Computer Science Department
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YP-TDS WAN: A WIDE-AREA NETWORK TO SUPPORT BATTLE SIMULATION

by

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ABSTRACT

YP-TDS is an inexpensive, commercial-off-the-shelf hardware and software system providing a tactical display similar to the Navy Tactical Data System, for potential use aboard Naval Academy Yard Patrol craft. Actual YP position received via GPS as well as simulated contact data generated according to a combat simulation scenario is disseminated across a wide area network using HF packet radio. Real-time display of actual and simulated contact data allows the YP-TDS system to be used for midshipman afloat training. YP-TDS represents embracing the Network Centric Warfare concept within the Naval Academy professional education environment.

Keywords: NTDS, Network Centric Warfare, ForceNet

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1. BACKGROUND

The 21st century US Navy will be based on information superiority and dispersed, networked force capabilities, a concept best described as *Network Centric Warfare* (NCW):

> An information superiority-enabled concept of operations that generates increased combat power by networking sensors, decision makers, and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization. In essence, NCW translates information superiority into combat power by effectively linking knowledgeable entities in the battle space.[1]

ForceNet describes the evolutionary transformation that brings NCW theory to practice within the US Navy:

> The operational construct and architectural framework for naval warfare in the information age that integrates warriors, sensors, networks, command and control, platforms, and weapons into a networked, distributed combat force that is scalable across all levels of conflict from seabed to space and sea to land. ForceNet implements the theory of network-centric warfare.[2]

The YP-TDS (Yard Patrol Craft Tactical Data Simulator) project completed in 2003 represents an initial effort towards embodying the concept of Network Centric Warfare within the afloat training environment at USNA. The goal of that project was a proof of concept: to use commercial-off-the-shelf (COTS) hardware components and

[1] *Network Centric Warfare: Developing and Leveraging Information Superiority*, 2nd Edition (Revised), David S. Alberts, John J. Gartska, Frederick P. Stein, CCRP, August 1999.
[2] *ForceNet: Turning Information into Power*, VADM Richard W. Mayo, USN, VADM John Nathman, USN, US Naval Institute Proceedings, February 2003.

custom designed software to inexpensively give functionality similar to the basic capabilities of NTDS (Naval Tactical Data System) for possible use aboard YP's.

YP-TDS provides a TCP/IP local-area network linking multiple PC hosts, each offering an NTDS-like display (Figure 1). When deployed aboard a YP, an on-screen chart of local waterways is updated with real-time position obtained via GPS. Simulated contacts generated by YP-TDS software are also displayed. Simulated contacts can be detected with simulated sensors, contacts can be classified (neutral, friendly, etc.), contact information such as course, speed and range can be displayed, and simulated weapons can be launched. As the real/simulated tactical picture changes, YP-TDS updates the display.

Figure 1: YP-TDS display

One of the YP-TDS displays functions as a damage control (DC) status board depicting a side elevation view of the YP craft (Figure 2). This display can be updated with the status of major ship systems and spaces, either automatically by the YP-TDS system according to a scripted scenario, or manually by a drill coordinator monitoring and controlling the execution of a training drill. The display may be marked, for example, to indicate the presence of smoke, fire and water in a space.

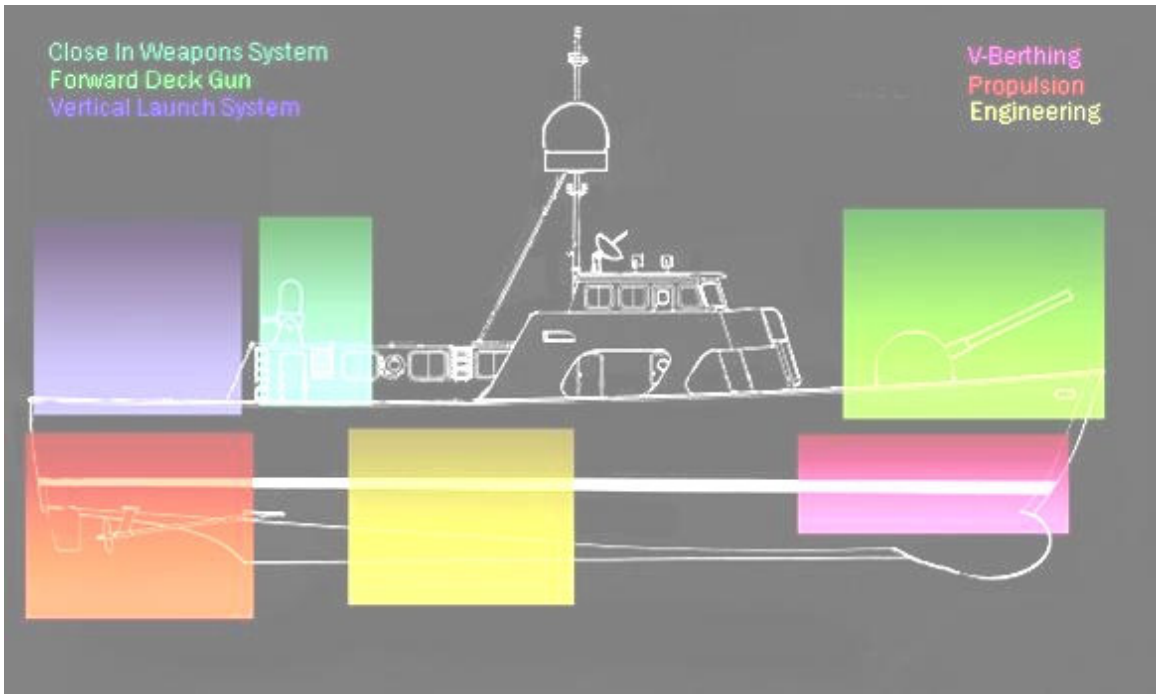


Figure 2: YP damage control zones

YP-TDS has met its limited initial objective. A tool has been created at minimal cost, using COTS hardware running midshipman-designed and implemented software that appears suitable for training use. To better exploit the potential of this system, however, a major improvement has been made. The real-time position of *multiple* YP-TDS equipped vessels are disseminated and displayed. YP-TDS with this wide-area capability is then a Network Centric system, not just a single-platform asset. Achieving this required the addition of system-to-system radio communication hardware and corresponding interface software. Finally, a YP-TDS User's Manual has been developed as a first step towards turning this research project into a usable tool for professional education and training.

2. IMPLEMENTATION

Improvements made to the existing YP-TDS software include new menus, title screen, sound effects and other user-interface elements, and functionality such as a right-click menu to quickly classify, engage or ignore a track. The major extension accomplished in the current project, however, was the addition of a wide area network capability via HF packet radio.

2.1.1 Packet Radio

Figure 3: Packet radio data path

The purpose of the wide are networking system is to allow YP-TDS systems located on separate ships to exchange tactical information. To send and receive data a Terminal Node Controller (TNC) is used to convert the binary packet data into an audio signal that can be transmitted and received over the air by high frequency (HF) radio. The TNC used for the YP-TDS is an MJF Packet-Pactor Controller. The HF radio used is an ICOM-710 marine version, found aboard every YP in the USNA fleet.

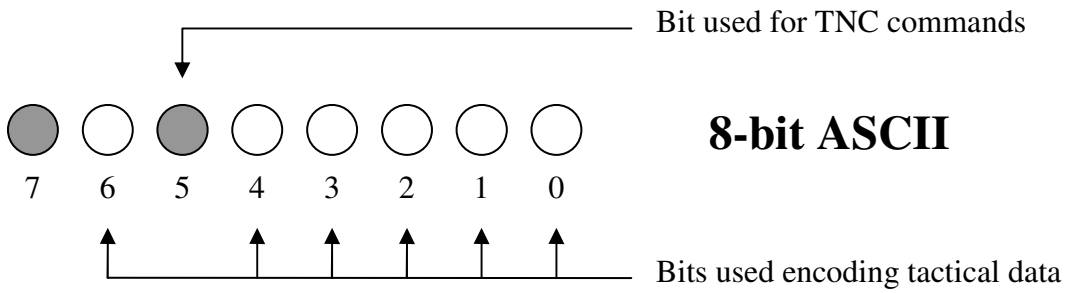


Figure 4: Formatting 6-bit tactical data in TNC 8-bit ASCII

Tactical data to be exchanged consists of floating point, integer, and boolean values, which must be suitably formatted for manipulation by a TNC. TNC internal data format is 8-bit ASCII characters. Not all bits are available for encoding YP-TDS information, however. Bit 5 is used by the TNC for internal commands, leaving bits 0-4, and 6-7 available for encoding. Using only bits 0-4, and bit 6 simplifies encoding and in practice does not degrade transmission efficiency, hence, all information to be transmitted is encoded in 6 bits, as shown in Figure 4.

Data shared among YP-TDS systems can be categorized as either position or condition updates, as follows:

Position Update Contains: own-ship position, depth/altitude, "net id", and packet type.

Condition Update Contains: sensor status, damage level, weapons launch requests, "net id", and packet type.

