Computers Aboard!
Design, Implementation and Specialized Applications

Vinit Sethi
Vintimar Inc.

ABSTRACT

This paper discusses design and implementation guidelines for computer networks, printing, backups, email and Internet access. Specialized applications such as logging of hours for maintenance reasons, fuel flow calculations and trim optimization are also discussed.

INTRODUCTION

Computers are becoming indispensable onboard yachts today. They fulfill several useful functions such as accounting, inventory, printing and email. This paper will address issues such as computer networks and printing and provide some implementation suggestions. Email and Internet access will be briefly discussed. Finally, computer applications customized to fulfill specific requirements on yachts will also be discussed.

SYSTEM IMPLEMENTATION

Issues pertaining to the overall computer system selection, design and implementation will be addressed in this section.

Computer Selection: The software applications that will run on a computer often determine what type of computer hardware is required. It is best to contact the software vendor to determine any special hardware requirements and if their software has been certified on any particular computer hardware. Items that should be determined include the number of serial communication ports required. Some charting packages require multiple serial ports to bring in NMEA data from navigational equipment such as the GPS, gyro and speedlog. This may require installing a multiport serial card such as a Digiboard card in the computer. The computer must have enough slots of the appropriate kind (PCI/ISA) to accommodate any such special purpose cards that may be required including a modem and a network card. Space is always at a premium on a yacht and hence the size of the computer should be a consideration. However, when going with small form factor computers, it is important to confirm that they can still accommodate any special cards that may be required. When it comes to installing or replacing components, some designs are better than others and this too may be a consideration along with the warranty and technical support availability. The operating system should also be chosen based on compatibility with the software applications that will be installed on the computer.

Computer Network: A computer network offers several advantages over standalone computers. With a computer network, resources such as printers can be shared between several computers. A network makes it possible to exchange documents between users over the network instead of via diskettes. It is also easier to backup (and restore) data over the network to a centralized tape backup device. With a network it is possible to monitor alarms and other information such as from a charting package at more than just one location without running a variety of signal cabling to each location. Networks allow email and Internet access from any computer if so desired and not just from the single computer that is connected to a Satcom or landline. When designing a computer network, all locations onboard must be considered where a network connection for a computer, printer, tape backup or any other network device might be needed. Since it is easier to run the cable during the initial build, it is best to run cables to locations where there is no immediate need for a network connection but where there may be one in the future. It may be most convenient to home-run cables back to a single location on a deck-by-deck basis where a network hub or switch would be located. The cabling required can depend on the type of computer network being installed and the distances involved. Category 5 twisted pair cable terminated with RJ45 style connectors is the most commonly used style of computer network cable. The network hub or switches on each deck should be interconnected with each other using multimode fiber optic cable to allow for the maximum data bandwidth. Fiber optic cable is typically terminated with ST connectors. Such a network configuration is referred to as a star bus topology as it has a few star type configurations (home-run configuration on each deck) connected to each other over a bus (the deck to deck interconnection). If performance were the main consideration, it would be preferable to use a network switch instead of a hub. A 10Base-T switch guarantees 10 Mbps over each port in the switch whereas in a 10Base-T hub, there is 10 Mbps of combined bandwidth available over all the ports in the hub. Switches are more expensive than hubs but are recommended in situations where more bandwidth is required such as when using video conferencing. When selecting a network hub or switch, it may be advisable to go with a 10/100 auto-sensing style as this allows connection of older 10Base-T devices as well as faster 100Base-T devices. Most computer network interface cards today are 10/100 but devices such as PLCs

(Programmable Logic Controllers) that are often used in alarm monitoring systems, still only support 10Base-T. An auto-sensing hub or switch automatically adjusts the port speed to 10 or 100 Mbps based on the speed of the device connected to it. Older style switches, which were capable of handling 10 or 100 Mbps, were not as flexible and had to be configured through software. Other hardware components that may be required in a computer network include a router. A router makes it possible to connect the yacht's local area network to the Internet via a high-speed data interface on the Satcom or a landline. Another device that can be useful in a network is a network time protocol (NTP) server. This device has a built-in GPS and makes it possible for all computers on the network to have their clocks automatically synchronized with the local time. When planning for a NTP server, a GPS antenna feed should also be planned. If most computers on the network will need to be able to access the Internet, then it is important to assign them legal IP (Internet Protocol) addresses. These can be obtained from some Internet service providers. Alternatively, if the computer network is only going to connect with a private land-based computer network, then the computers do not need to have legitimate IP addresses and can instead be given phony addresses. Addresses for the computers on the network can be either fixed (referred to as static IP addresses) or dynamic where a server on the network dynamically assigns an address to a computer from a pool of available addresses during login. Going with a server that can dynamically assign addresses can make life easier but it also adds complexity to the network. Complex networks can result in requiring a full-time network or system administrator to be part of the crew. Installing an application like PCAnywhere on each computer on the network can make it convenient to administer computers on the network from any location on or even off the yacht through a dial-up connection.

