry installed on your stations.

The Communications Profiles panel contains the following items:

- *Communications Profiles* – a list of available communications profiles including type, description and current status;
- *Add* – displays a menu of items to initiate the creation of a new profile in the database:
    - *Add Serial – Add Dialup –Add Email – Add TCP Client – Add TCP Server – Edit* (modify an existing profile) – *Delete – Clone* (duplication of an existing profile);

Each of these options will have a pop-up window with configuration items specific for the telemetry connection. Each communications profile has an associated Terminal Panel. A Terminal Panel displays all data received from the underlying connection and allows data to be sent out via the underlying connection as shown in Fig. 2.

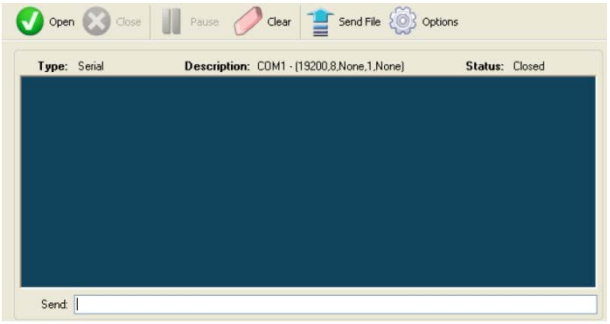

Figure 2. DMS User Interface-Terminal Panel.

The DMS supports standard communications: TCP Server; TCP Client,;Email (POP3,SMTP,IMAP); Serial; Modem Dialup;FTP; as well as custom interfaces direct to InmarsatM2M, Inmarsat IsatDataPro, and GOES. These communications make it possible to support telemetry options like: VHF/UHF Radios, CDMA Modems, GPRS Modems, Inmarsat C, Iridium, Inmarsat M2M, Inmarsat IsatDataPro, Wi-Fi, Bluetooth, GOES, and GlobalStar.

The DMS is capable of ASCII text logging, database logging, raw communications data relaying, message broadcasting.

The station(s) must be uniquely identified in the database before the DMS can be used to manage a station(s). The popup dialogue box in Fig. 3 shows the required elements to be entered for each system; many of these are automatically populated when synchronizing with a new WatchMan500 station.

With all AXYS products, the *License Serial Number* is the silicon serial number of the primary WatchMan500 node of any station. The registered *License Key* signals the DMS that the end user is authorized to manage the

station. Each station in your network will have a unique license key.

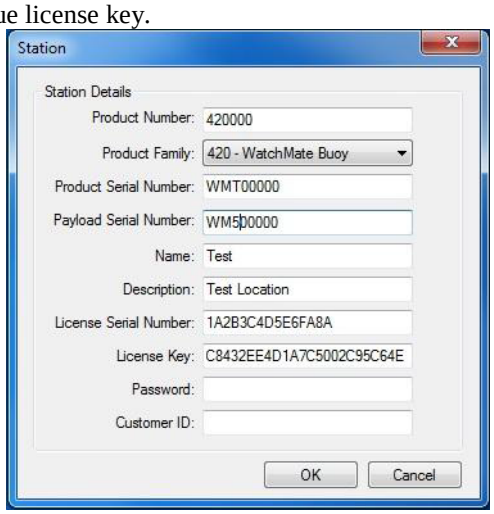

Figure 3. WatchMan500 Station Identification.

Each station must be synchronized with the DMS before any station data messages can be decoded by the DMS. The synchronization process requires a relatively large amount of data to be exchanged and stored in the database. This can be done in a number of ways; direct connect to the station, via two way telemetry to the station, on a secondary service PC which then imports the synchronization file.

3.1 DMS Station Configuration and Action Scripts

The WatchMan500 **Station Configuration** features are managed via the DMS User Interface. This application gives users complete control over the operation of a WatchMan500 station including: device hander (sensor) configuration, system sampling regime, data message formats and contents, onboard data logging and system diagnostics.