Forty-eight (48) bits can be used to efficiently encode position and condition update information, as shown in Figure 5. Each 48-bit packet represents a single new discrete piece of simulation state information, be it the generation of a new contact (or request to generate a new weapon), or a change in status of an existing contact (e.g., position or course change). YP-TDS information encoded in 48-bit packets, plus the one bit per byte

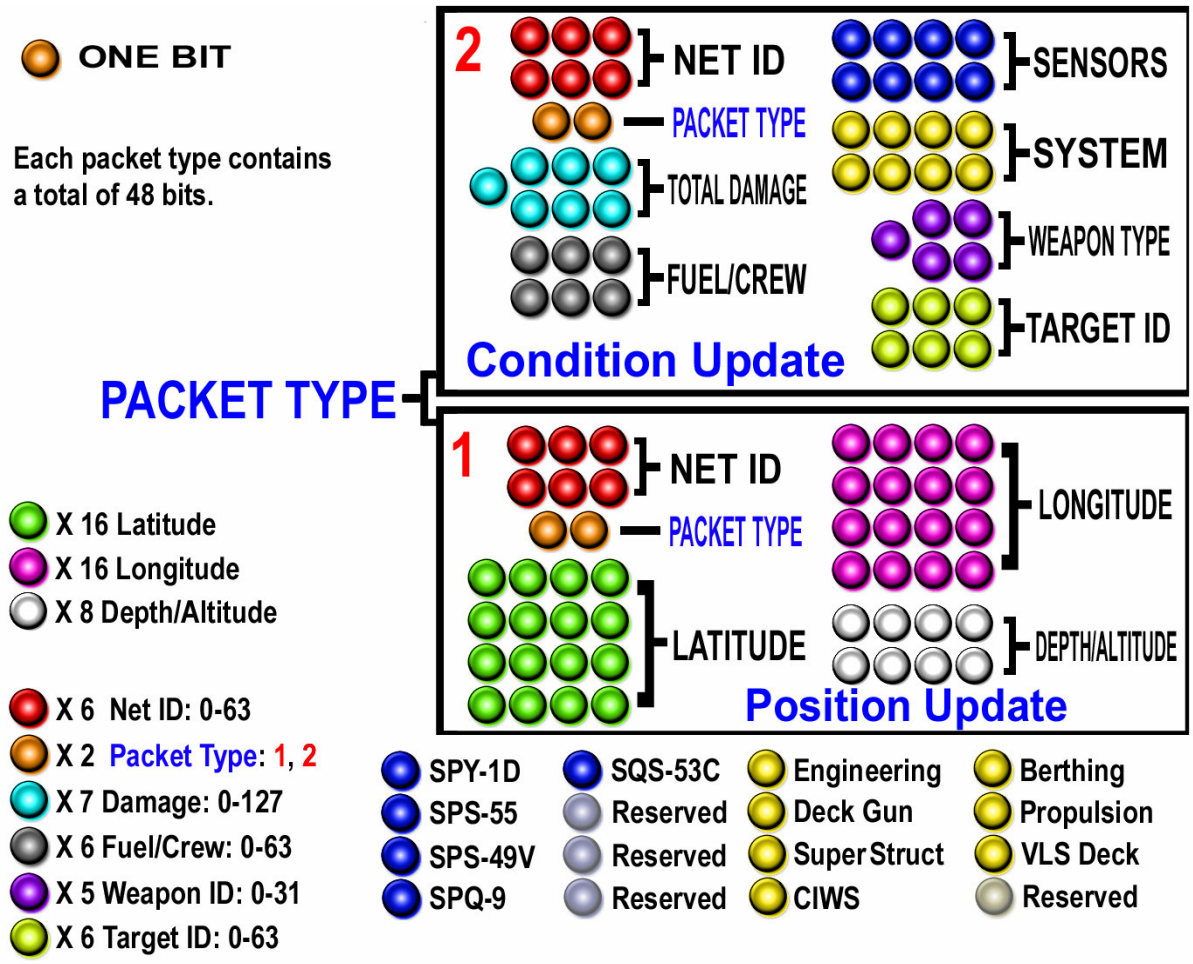


Figure 5: YP-TDS WAN packet architecture

used for TNC commands results in a 64-bit physical packet size. Multiple packets can be transmitted in a single HF radio transmission.

The wide area network employs a turn-based event-driven communication cycle. Every YP sends a **Position Update** packet during every cycle. In addition, if the material condition of the ship has changed, a weapon is launched, or a sensor is changed, a **Condition Update** is sent. Synchronization is maintained by strict ordering of transmissions between a "Master" server and "Remote" servers.

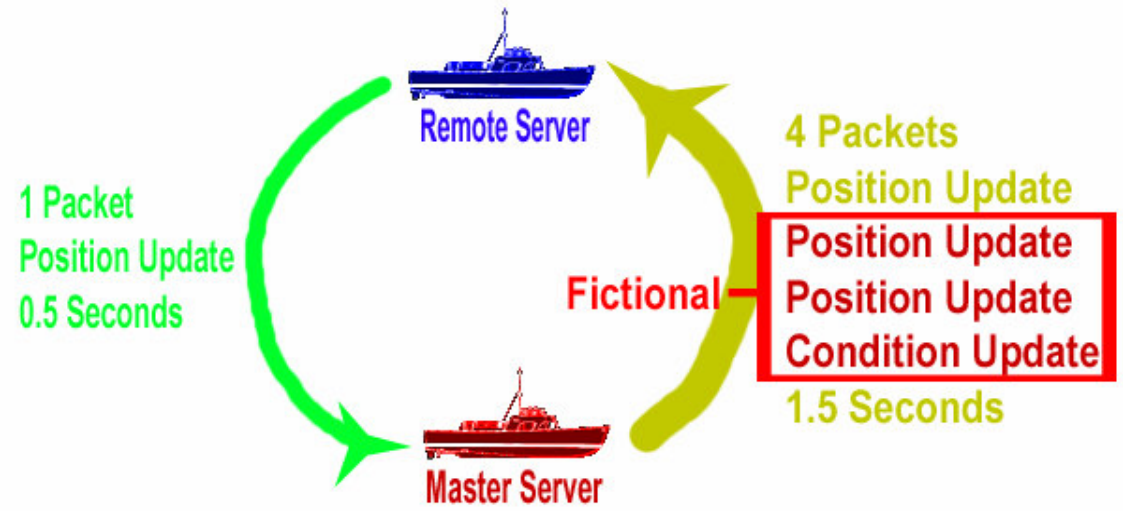


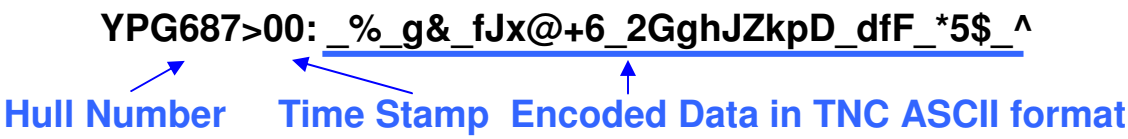
Figure 6: Master/Remote server WAN communication protocol

Remote servers are responsible only for reporting their own position and condition. The Master server is responsible for own position and condition, as well as information related to all simulated tracks such as missiles, aircraft and submarines. Master and remote servers exchange information in a round-robin fashion, with the Master server usually requiring more transmission time. Figure 6 shows remote servers completing their individual (short) transmissions, followed by the Master server broadcasting its much longer amount of information, which in this example includes its own position, the position of two simulated contacts, and a condition update for one of them.

Because data loss is possible when using HF communications, it was decided early in development that the system be designed to accommodate data loss and still accurately maintain the YP-TDS simulation and wide area network synchronization. The above encoding and transmission scheme, as well as built-in TNC hardware checksum error detection gives an efficient means of accommodating data loss.

2.1.2 TNC

The TNC modulates a discrete bit stream of tactical information into an analog audio stream that is then transmitted by HF radio. The TNC hardware adds a 14-byte header containing error detection bits and a station identifier, to each transmission. A portion of this 14-byte header is used by the YP-TDS to (1) identify a transmitting YP by hull number, and (2) indicate packet age via a time stamp, as depicted below:



Tactical data, encoded as TNC ASCII text strings, are sent from the YP-TDS program to the TNC through the serial port using an RS232 serial library created by the author specifically for this project.[3] Before transmitting across the wide-area network, however, a TNC must be initialized. The following figure details the specific commands sent to the TNC on YP-TDS system startup:

RESET	Resets the TNC, clearing all settings.
E OFF	Echo off. Prevents sent characters from being fed into the receive buffer.
MY YPGXXX	Sets the transmitter's call sign to YPGXXX, where XXX is the YP's hull number.
U 0	Normally the station number, this value is used as a time stamp to determine the age of a packet.
FU ON	Enables full duplex, disabling the TNC's internal packet collision mechanism. Required for external synchronization.
TX X	Sets transmit delay to X milliseconds. If set too low, the radio will not receive the beginning of a packet from the TNC.
DW 10	Sets receive delay to 10 milliseconds.
k	Enter data transmit mode.

Figure 7: TNC Initialization commands

[3] This library has proved to be of enormous value outside of the YP-TDS project. It is currently being used by six other midshipman research projects at USNA.

2.1.4 Radio- TNC - Laptop Interface

The TNC connects directly to the ICOM 710 HF radio aboard a YP. For proper operation with the TNC, the radio must be programmed manually to operate in Upper Side Band (USB) mode, and set to receive and transmit at a specific military band frequency reserved for YP-TDS use. To properly interface the ICOM 710 HF radio to the TNC and the TNC to the laptop terminals, customized cables must be used. Specific details of their construction are available in the **User's Manual**.