Printing: A computer network onboard makes it possible to share printers between several computers. This can be accomplished in a few different ways. The simplest way is for the printer to be connected to the parallel port of a computer through a printer cable and that computer shares the printer with other computers on the network. The disadvantage of this approach is that the computer, to which the printer is connected, has to always be online. Another option is to have the printer connected directly to a network file server. The most convenient approach is to use printers with a built-in network interface, which allows them to become nodes on the yacht's computer network. This makes it possible for any computer to print to them without having to go through a specific computer. If the printer does not have a built-in network interface, then it is possible to use devices called print servers that have a network interface and also have connections for one or more printers. With a print server, the CPU intensive print processing is off-loaded from the network file server and results in both a significant improvement in the network server's performance as well as faster network printing. Print servers come in 10 as well as 100Base-T models to match the speed of the yacht's network. Hewlett Packard (HP JetDirect) and Intel are two companies that manufacture print servers. Things can still get complicated if a guest brings their own notebook computer onboard and wants to print from it. The simplest approach in this case would be for a crew member to print the file for the guest from a computer on the yacht's network. This also could be difficult if the file to be printed does not fit on a diskette or if the application in which it was originally developed does not exist on the yacht's computers or the guest may not want someone to look at the document. The alternative is to either put the guest's computer on the network, which means installing network and probably also printer drivers. The simplest answer may actually be to keep a spare printer onboard along with a set of printer driver diskettes that can be brought to the guest's room for their use. Having a printer in a central lobby area with an automatic printer sharing device is another option but requires printer cabling to be run from the printer to the relevant guest staterooms along with the installation of appropriate printer connectors. Length limitations of printer cables should be taken into account or alternatively line drivers/extenders can be used if the cable length becomes an issue. Even in this case, the guest may need to install printer drivers on the computer in order to print to the printer but this can be easier and perhaps preferable to giving a guest access to the yacht's computer network. Blackbox (www.blackbox.com) is a good source of printer sharing devices and line extenders.

Backups: Backing up data frequently is the best safeguard against loss of valuable data in case of a hard-drive failure. Hard-drives have become much more reliable but they can still fail. Having a tape backup device on the network makes it easy to perform backups of the entire hard-drive of a computer due to the large capacity of tape backup devices. For a computer that solely performs a standalone function such as alarm monitoring or charting, having a restore CD to restore the entire hard-drive along with the boot partitions is another extremely convenient and quick way of restoring a computer after a hard-drive crash. There are several good programs such as Norton Ghost that make it possible to make an image of the entire hard-drive as a singe file which can be burnt to a CD. These programs can handle different types of file systems such as FAT16, FAT32 and NTFS and also handle long filenames. All a user has to do after a hard-drive failure is to install a new hard-drive, format it and then run the image software such as Ghost from a diskette and provide a CD with the image file and the computer can be restored. Alternatively, the image file could be on the network in which case the computer will need to be booted with a disk containing network drivers that allow it to access files over the network. Some computers also come with restore CDs that restore the operating system and any special drivers,

but such CDs will typically not contain any special applications that a vendor may have installed on the computer.

Email: Email has become one of the most popular means of communication today. It allows crew members to remain in touch no matter where in the world they may be. There are several good email programs as well as Internet/email service providers. A consideration when picking an email provider is knowing whether or not they have local dial-up numbers in parts of the world where the yacht is likely to be. Some of the providers that have dial-up numbers throughout the world include IBM, AOL, MSN and CompuServe, which is why they are the providers of choice for most yacht crews. In addition, email services such as Hotmail and Yahoo offer a convenient Internet based interface for reading/sending email. This makes it possible to access email from Internet cafes without having to dial in to an email provider. Ease of connection and connection speed should be considered when selecting a provider. A land-based email server in the owner's office, for example, can eliminate the need for one of the commercial providers such as AOL or CompuServe. This can, however, require calling long distance to retrieve/send email depending on the location of the land-based server as well as the yacht. In order to limit the expense, especially when one has to resort to Satcom to retrieve/send email while underway, certain features in the email software can help. Features such as the ability to limit attachments above a certain size can help control costs. Also pre-compression of email before it is sent out can also help limit satellite time. Configuring the email system to connect with the land-based server to retrieve and send email at fixed intervals is another way of controlling costs. It is best to consider all scenarios when selecting an email server. For example, by locating the email server onboard as opposed to at a land-based location, crew members would need to dial in to the yacht to send/retrieve email even when they are off the yacht. This can be quite expensive and difficult and hence may not be a desirable approach. Another scenario to consider is how to handle the email requirements of the owner or guests while they are onboard. For example, how to permit guests to receive and send email while onboard without having to call in to their email providers. This may be possible but can require a fairly elaborate land-based email server with the ability to have a guest register his email logon and password details so that email can be forwarded to them while they are onboard through the yacht's email system.

