MILA Antenna Control Unit Replacement Project

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ABSTRACT

The Air to Ground Subsystem (AGS) Antenna Control Units at the MILA Ground Network Tracking Station are at end-of-life and are being replaced. AGS consists of two antennas at MILA (Quad-Helix and Teltrac). Software was taken from the existing Subsystem Controller and modified for the Antenna Control Unit (ACU). The software is capable of receiving and sending commands to and from the ACU. Moving the azimuth clockwise, counterclockwise, moving the elevation up or down, turning servo power on and off, and inputting azimuth and elevation angles are commands that the antenna can receive.

INTRODUCTION

The Merritt Island Launch Annex (MILA) tracking station houses several antennas. MILA is responsible for tracking the Space Shuttle and several scientific/engineering satellites. The antennas receive telemetry, voice, and data from these spacecraft. MILA is the only tracking station that has a line of sight to the Shuttle's launch pad. It also tracks the first seven minutes of the Shuttle's flight, and also handles the video recording for the Shuttle's external tank TV.

Basic Antenna Controls

The antenna is capable of performing basic movements. The elevation can be moved up or down, and the azimuth can be moved clockwise and counterclockwise. Power is supplied to the antenna via the servo power module.

Hardware Platform

The antenna is controlled by the Antenna Control Unit (ACU). The ACU is a rack-mountable all-in-one computer with a built-in touch screen. The subsystem controller (SSC) is the remote computer that is capable of monitoring and sending data to the antenna. It has the same capability of the ACU.

Software Platform

OmniServer is the I/O communications software package used to define protocols and items between WonderWare and the ACU. InTouch WonderWare is software package used to implement the graphical user interface screens for the Quad-Helix and Teltrac ACU. The main purpose of OmniServer is to define the packets sent to the ACU, and serves as the intermediate between WonderWare and the ACU.
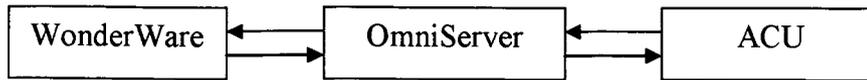
Figure 1: Flow of Control

WonderWare and OmniServer communication is possible by WonderWare's tagnames and OmniServer's item names. A WonderWare tagname is the name of an object. An OmniServer item name is the name of an object used in conjunction with host messages. Host messages are the mechanisms used to give commands to the ACU. WonderWare tagnames and OmniServer item names have the same name.

A user selects a command from the interface window from WonderWare. OmniServer interprets the command and passes the item name to the host message. Then, the host message is sent to the ACU. The ACU carries out the command, and sends a response back to OmniServer. OmniServer then takes the item name from the host message and passes the item name to WonderWare. WonderWare then sets the appropriate status field on the interface screen.

OmniServer Component

Packet Definition

OmniServer is the I/O communications software package that is used as the intermediate between WonderWare and the ACU. OmniServer uses item names and host messages to communicate with the ACU. The general packet is composed of three elements, and various variables. The first element contains the header segment length, which is always 12 bytes long. The second element contains the data segment length, which can vary, depending on command.

The third integer element contains the command/response number.

```
                                          ┌─────────────────────┐
                                          │ Variables used to   │
┌────────────────────────────────────┐   │ return values, if   │
│ Segment Length (always 4 bytes)     │   │ needed.             │
└────────────────────────────────────┘   │                     │
                                          │ Varies with each    │
                                          └─────────────────────┘
```