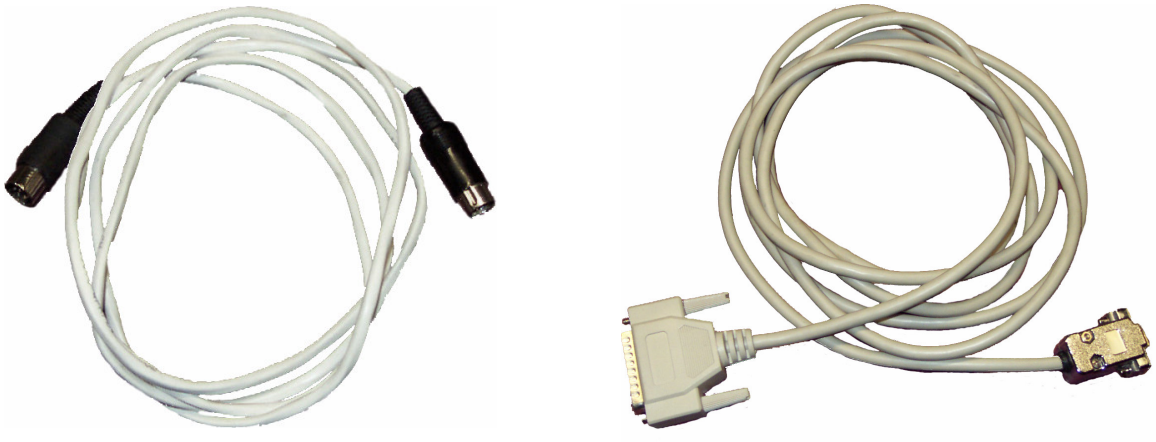


Figure 8: Laptop to TNC and TNC to radio adapter cables.

2.2 User-interface and functionality improvements

A main menu was added in anticipation of future extensions to the program (SINGLE- and MULTI-PLAYER options, for example, are described in section 5). The program can be terminated by selecting *EXIT*, or the local area network settings can be accessed by selecting *FLEET BATTLE* (Figure 9).

A wide area network menu is accessible from the local area network menu (Figure 10). From here, a user can configure the YP's role in the network as a Master or Remote Server, and select the team on which the YP will participate. The option exists for non-participating YP to observe, however. A participating YP team may be either Stripes or Stars, with different teams each having their own physical flags - a Union Jack (Stripes), or Navy Jack (Stars) - flying from the YP mainmast staff (Figure 11). It is

intended that these flags will be used to visually identify a friend or during a simulated battle.

Figure 9: Main menu

Figure 10: Wide area network menu

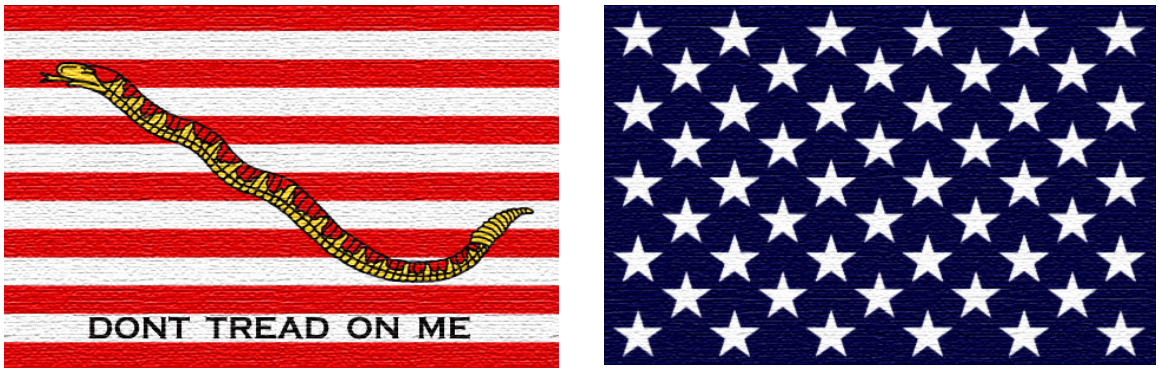


Figure 11: Stripes and Stars team flags

The right-click pop-up menu shown in Figure 12 was added to allow the user to easily manipulate displayed track data, classify a contact, or engage it with an offensive weapon. Each of these options are detailed below.

Classify Track – Allows the user to assign a classification. For example the user may reclassify an unknown track as hostile.

Engage – Opens a weapons launch window to allow engagement with an appropriate weapon.

Display – Toggles various track attributes such as the velocity leader, contact ID display, etc.

Profile – Toggles the Profile Window which displays important track information such as position, course, classification and name.

Drop – Allows tracks to be hidden from display. Confirmation is required to prevent accidental dropping of a track.

Figure 12: Pop-up menu

Sound functionality has been added in preparation for eventual implementation of a 1MC interface to allow sound effects to be broadcast over the ships announcing system. Sound effects to eventually be played over the 1MC are currently played through the left stereo audio channel, while all other interface sound effects are played through the right stereo channel.

The YP-TDS system now reads from a configuration file. The details of this file and the definition of each of its configurable variables are detailed in the User's Manual.

2.3 Lessons Learned

Considerable effort was spent learning the capabilities and limitations of the TNC hardware made available - at no cost - to this project. Because the TNC hardware provides scant information about its internal state during operation, it is often difficult to track problems down when it is not functioning as intended. Future upgrades to the system should include newer and more development-friendly TNCs.

Because our approach was to minimize cost by using available materials already on-hand at USNA, the hand-built adapter cables broke frequently due to poor construction. The result was lengthy troubleshooting sessions. Future cables should be constructed with new materials, including proper heat-shrink, adapter shells etc.

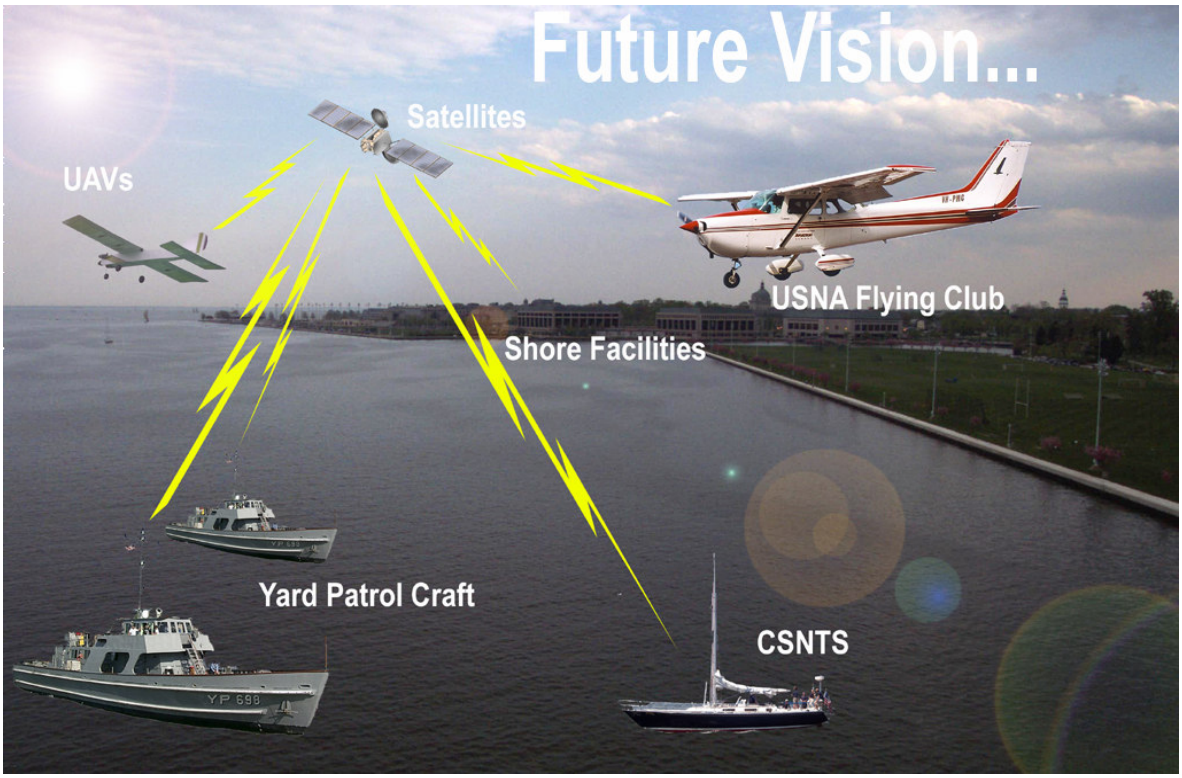
The serial interface took the longest to develop and required several weeks of debugging. As was previously noted, however, the effort has benefited many other ongoing midshipman projects.

3. Results

Initial testing proved the YP-TDS system can exchange the latitude and longitude of two contacts using two laptops communicating through a direct TNC to TNC connection, without using HF transmission. This test demonstrated the viability of the packet architecture described in Section 2.1.1. A date rate of one update per second was achieved.