Before a station can collect data from its various sensors, it has to be configured to accept the specific inputs for each individual sensor. This is accomplished by installing device handlers included in the stations firmware and assigning (mapping) specific hardware, such as an A/D Channel Input or a Serial RS232 IO, to the installed device handlers. A device handler is a specific piece of the station's firmware that handles interfacing with a particular sensor. Each device handler requires a unique set of hardware that defines how and where the sensor is connected to the station.

The DMS interface has advanced capabilities to configure the remote WatchMan500 stations down to primary node port level defining the various sensor inputs and signal characteristics using what is called a "Device Handler". There are a host of predefined Device Handlers for commonly used sensors, devices and math operands available as part of the DMS/WatchMan500 device library. Options are available to interface to sensors of which defined Device Handler's are not available using either the Generic Serial or Analog Device Handler depending on the type of sensor or device to be interfaced. Custom Device Handlers are routinely developed for new sensors.

A supplementary configuration tool is the use of **Action Scripts** which are commands that cause the WatchMan500 to perform one or more tasks. Action Scripts to respond to certain conditional events with a configured set of instructions. For example, The GPS device handler can trigger an Action Script if the station moves out of a specified watch circle radius by transmitting position more frequently. Others might deal will system power and go into a power conservation mode if certain threshold voltages are exceeded.

3.2 DMS Station Message Builder

The DMS allows you to configure message definitions for the data messages being transmitted or logged by your station(s) using **Message Builder** dialogue panels. A message definition includes the content, formatting, frequency and internal data logging options of a specific data message. Typical message formats follow National Marine Electronics Association (NMEA) format or custom Binary messaging.

Data messages encoded in the NMEA format are comprised of a header, body and a checksum. Users have the ability to edit default message content or create custom message content through the NMEA Message Configuration dialogue of the DMS User Interface as shown in Fig. 4.

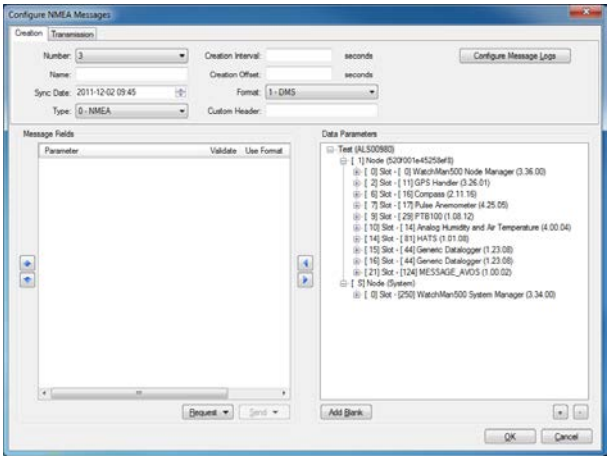

Figure 4. NMEA Message Configurator.

Binary messages can be created to minimize the amount of data sent via the selected communication profile for cost saving/bandwidth reasons. Binary messaging requires the station's firmware to contain the Binary Message Builder device handler.

3.3 DMS Host/Server Notifications

To aid the monitoring of the health of your station(s), the DMS provides the ability to define notification profiles.

A notification profile specifies a set of conditions used to determine if an alert should be raised warning a DMS user(s) of a station's status. The conditions are based upon the data parameters contained in the data message defined on each station. Therefore, if there is a specific parameter that needs to be monitored on a given station, then that parameter must be mapped to a data message before it can be used in a notification profile. A threshold notification allows the DMS to check a single received data parameter against one or more reference (threshold) values. The checks that can be performed are any combination of: "less than", "less than or equal to", "equal to", "greater than or equal to", "greater than", "not equal to" and "blank". The Notifications are set up using a series of pop-up dialogue panels in which the various threshold values are set for parameters such as system voltage, water intrusion or system inactivity, along with a definition of the output data message to be broadcast via the available telemetry devices (email, SMS) or initiating audible/visual local alarms.

One of the key Notifications for managing moored station(s) is to monitor the position by establishment of a geofence called a "Watch Circle". A watch circle notification allows the DMS to ensure a station does not wander off position by checking a received GPS longitude and latitude against a reference longitude, latitude and radius. The Watch Circle parameters are setup through a separate dialogue panel with similar message notification parameters to be set.