Request {12:4B}{8:4B}{1000:4B}{Float:4RB}{Float:4RB}

```
┌──────────────────┐
│ Header Length    │   ┌──────────────────────┐   ┌──────────────────────┐
│                  │   │ Command Length        │   │ Command/Response      │
│ (Always 12       │   │ (Variable bytes)      │   │ Code                  │
│ bytes)           │   │                       │   │                       │
└──────────────────┘   └──────────────────────┘   │ (Varies with each     │
                                                   │ command)              │
                                                   └──────────────────────┘
```
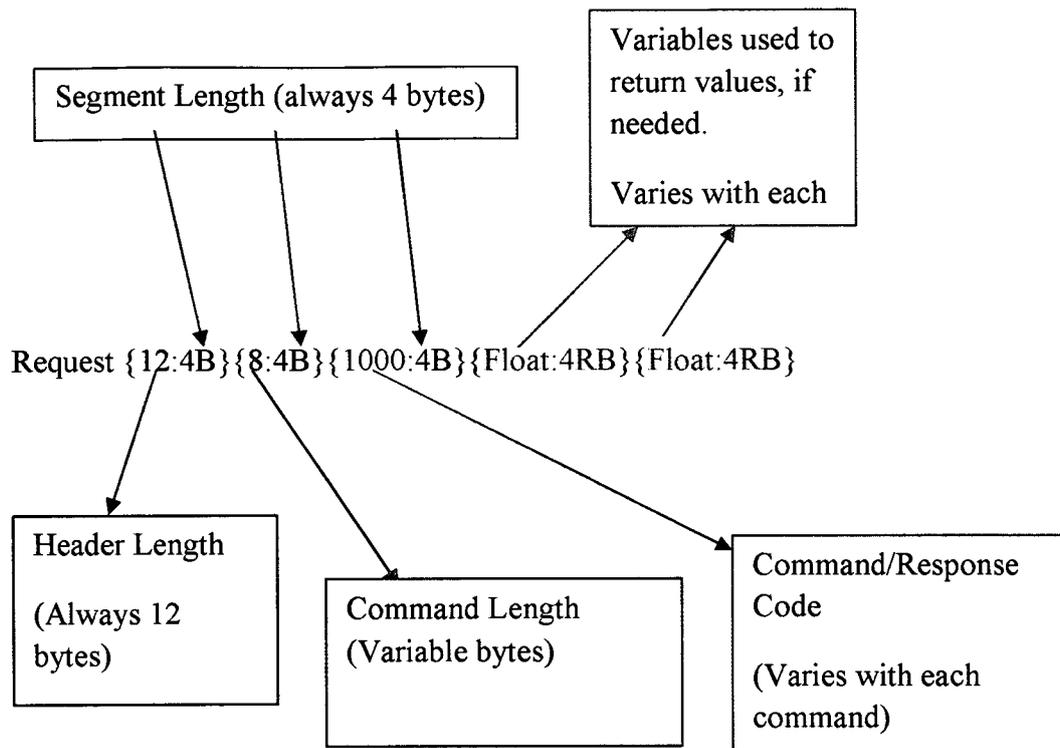
Figure 2: Sample Packet Breakdown

WonderWare and ACU Communication

In order to communicate with the ACU, the format of the segment length must be specified. If the segment length is not specified, then communication between the ACU and OmniServer will fail. To prevent this situation, place a "B" at the end of the segment length. The "B" is the binary format code. The "R" format is the ASCII real number format. In order to use float data types, a format code of "RB" must be specified.

To determine if OmniServer and the ACU are communicating, use the OmniServer I/O monitor feature. The I/O monitor shows real-time communications between the ACU and OmniServer, and you will be able to see the actual commands (in hexadecimal) and the actual decoded values.

Font colors used in OmniServer I/O Monitor

The I/O monitor uses four different colors to distinguish between data being transmitted (black), data being received (blue), bad data (purple/red), and good data(green).

<u>Black</u>

Data is being transmitted from OmniServer to the ACU.

<u>Blue</u>

The ACU is transmitting data to OmniServer. At this point, OmniServer is not parsing the data yet, it's just receiving data. The font color will change in the light of good or bad data.

<u>Magenta</u>

OmniServer is receiving bad data from the ACU, or OmniServer does not know how to deal with the data. This stems from the segment length not having a specified format. There must be a specified format in order for OmniServer to interpret the data correctly.

<u>Green</u>

OmniServer is receiving good data from the ACU. OmniServer is interpreting the data correctly. This is the best situation to look for.