A second test involved one YP-TDS system communicating from a YP via HF with a land based radio (located in Rickover Hall). Results indicate lossless data transmission at a range of five miles under conditions adverse to HF reception: at dusk, in foul weather. Transmissions were garbled beyond five miles due to loss of line of sight. Though a YP to YP test while at sea was never performed, based on the success of the shore to YP test we expect the system to perform at least as well when communicating ship to ship

Limited testing indicates the most efficient HF data transmission burst size is 64 bytes, corresponding to eight position/condition updates per transmission. This transmission length sends the most data in the least time with minimum loss. Further testing should be done to confirm this burst length.



4. FUTURE WORK

The YP-TDS system is maturing into a useful tool. Further development is required to make it more robust, more flexible, and more functional. Some suggested areas for further work include the following:

- VPF support (vice BSB) - Currently the YP-TDS uses raster charts encoded in BSB format, which is analogous to a bitmap file. Using these files requires preprocessing and would make shifting charts complex and inefficient. Vector Product Format (VPF), allows for seamless transition between charts, and does not require pre-processing.

- USB Interface Support - The majority of laptops available today do not have an RS-232 serial port. We expect support for this interface on laptops will disappear. By transitioning to the USB (Universal Serial Bus) standard, we can guarantee compatibility with the emerging generations of laptops.

- Wireless vice twisted pair - Physical ethernet cables are currently used to connect YP-TDS terminals in the local area network, resulting in long cable lengths sometimes routed through water-tight hatches. It may be possible to eliminate physical cables by shifting to a wireless LAN.

- OpenGL or DirectX - YP-TDS uses freeware Allegro graphics libraries. Future YP-TDS software versions should be written using OpenGL or DirectX to take advantage of hardware acceleration and guarantee forward compatibility.

- Improved Contact Control- Capability should be added to allow the actions of friendly simulated contacts to be directed as if it were real - such as directing the flight of friendly air assets.

- Better AI - "Artificial intelligence" refers to the dynamic behavior of any simulated contact. It should be difficult for a YP crew to distinguish between a real and artificial track based on its behavior.

- Scenario Director - A wide area network participant should be able to control simulated contacts "on the fly" to interactively direct the course of a scenario.

- Sound: Local & 1MC - Sound effects are currently played through left and right speakers. Console sounds are played through the left stereo channel and weapon, explosions and other environmental sound effects are played through the right stereo channel. The right channel should be linked to the 1MC announcing system so that these environment sound effects can be broadcast throughout the vessel.

- Portfolio of Scenarios - A scenario format using UML should be designed. This will allow mission scenarios to be constructed without requiring programming experience. A portfolio of example missions should be created.

- Luce Bridge Simulator - We should investigate integrating the Luce Hall Bridge Simulator into the YP-TDS system so it can be used to control an additional simulated vessel of a configurable class, to participate in YP-TDS training.

- Integrate Real YP Sensors- Thus far, the YP-TDS only uses the GPS provided by the YP. Future versions should allow an interface with the radar, fathometer and compass if possible. As future versions of the YP are fielded, any digital sensor that can be integrated should be integrated.

- Fire/Flooding Box - As the YP sustains damage during a virtual battle, a physical device could generate artificial smoke of varying colors to indicate what type of fire is present in that zone. Flood indicators show the level of flooding in that compartment. The devices could be connected to the nearest YP-TDS terminal in their zone.

- DC Status Repeater - Panels overlaid with the YP Damage Control Status diagram, using LEDs to display fire and flooding damage, could be stationed throughout the ship and connected to the nearest YP-TDS terminal.

- AEGIS-Like Consoles - Track-ball and button operated consoles similar to those used in a modern CIC can be made cheaply from retired keyboards and connected to the laptops through a PS2 port, and server as an additional input device to the system.

- 3D Replay - Entire battles could be stored in a file for later re-creation in a 3-dimensional engine allowing viewers to see the battle with the ability to fast forward, rewind, pan and zoom to any part of the battle.

- Single/Multiplayer - YP-TDS can be modified to be used as a stand-alone program on a single laptop for personal training ashore. In this case, extra controls would be added to control all ships and aircraft in the battlegroup and accomplish an objective, without requiring a local or wide area network, a GPS or a YP. A network version would allow multiple users to work together on a common mission, or work against each other.

5. REFERENCES

[1] *YP-TDS A Tactical Data Simulator for USNA Yard Patrol Craft*, Jeffrey P. Wilcox. 2003.

[2] Network Centric Warfare: Developing and Leveraging Information Superiority, 2nd Edition (Revised), David S. Alberts, John J. Gartska, Frederick P. Stein, CCRP, August 1999.

[3] ForceNet: Turning Information into Power, VADM Richard W. Mayo, USN, VADM John Nathman, USN, US Naval Institute Proceedings, February 2003.

[4] HF Marine Transceiver IC-M710 Instruction Manual. Icom Incorporated 1999.

[5] MJF-1270B/1274 TNC 2 Packet Radio Owner's Manual. MJF Enterprises Inc. 1986

YP-TDS

USER'S MANUAL

TABLE OF CONTENTS

1. Introduction

The YP-TDS is a tactical battle simulator intended for use aboard US Naval Academy Yard Patrol Craft (**YP**). It consists of one or more YPs each with a Local Area Network (**LAN**) that in turn consists of four laptops connected through a hub.

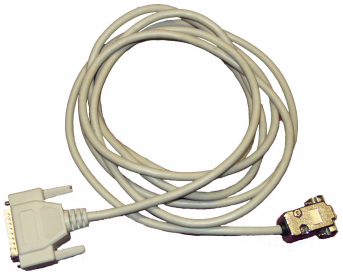
The Wide Area Network (**WAN**) is established using the ICOM 710 High Frequency (**HF**) radios aboard the YPs as well as Terminal Node Controllers (**TNC**) to interface between the radio and the laptop. The WAN facilitates the exchange of tactical data between YPs. Within the WAN, there is one YP designated as a **Master Server** and all other YPs are designated **Remote Servers**. The differences and capabilities of both will be discussed in greater detail in Chapter 7.

Equipment

ICOM 710 Used for WAN HF communication.

GPS Used for own-ship position**.**

DIN-5 to DIN-8 Adapter
Used to connect the TNC to the radio**.**
Build using schematics in the Appendix.



RS232 DB9 to DB25 Adapter
Used to connect the laptop to the TNC.
Build using schematics in the Appendix.

Laptops
Up to four per YP

Ethernet Hub
Used to network laptops over a LAN.

TNC
This device encodes and decodes binary information to and from audio frequencies coming through the radio.

(no picture) **TNC Power Supply**
12V AC adapter with reverse polarity. Must be purchased.

(no picture) **Ethernet Cables**
Four required to connect laptops to the hub.

IMPORTANT: When constructing adapter cables it is vital that the proper pins are soldered together. Incorrect wiring may cause permanent damage to a laptop, TNC or radio. Also, connecting the wrong power supply to the TNC may result in damage to that unit. Ensure the power supply you use is the correct voltage and polarity.

2. Installing and configuring YP-TDS software

2.1 Installing software

Copy all files from the YP-TDS CD ROM onto your local harddrive under the folder YP-TDS. Once this is done, you may wish to make a shortcut to the YP-TDS.exe file and place it on your desktop.

All files after being copied off of the CD ROM are set to *read only*, select the entire YP-TDS folder and right click. You should see a grayed out checkbox for *read only*. Uncheck the read only box, and hit apply.

2.2 Configuring software

Locate the file **config.txt** and double click on it. You should see this:

```
<HULL_NUMBER>
689
<SERVER_IP_ADDRESS>
169.254.22.70
<GRAPHICS>
16
<SOUND>
1
<TNC_XMIT_DELAY>
12
```

The **HULL NUMBER** is only important if the computer you are configuring is the server for your YP. As a rule of thumb, you should set this value to match the hull number of your YP regardless.

SERVER IP ADDRESS should be set to the IP address of the server on board the YP. This isn't required if the computer being configured is the actual server. To find the IP address of any computer, click the windows START button, click on Run… and run **command**. A black DOS box should now appear. In this new window type **ipconfig** and press enter. The computer's **IP Address** will be displayed among other addresses.

Currently, the color bit depth under **GRAPHICS** is set to 16-bit mode. This can be changed to 24-bit or 32-bit color modes depending on your computer's hardware by changing the number.

Caution: Most computers do not support all three of these modes. If the YP-TDS displays garbled pixels or exits upon start up, you may have selected an invalid mode.

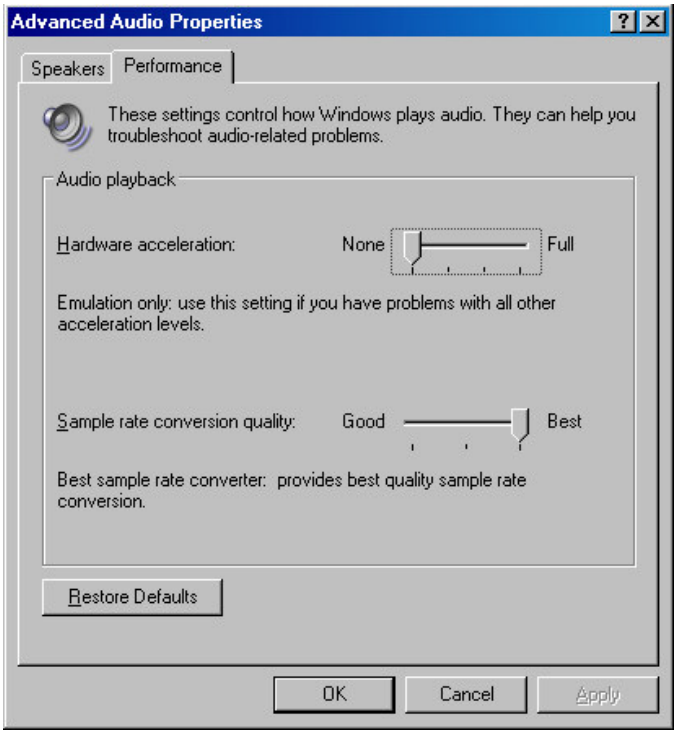
The **SOUND** toggle is used to turn sound on and off. A **1** will enable sound, a **0** will disable.