4. DMS Data Dissemination

The DMS provides two methods to distribute received data to other systems. The first method is *Message Broadcasting*. Message Broadcasting will only disseminate valid data messages. The second method is *Communications Relay*. Communications Relay will disseminate, in real time, all data, regardless of content.

5. DMS Data Display, Export and Graphing

The DMS data can be viewed using a desktop based system called SmartView[2] or a web based application called SmartWeb[3]. Examples of the SmartView home screen and graphed data are provided in Fig. 5 and 6, respectively.

The AXYS SmartView™ software designed to: display data, station configuration information and to export data from the system in common formats such as CSV, XML, or Excel. SmartView must be linked to supported AXYS DMS product databases.

The home screen of the SmartView application has a number of panels showing a tree view for station ID's and map panel showing the station locations. On selection of a station, an operator can drill down to the individual parameters of interest (data or configuration details). Once data is selected, a default range (selectable by # of samples or date range) of data will be displayed in tabular format.

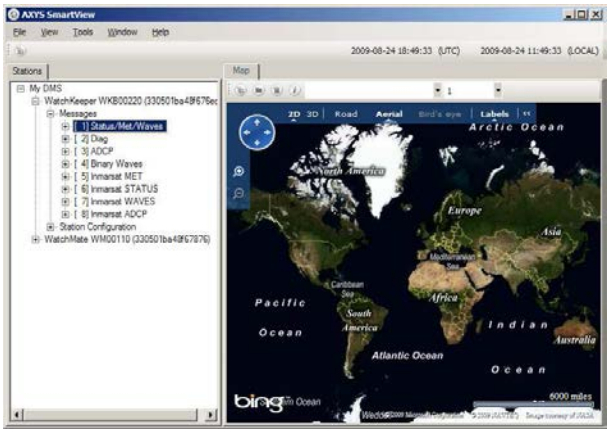

Figure 5. Screen. SmartView Home

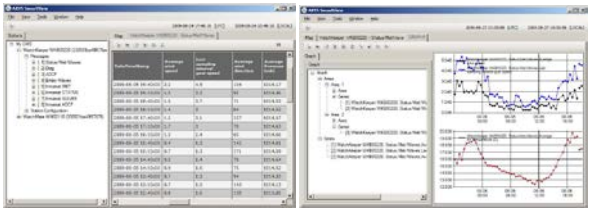

Figure 6. SmartView Tabular or Graphed Data.

The AXYS SmartWeb™ software is a web based application to: display data, station configuration information and to export data from the system in common formats such as CSV, XML, or Excel. The end user can access the data with appropriate security log-in and DMS database URL parameters.

Additional data viewing is available with the DMS plug-in framework which allows the functionality of the DMS to be enhanced and extended to support more complex data flows, message parsing and other various tasks. DMS plug-ins are components that are installed separately from the DMS.

For example, the TRIAXYS Data Processor Plug-in (TDP) allows the DMS to receive, decode, parse, store, and disseminate data from a TRIAXYS Wave Sensor with full functionality of the older non-supported WaveView™ Software. The TDP allows for a range of graphical outputs not normally supported by DMS such as Fig. 7 showing a Directional Wave Spectral.

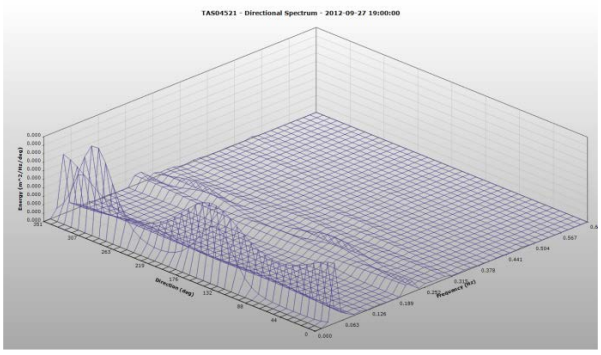

Figure 7. TDP Directional Wave Spectral Plot.