WonderWare InTouch

WonderWare is the programming language to code the software. WonderWare is a software development program used for industrial applications, such as those for boiler systems and nuclear power plant monitoring systems. Actions are controlled by scripts behind the animation links. The animation links control the action of the program, just like events procedures in Visual Basic.
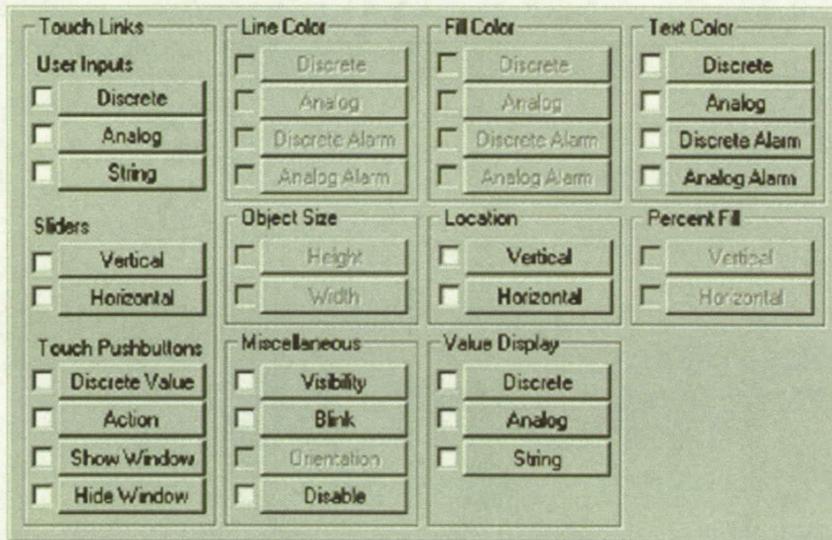
Figure 3:

WonderWare

Animation Link Window

PROJECT IMPLEMENTATION

To implement the project, WonderWare was used to develop the interface screens for the ACU. OmniServer was used to send the messages and tagnames to the ACU for processing. After the ACU finished processing the message, it sends a response if needed. Separate sets of item names were developed, and were based on the Telemetry & Communications Systems, Inc. (TCS)

Antenna Control Unit – M1 (ACUM1) Ethernet Interface Control Document (Version 1.22h). The project was developed in two components. OmniServer was the first component, and the WonderWare was the second component. Variables in OmniServer are called Item Names, but are also called tagnames

OmniServer

Item names, host messages, and topics were developed first. The item names were given names that reflect the ICD. The ICD groups item by available commands, which contain individual items. The commands in the ICD were translated into OmniServer. Specific commands were taken and translated as host messages. The topic was configured for the Quad-Helix and Teltrac in order for them to communicate with WonderWare. The topic was configured for the IP address of the ACU and to transmit over an Ethernet connection.

WonderWare

First, the tagname dictionary for the Quad-Helix and Teltrac was constructed and the access names defined. The tagname dictionary is a place to store all tagnames used in any windows. The datatype, minimum and maximum range can be specified. The access name tells WonderWare what OmniServer protocol to use. After the tagnames were created, they can be used in any window. The existing Quad-Helix subwindow was taken out of the main screen and modified. The modifications are shown in the figure below.