TNC XMIT DELAY is used to control the time between sending a packet to the radio for transmission and actual transmission. The Default is 12. This not important if the system you are configuring is not the server.

2.3 Configuring the PC

If you are using sound you must turn off Audio Acceleration. The configuration menu varies from system to system.

A common path is: **START ->Settings->Control Panel ->Sounds and Audio Devices ->Audio->Advanced ->Performance**



If you experience your mouse cursor spontaneously halting during the main menu screen, this is most likely caused by the audio acceleration.

NOTE: Quit all non essential applications that may be running in the background to gain the best performance from the YP-TDS and the computer system.

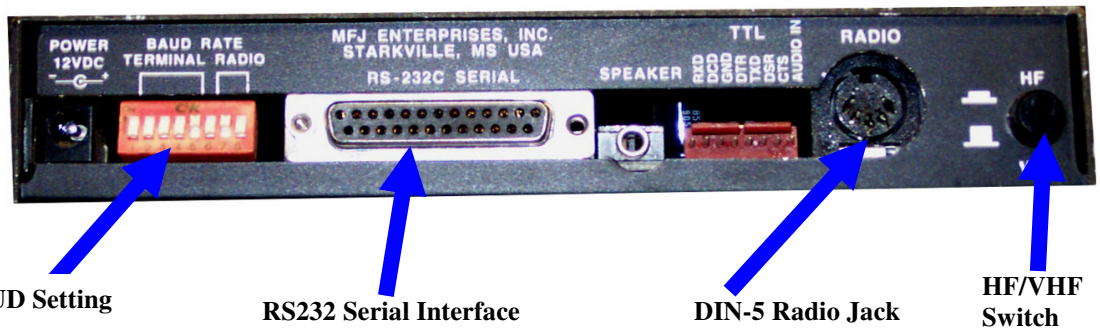
3. Hardware setup

For the YP-TDS system to be properly set up, several external devices must be attached and most require a configuration of their own. YP-TDS servers communicate through HF radio to other YP-TDS servers using a Terminal Node Controller (TNC). This will interface with the radio and convert the audio tones it receives to binary information, and vice versa.

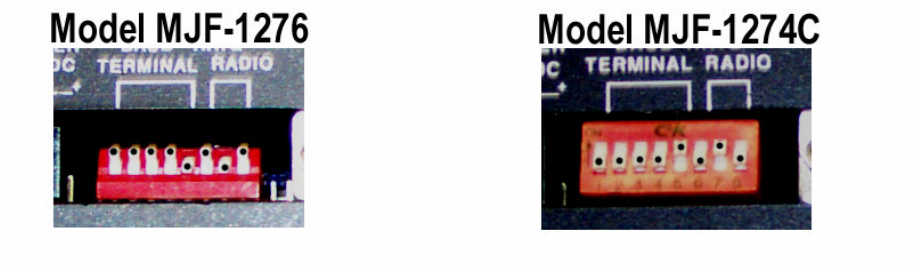
3.1 Setting up the TNC

The Baud speed for serial communications to the laptop must be set as well as the radio audio data speed, transmit audio and receive audio. If any of these settings are not configured properly, the system will not work.

You will need to connect the RS232 DB-9 to DB-25 connector into your laptop's COM1. Schematics detailing the construction of this adapter are located in the **Appendix**.



The BAUD DIP Switches must be set to 9600. There are two versions of TNCs, the MFJ-1274C and the MFJ-1276. Their model number is located on their front panel. Their DIP configurations are detailed below.



The HF/VHF switch should be in the VHF position (out).

Transmit and receive audio

Use a small screwdriver to gently turn both potentiometers to the right until they cannot move. Then turn them back to the left one quarter of a turn. This is to ensure that both transmit and receive audio levels are satisfactory for the YPs HF radios.

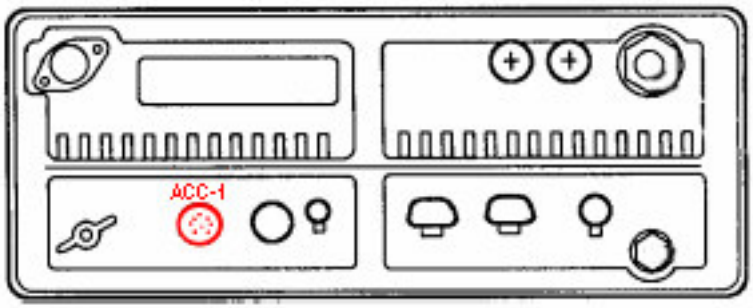
Finally, the TNC must be plugged in and turned on. The large red button on the face of the unit must be pushed in. Immediately, the red PWR led should be lit. If the PWR led is not lit, check and make sure the power supply is attached. The power supply must be 12 Volts and must have the  symbol located on it indicating it is reverse polarity.

WARNING: You must not connect a power supply that is not reverse polarity or permanent damage to the TNC may occur.

3.2 Setting up the radio

Each YP is equipped with an Maritime ICOM 710 HF radio. The radio must be programmed with the correct transmit and receive frequency, be put in the proper mode, and must be hooked up to the TNC for it to function correctly.

Connecting the ICOM and TNC



Attatch the 8 pin side of the ICOM-to-TNC adapter to the **ACC-1** port located on the left side of the radio when looking from behind. Plug the other 5-pin end into the TNC jack marked **RADIO** on the back

.Configuring the ICOM 710

If the radio is already programmed, you may skip to **Step 13**.

Step 1: To program the receive channel select the desired channel by rotating the **CHANNEL** selector knob.

Step 2: Push and hold the **CE** button to enter frequency selection mode. A ▶ symbol should now appear in the display.

Step 3: Enter the desired frequency using the keypad with 5 or 6 digits. You may also rotate the **CHANNEL** knob.

Step 4: Change the operating mode to **USB** mode by pushing the **MODE** button. Now push and hold **RX** for one second to save your settings.

Step 5: To set the transmit channel, push **TX** until TX begins to blink.

Step 6: Push the **CE** to select frequency selection mode again, ▶ should appear on the display.

Step 7: Enter the same frequency as your receive frequency using the keypad. Note: The **CHANNEL** selector can't be used to do this.

Step 8: Push and hold **TX** for one second to save your new settings. Push **TX** again to clear the blinking TX.

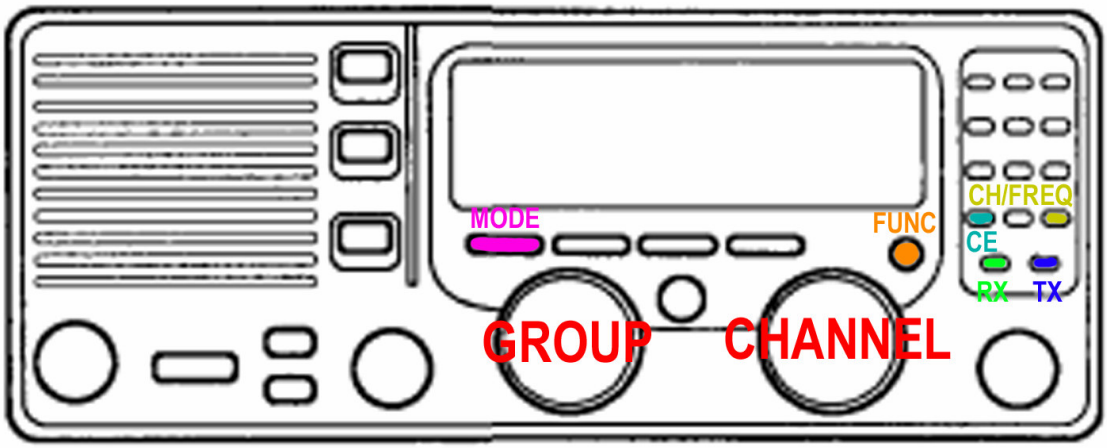
Step 9: You should program this channel to display **YP_TDS**. To select a name for the channel, push **CH/FREQ** to select channel indication.

Step 10: Push the **FUNC**, then **CE**. The channel's text box should now blink.

Step 11: Rotate the **GROUP** selector for cursor position and the **CHANNEL** selector to change cycle through available characters. To cancel, push **CE** again.

Step 12: To save your work, push and hold **RX** until the blinking stops.

Step 13: Rotate the **CHANNEL** knob to select the channel labled **YP_TDS**.



3.3 Setting up the GPS

Depending on the type of GPS used onboard your YP, the configuration method may vary widely. You should consult the user's manual for your GPS unit for specific details. The GPS must have the following configuration:

Bits Per Second:	4800 baud
Data Bits:	8 bits
Parity:	None
Stop Bits:	1 bit
Flow Control:	None

When connected correctly to **COM3**, the **GPS** on the Network Menu will be illuminated. Do not connect the GPS unit after starting the YP-TDS as it will not detect it and may cause malfunctions.