6. DMS System Flexibility

An integral facet of the DMS software is the ability to be configured to control a single station to an entire network with multiple routings for the ingestion of data, as well as the dissemination of tertiary data products.

In Fig. 8, a simple example of a single wave buoy is transmitting low bandwidth data via an Iridium and INMARSAT D+ satellite links. The data is received at the Land Earth Station and forwarded by email to the DMS Server. With this configuration, the DMS also has the ability to have two way communications via the Iridium and INMARSAT D+ satellite link back to the buoy to change operational parameters or query different messages.

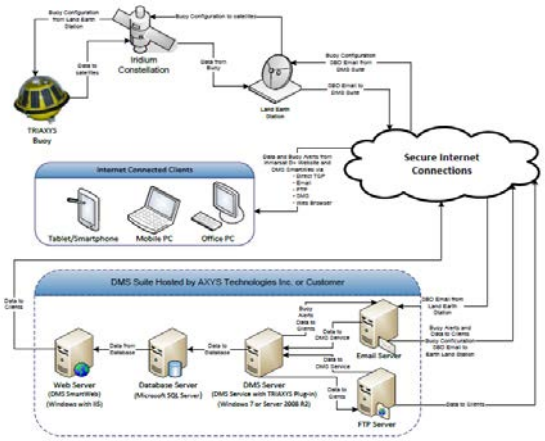

Figure 8. Example of a Typical Data Schematic for a Single Station with Single Telemetry Option.

In Fig. 9, a more complex example of multiple wave buoys transmitting low bandwidth data via an Iridium and INMARSAT D+ satellite links along with a secondary UHF data link transmitting high bandwidth data such as full directional spectral wave data. As before, the data is received at the Land Earth Station and forwarded email to the DMS Server. With this configuration, the DMS also has the ability to have two way communications via the Iridium and INMARSAT D+ satellite link back to the buoy to change operational parameters or query different messages as well as the UHF data link. In this example, there are two DMS servers receiving the data which can also be synchronized.

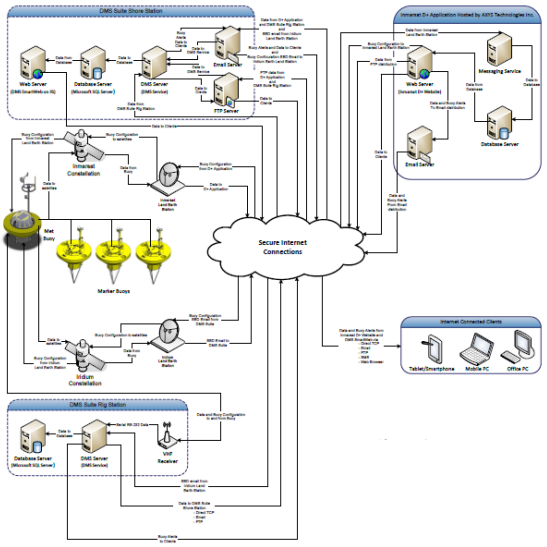

Fig. 9. Example of a Typical Data Schematic for Multiple Stations with Multiple Telemetry Options.

7. Conclusion

What sets the DMS apart is the integration with the WatchMan500 and the ability to automatically request data from the datalogger, schedule and send configuration changes, update firmware, and pipeline directly to individual sensors.

The desktop viewing software, SmartView, allows users to query data, produce graphs, and check configuration. The web based software, SmartWeb, does the same and was developed supporting Javascript REST operations, allowing for further customization.

Current and future development involves enhancing the mobile and web interaction with the systems through the DMS Service.

Operational systems such as SmartBay are applying these technologies[4]. Users of complex Met-Ocean systems need software applications to operate their remotely deployed systems, and manage large databases from collected transmitted information - DMS is one such tool.

References

[1] AXYS Data Management System™ User Manual ver 0325326Z: December 2012.

[2] AXYS SmartView™ User Manual ver 5100900100Z: August 2009.

[3] AXYS WebView™ User Manual ver 0375801Z: August 2007.

[4] SmartBay. Available online. URL: http://www.smartbay.ca/. Accessed on January 24, 2013.