Interface Window Breakdown

The labels serve as placeholders for status variables, such as the actual, commanded, slave, and azimuth and elevation angles (the ones that contain #.#). These labels do not change. The squares, with a red background, are alarm indicators. If there is something wrong with the antenna, the appropriate alarm indicators will light up. There are alarms for the elevation up and down limits, azimuth counterclockwise and clockwise limit, fiber Tx and Rx, antenna safe mode, and stow pin status. Two types of buttons are present on the form: buttons with borders, and buttons without borders. Buttons without borders are another form of status indicators, and will not accept mouse clicks. Buttons with borders are buttons that will accept user clicks. Clickable buttons include ones that move the elevation up, elevation down, azimuth clockwise, azimuth counterclockwise, to Pad A, to Pad B, to Runway, and to stow the antenna. The cable wrap indicator is the largest item on the window, and it indicates the location of the antenna's cable wrap. When the ACU is in local mode, the SSC can only receive status from the antenna, but is unable to issue commands. As a result, the clickable buttons are disabled when the ACU has control.
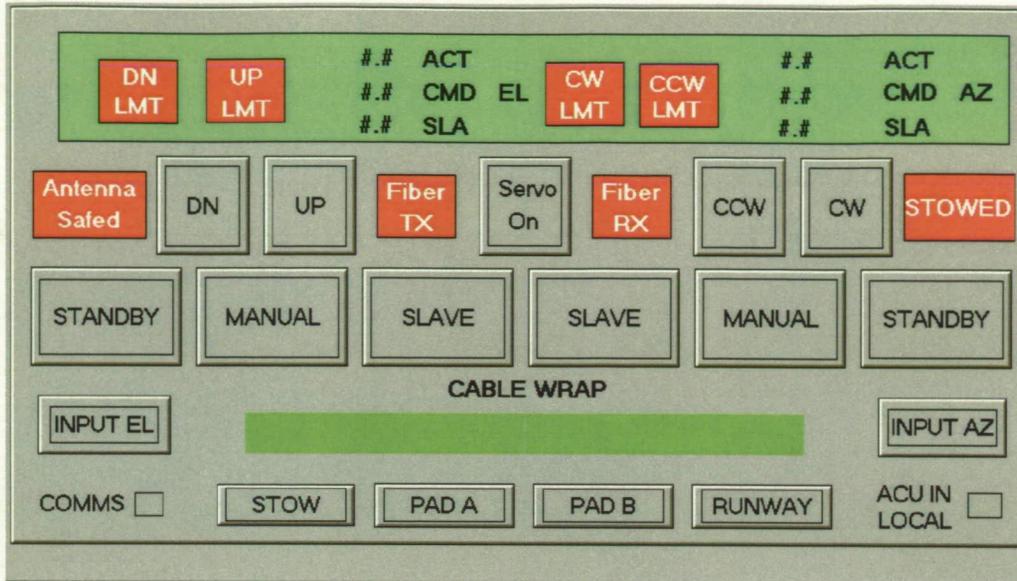
Figure 4: ACU Interface Screen

Testing

Testing commenced on June 26, 2007, with the first successful test being July 3, 2007. There is a process to follow before testing can commence. First, the OmniServer and WonderWare files must be burned to a compact disc (CD) and virus scanned. Second, the Air-To-Ground (AGS) SSC and Quad-Helix ACU was disconnected from the main network. Both systems were connected to their own network to prevent any problems that might affect the operational network. Testing began after the testing environment was set up.

All status indicators were tested first, because the antenna's status is always streaming to the SSC. The angles displayed on the SSC were compared against the angles on the ACU. If the angles were the same, then testing was successful. The azimuth and elevation angles were changed on the ACU, and the antenna were tracked to the commanded angles (angles entered in by the operator). The change was reflected on the SSC, and the angles were the same. When the commanded angles are entered, the commanded angle indicators show the angles entered by the operator. The behavior of the angles changing is similar to that of a running stopwatch. The azimuth and elevation operating modes, remote/local, and cable wrap indicators were tested next. If these button indicators were the same color on the ACU and on the SSC, then the test was successful. The command buttons were tested next. When the SSC changed the condition of the antenna, the change was reflected on the ACU. In summary, if the screens on the ACU and the SSC were the same, then testing was successful. Otherwise, there were problems that needed to be fixed.

CONCLUSION

Software was taken from the existing Antenna Control Unit (ACU) and modified for the Subsystem Controller (SSC). The software is capable of receiving and sending commands to and from the ACU. Moving the azimuth clockwise, counterclockwise, moving the elevation up or down, turning servo power on and off, and inputting azimuth and elevation angles are commands that the antenna can receive. WonderWare and OmniServer were the two components used to implement the project. Testing was successful for every item on the interface screen.

Acknowledgements

References

Ethernet Interface Control Document. Telemetry & Communications Systems, Inc.

Version 1.22h

NENS OmniServer Reference Manual.