4. Starting the program

In the main menu, you are presented with five options.

SINGLE PLAYER and **MULTI PLAYER** are grayed out, and reserved for future use.

OPTIONS allows you to toggle various game settings but is not functional in this build of the program.

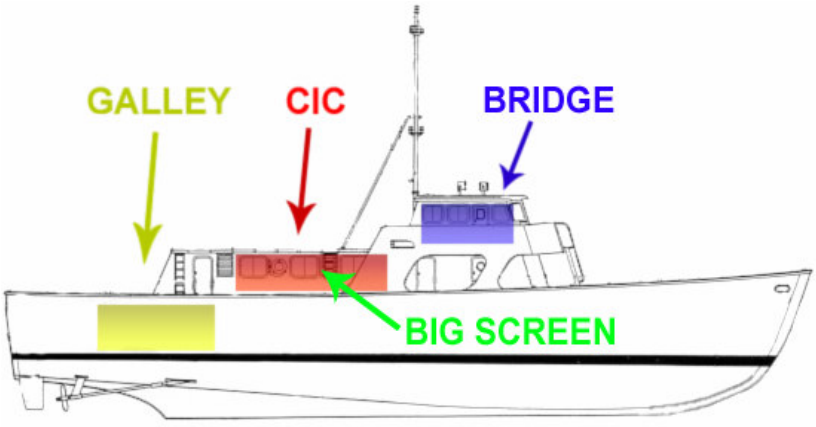
EXIT quits the YP-TDS program.

FLEET BATTLE takes you to the Local Area Network screen. Whenever you exit the simulation, you will be brought back to this menu.

5. Local area network

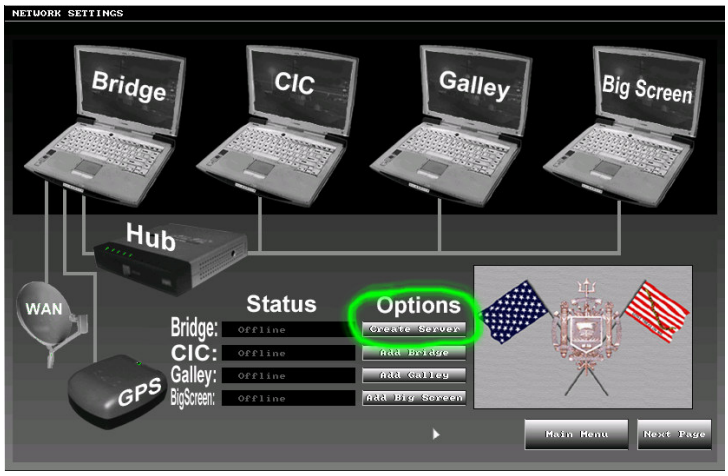
The YP-TDS system relies on **a Local Area Network** (**LAN**) to be installed on board all YPs participating in the YP-TDS battle simulation. The LAN requires the use of an Ethernet hub such as the LINKSYS SD208 shown to the right. A total of four systems may be connected through a LAN on each YP. Each system, called a Terminal will be located in a specific location to facilitate that Terminal's role
in the YP-TDS simulation.

The four terminals are the **Galley**, **CIC**, **Bridge** and **Big Screen**.:



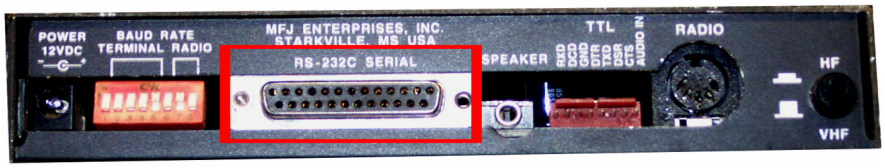
5.1 Running as a client

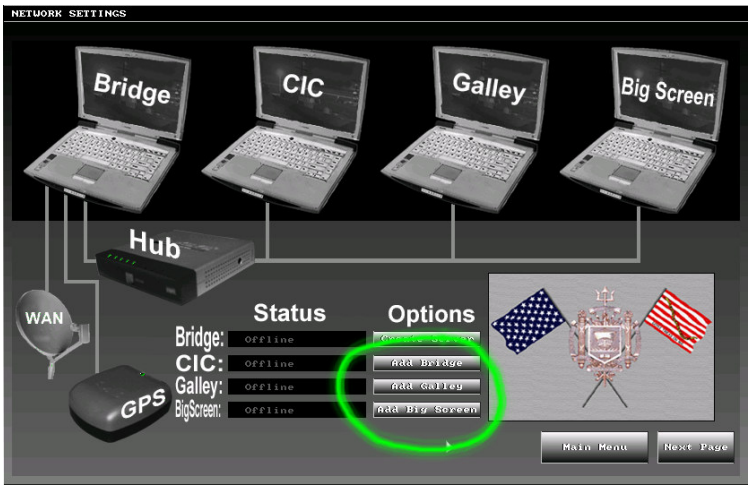
If the server has been established, select the **CIC**, **GALLEY**, or **BIG SCREEN** buttons to connect to the server as the respective role of your client computer. Once connected, your computer will automatically begin the simulation once the server has begun. If you attempt to connect to the server and get a **Connection Failed**, verify you have entered the server's IP Address in correctly, and that the Server has been established. Also be sure to check your Ethernet connection to the hub. If all else fails, simply keep trying. Once connected, you will now wait for the Server to initiate the simulation.

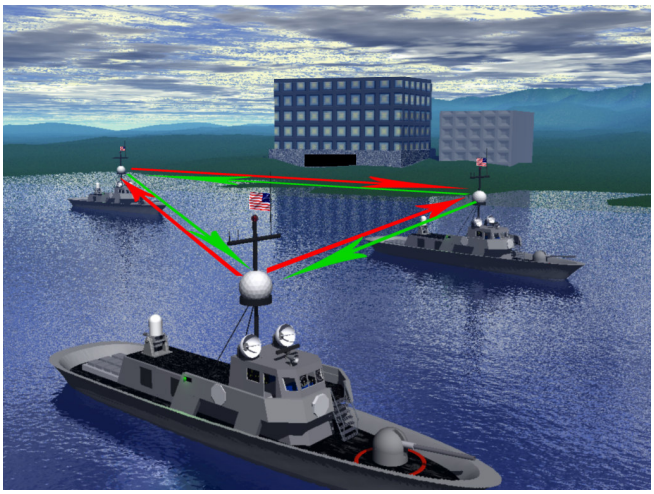


5.2 Running as a server

Click the BRIDGE button to establish the server. You may see additional clients connect to you at this time. Click the **Next Menu** button to proceed to the Wide Area Network Menu. If for some reason, you get an error when trying to connect the server, verify you are plugged into the hub. As the server, you will need to plug in the GPS used by the YP into your laptop's COM3 port. Connect the RS232 DB-9 to DB-25 adapter into your laptop's COM1. Schematics of this adapter are available in the **Appendix**. Shown below is where you are to plug the other side into the TNC.





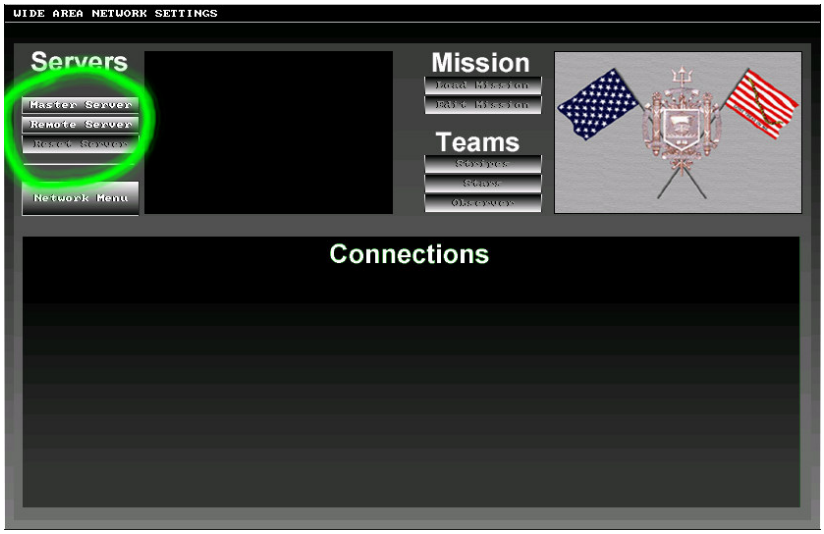


6. Wide area network

The YP-TDS utilizes the HF radios on board to implement a **Wide Area Network** (**WAN**) that can be used to transmit and receive tactical data. Just as in a local area network, a wide area network requires a server. In the case of the YP-TDS system, the WAN server is referred to as a **Master Server**, and all WAN clients are **Remote Servers**.

To select which type of WAN Server your YP is to be, click either the **Master Server** or **Remote Server** buttons on the left of the Wide Area Network Menu.

NOTE: If you want to be an **Observer** your server cannot be the **Master Server**.



6.1 Master server

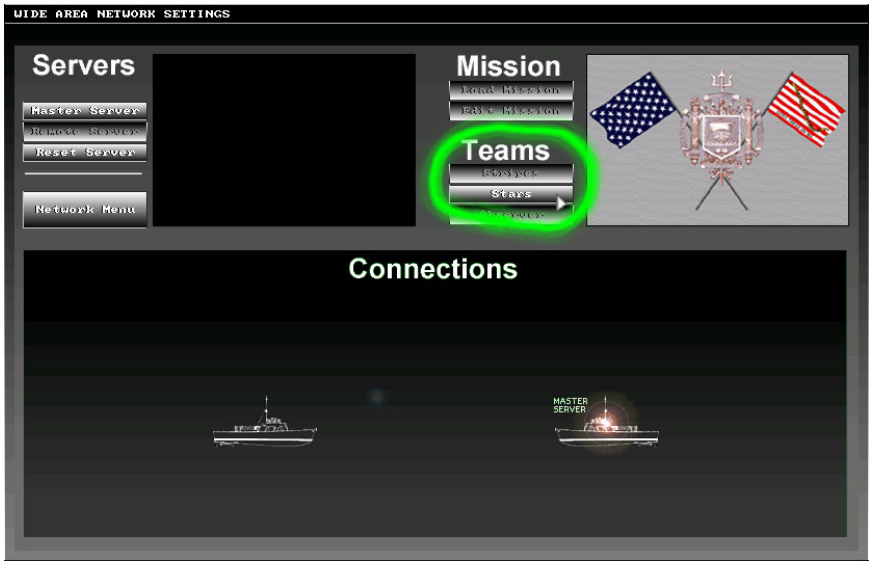
Once you have established the **Master Server**. You will need to load a mission file. Currently, this requires only the clicking of the **LOAD MISSION** button. In the **Connections** box, you will see a grayed out diagram of the YPs that are expected to participate in the mission scenario. You must then select a team, either **STARS** or **STRIPES**.

As soon as a team has been selected, your system will begin to send an information pulse out into the airwaves for other YPs that are configured as **Remote Servers** to receive. As they receive the pulse, they will transmit their own pulse containing their identity, and team. You will see them light up on the **Connections** diagram at this time. When all members of the YP-TDS battle scenario have joined the WAN, you may begin the simulation by clicking the **LAUNCH** button.

6.2 Remote server

When you have chosen your YP to be a **Remote Server** your terminal will wait indefinately for either a pulse from the YP acting as the **Master Server**, or until you quit the program. Once the pulse has been received the Connections diagram will display grayed out YPs that are expected to participate in the mission scenario. Currently your YP is in **Observer** mode. If they are not already filled to capacity, you may select a team, either **STARS** or **STRIPES**.

Once selected, your YP will wait until the **Master Server** initiates the simulation, at which time you will automatically launch. If you stay as an **Observer**, you will automatically launch, but will be allowed to observe the battle with all unknown tracks automatically identified and have infinite radar coverage. You will not, however be able to communicate with the either team, nor will you be able to launch any weapons or in any way interefere with the battle.



7. Running the simulation

Once the simulation begins, all YPs will be in synchronization. Each terminal aboard each YP will be able to access different menus depending on that terminal's location.

Each terminal will be able to manipulate the interface independently from any other terminal. A description of the controls are detailed below.

Interface Controls

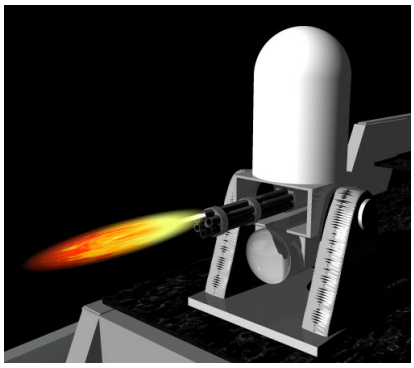
Action	Keyboard	Mouse
Pan Left/Right	Left/Right Arrow Keys	Cursor Left/Right Edge of Screen
Pan Up/Down	Up/Down Arrow Keys	Cursor Top/Bottom Edge of Screen
Zoom In/Out	A or Z key	Mouse Wheel Up/Down
Grid Lines On/Off	G	
Mini-Map On/Off	M	
Profile Window On/Off	P	
Hook a Track		Left Click
Track Menu		Right Click
Draw Bearing Tool		Left Click and Drag

Grid Lines: This option allows you to toggle the nautical grid lines on the interface.

Mini-Map: The mini-map is displayed in the lower left hand corner, and allows you to see the entire operational area at once. By clicking anywhere in the minimap, you're view will be taken there.

Profile Window: This window will display important information about the track that is currently hooked. You may hook a track by left clicking on it.

7.1 Weapons and countermeasures

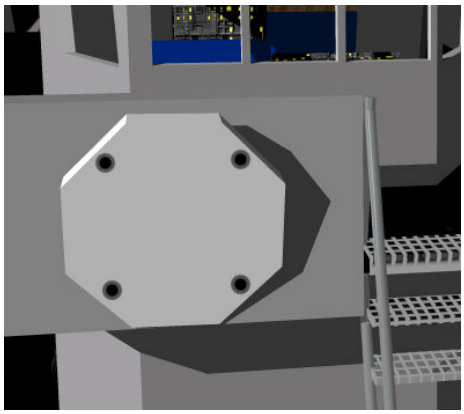


If your terminal is set up as the **CIC**, you will have the option to launch weapons counter measures. There are two menus that control this: One is located in the **Tool Bar**, which is avaialble if you click at the top of the screen. The other is avalailable when you right click on the track you wish to target.

In the **Tool Bar** accessible menu, you can select the weapon by clicking on its button. The ammunition count is displayed in the small box to the right of the button. From here, countermeasures can be toggled on and off, or launched. The current build of the YP-TDS does not allow the use of the MK-16 CWIS, MK-75 Oto Melera or any of the countermeasures such as Chaff, Flare and Nixie drone.

When right clicking on a track and selecting the **Engage** option, you will be given a menu like the one to the right. Simply click the weapon you wish to engage the track with. The ammunition of the weapon is displayed following the X after its name.

7.2 Sensors



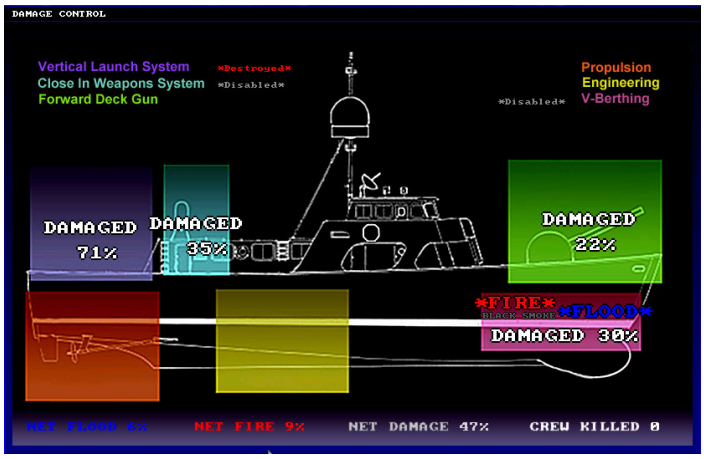
When operating your terminal as a **CIC**, you will able to manipulate multiple types of sensors. Other enemy YPs will be able to detect your radiating sensors such as your SPY-1D, and possibly identify you sooner, giving them an advantage so you may wish to turn off this sensor as well as some of your others and rely on those other members of your battlegroup to be your eyes and ears while you lay low. This can give you a tactical advantage.

When accessing the sensor menu through the **Tool Bar** by clicking at the top of the screen you will be given a list of sensors. By clicking on each sensor's button, that sensor can be toggled on or off. Only the SPS-64 is continuously on, because the YPs are equipped with a real SPS-64 radar, and this radar is not integrated with this system.

EMCON stands for emissions control. When it is on, all sensors are controlled by their individual buttons. When it is set to off, all sensors will shut off automatically making the YP radiate nothing aside from its SPS-64 navigational radar.

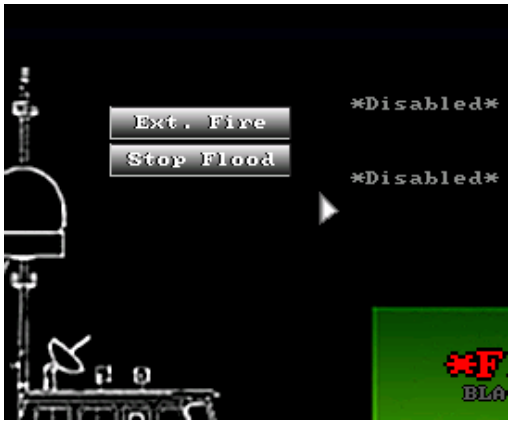
7.3 Damage control

When your YP sustains virtual damage it will be displayed on the **Damage Control** menu which is accessible through the **Tool Bar** by clicking the top of the screen. This menu contains important data such as the **Net Fire, Net Fire**, **Net Damage** and **Crew Killed**, as well as individual damage levels and conditions of the six different damage control zones. In each of these zones a word “DAMAGED” will appear with a



percentage of structural damage. This will contribute to the **Net Damage** readout, which upon reaching 100% will sink the ship. The system in any zone will become disabled if it reaches 25% or higher. 50% or higher will destroy the system entirely. Merely disabled systems will come back online after a certain amount of time has passed to simulate repair.

If the a zone is on fire the Net Fire readout will increment slowly. If one of the lower three zones are flooded, the flooding readout will also increment. If either two of these readouts reaches 100% the ship will sink. The more zones with fire and flooding, the faster the incrementation. Only the **Galley** terminal will have the ability to top flooding and fire, and will be manned by a neutral referee during a YP-TDS battle simulation.



7.4 Options, Tools and other menus

There are several options and tools available to the user to manipulate the interface. The **Options** menu is accessible to all terminals on the YP through the **Tool Bar**, which can be reached by clicking at the top of the screen. It allows you to alter the appearance of the interface and contains the following options:

Options Menu

IGNORE ALL NEUTRALS –Allows you to filter out all neutral tracks that otherwise may clutter your display.

IGNORE ALL WRECKS –This option is similar to the option above though it pertains to recently destroyed vessels and aircraft.

SHOW ALL CONTACTS – This will restore all hidden tracks to a visible status.

SHOW RANGE CIRCLES – This option has yet to be implemenented.

SHOW VELOCITY LINE – This will toggle the velocity line that shows what course each track is holding and relative speed.

TOGGLE TRACK NUMBER – There are three different settings for this option: The track number will be hidden, printed above or printed below.

THICK SYMBOL MODE – If the symbols are thick they are slightly easier to see. Thin symbols look closer to the real NTDS used in the fleet.

The **Tools** menu, like the **Options** menu is also accessible through the **Tool Bar**. It contains various tools that help you gain better situational awarness by allowing you to access your radar coverage, and detailed track information. The menu options are detailed below:

Tool Menu

Mini Map –Toggles the Mini Map. Also bound to the **M** key.

Coordinate Grid – Overlays the nautical chart with gridlines. Bound to the **G** key.

Radar Range – This darkens the screen and displays each of your friendly track's radar envelope. This tool is bound to the **R** key.

Contact Profile – This toggles the Profile window. The profile window displays important information about the current hooked track. Bound by the **P** key.

Tool Bar Autohide – If off, the tool bar will remain open at the top of the screen.

The only options currently available on the setting menu is the **Network Settings** menu, which is covered under Chapter 4 and the **Exit Program** option. This menu is accessible through the **Tool Bar**, which is invoked by clicking at the top of the screen.

Selecting the **Exit Program** will prompt you to confirm your descision to leave the simulation. If this is true, you must select **Confirm**. If not, select **Cancel**. Once confirmed, you will be taken back to the main menu. All wide and local area connections will continue to be connected. If your YP is the **Master Server**, quitting the simulation will halt it for everyone else

on the Wide Area Network. If your terminal is a Server, all clients will exit the simulation and will have to rejoin after you have re-established your server.

The **Air Assets** and **Help** menus are currently under construction.

8. Troubleshooting

The TNC won't turn on
Most likely you have plugged in the wrong type of power supply. Ensure that your power supply in face provides 12 volts and has the 

symbol on it.

The TNC DCD led lights but no packet reaches the laptop
This is usually the result of a bad RS232 adapter. You should check the connections and ensure they are not loose. If this doesn't help, check the pins using an OHM meter to ensure continuity and also check to make sure they are not electrically shorted together.

The TNC PTT led lights but no transmission is made on the radio
Most likely, the DIN-5 to DIN-8 adapter is bad. Follow the same actions detailed above.

The TNC and Radios transmit a packet, but it is intermittently received
This could be the result of either a loose connection, a bad cable, or most likely too short of a **TX delay** setting. Within your configuration file **config.txt** verify that the TNC_XMIT_DELAY value is at least 12.

The openning YP-TDS screen is too big and the wrong colors and crashes
This is caused by an innapropriately configured graphics Bit Depth. Within your configuration file **config.txt** verify that the GRAPHICS value is set to a bit depth value your computer can display. The options are 16, 24 and 32.

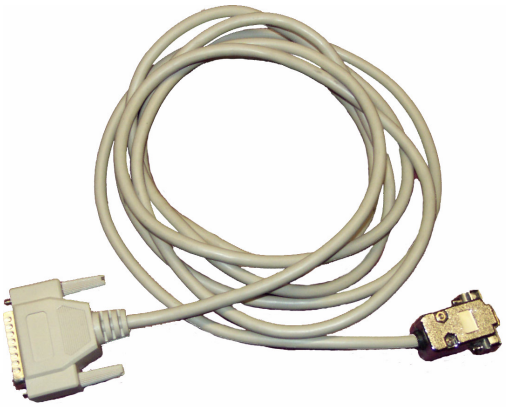
The YP-TDS randomly pauses for several seconds at the main menu
You must disable audio accelaration. This procedure is described at the bottom of **Chapter 3**.

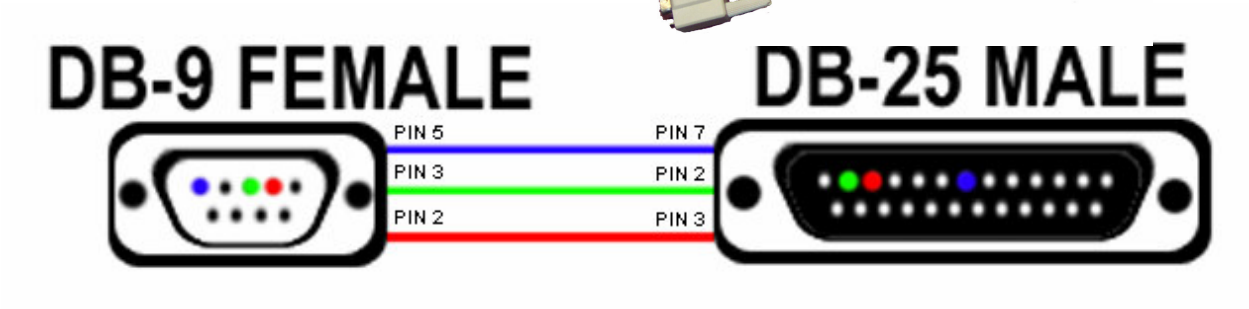
The YP-TDS clients cannot connect to the server
This is usually caused by the wrong IP address being entered into the **config.txt**. Open the configuration file and verify the IP address matches that of the server. This procedure is described in detail in **Chapter 3**. If that does not help, make sure your ethernet cables are properly connected. Make sure the Server is established. If it continues to fail, exit the program, restart it, and try again.

Appendix

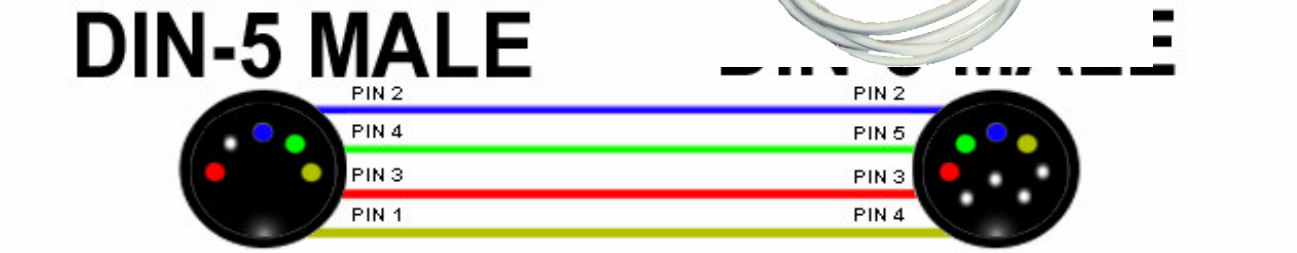
WARNING! Incorrectly wired adapters may cause damage to equipment!

TNC to RS232 Connector – This cable will allow you to interface your TNC with your laptop via the RS-232 serial port.





ICOM M710 to TNC Connector – This cable will allow you to interface your TNC with the radio on your YP.



Glossary

YP	-Yard Patrol Craft. Used at the USNA for afloat training.
LAN	-Local Area Network. A network of more than one computer to exchange data at high speeds.
WAN	-Wide Area Network. Wireless network.
Hub	-Ethernet hub. All Ethernet cables will route through here.
TNC	-Terminal Node Controller. Used to interface between the laptop and the radio.
LED	-Light Emitting Diode. On the TNC, these will light to display certain indications.
PTT	-Push-To-Talk indicator. When transmitting, this will light on the TNC.
DCD	-Decode indicator. On the TNC, this lights up when data is received.
Reverse Polarity	-The TNCs require a power supply with swapped negative and positive wiring.
Baud	-Bits per second. Rate of data.
RS232	-A serial interface between the laptop and TNC.
COM1	-A serial port installed in a laptop.
COM3	-A serial port installed in a laptop.
Pin	-The part of an adapter that plugs into a device. Connected to a single wire.
HF	-High Frequency. Refers to radio frequency or data rate
VHF	-Very High Frequency. The TNCs must be set to this mode.
Master Server	-A YP that is responsible for WAN synchronization and automated tracks.
Remote Server	-A YP that connects to the Master Server.
ICOM 710	-This is the radio used aboard the YP.
Tool Bar	-Menu options located at the top of the screen.
Track	-A neutral, friendly, hostile or unknown entity being tracked by a sensor.
GPS	-Global Positioning System. Satellite based navigation system.
USB	-Upper Side Band. Used in HF Radio communications.