Internet: Similar considerations apply to the Internet when browsing means costly satellite time. Least cost routing through the phone system ensures that data connections are attempted over less expensive landline or cellular connections before resorting to satellite. An alternative approach to accessing the Internet over a satellite connection is off-line browsing. This involves coming up with a list of Internet sites that are likely to be of interest to the owner and crew such as CNN or stock sites. A computer connected to the Internet in the land-based office can periodically visit these sites and save their entire web-pages, compress them and send them to the yacht at designated intervals, perhaps at the same time as when email is sent or retrieved. It becomes possible to browse Internet sites offline once the Internet content resides on a computer on the yacht's local network. Connecting with the Internet comes with the risk of picking up computer viruses. Virus detection programs should be run routinely on all computers on the network as well as on any files downloaded from the Internet to reduce the likelihood of a virus getting into computers onboard. Mission-critical computers should not share their hard-drives to reduce the risk of their files getting infected. Microsoft Word documents are also susceptible to certain types of Macro viruses and these too should be scanned. For additional security, it is important to consider installing a firewall in the network to reduce the risk of someone hacking into the yacht's network. Network security risk increases anytime the yacht is allowed to receive data connections from outside instead of initiating all data connections from within the yacht.

SPECIALIZED APPLICATIONS

In this section a few specialized computer applications will be discussed.

Tank level monitoring: Tank monitoring systems display fuel, potable water and wastewater tank levels. They correct for the effect of sloshing while underway by using filtering techniques to provide stable and accurate numbers. These systems can also provide alarms at user specified setpoints for low levels as well as high levels to prevent overfill. A computer based tank monitoring system can be integrated with other computer based systems that can compute the trim of the yacht, estimate how far the yacht can go based on the current rate of consumption when used in conjunction with a fuel flow monitoring program. The main components of a tank monitoring system include tank level sensors, hardware which reads, scales and filters the signal generated by the tank level sensors, and a display, which shows the tank volumes. Computer based screens typically display the tank volumes as bar graphs and provide the ability to trend the tank volumes and acknowledge alarms. Tank level sensors are the most significant component of the system. Common types of tank level sensors measure the fluid level using either a float type system or by measuring hydrostatic pressure due to the column of fluid in a tank. The float type sensors use a float that slides up a stem, which is fitted along the side of the tank. These types of sensors are the most accurate but can be more susceptible to sloshing and can also be difficult to replace. The pressure sensors measure the difference in pressure across the two sides of a diaphragm that is subjected to

atmospheric pressure on one side and to a combination of atmospheric and hydrostatic pressure due to the fluid in the tank on the other side. Depending on the method of venting, these sensors can be susceptible to pressure variations. To provide accurate readings, tank monitoring systems must be properly calibrated by taking measurements while slowly filling the tanks from empty to full in equal increments. The accuracy of the system depends on the number of readings taken during the filling process.

Trim calculations: Computer applications can automate the process of computing the trim of a vessel. These applications use the vessels hydrostatic tables to automate the process of calculating the center of gravity and the center of buoyancy of a vessel. Based on these numbers, the trim of the vessel can be computed. The main variable that affects the trim of a vessel is the onboard tanks as well as any items such as water toys or helicopters that can be either onboard or offboard. A trim calculation program should interface with the tank monitoring system so that it can receive real-time updates of the tank levels. Real-time calculations give an engineer the ability to manually transfer fuel/water between tanks to optimize the trim. This can improve the fuel efficiency and handling of the vessel. A trim calculation program should be extensively calibrated to make it accurate and useful. This involves correlating the computed draft and trim of a vessel against measured values and then making suitable corrections to the program.

Fuel flow monitoring: A comprehensive fuel flow monitoring application can display fuel burn rates from all the engines and generators. This requires having the engines instrumented with appropriate sensors that measure the fuel flow rate and total this rate over time to come up with the total fuel consumption over a specified period of time. A computer based fuel flow monitoring system makes it possible to generate and observe trends showing the rate at which fuel is being consumed. Projected estimates of range at the given rate of consumption based on how much fuel is onboard at the time can also be made. It is also possible to try and optimize operating parameters, such as speed, to achieve the best fuel economy when one can see what effect varying a parameter has on the overall fuel consumption. With any fuel monitoring system, the net burn rate can fluctuate a lot, so often the net burn rate is averaged to come up with a more stable and usable number. However, this average can be calculated in different ways. A moving average can indicate a non-zero burn rate for some time even after the engine has shut down. One option may be to zero out the average if the net burn rate falls below a certain minimum value that indicates that the engine has shut down. It is usually advisable to get a recommendation from the engine manufacturer on which brand of fuel flow sensor to use. This ensures that the sensors will not be in question in case the manufacturer needs to be contacted regarding fuel consumption issues. A common design of fuel flow rate sensors uses rotating impellers with embedded magnets, which provide a pulsed output signal with every rotation. Each pulse indicates a known volume of fuel. Built in temperature sensors automatically correct the flow rate for temperature variations. Resettable event counters can start totaling after refueling or before starting a trip to indicate how much fuel is consumed during the trip. Logging this data makes it possible to review and plot the results in the future.

Maintenance Tracking: Specialized maintenance applications can help an engineer keep track of scheduled maintenance. Elaborate applications contain scheduled maintenance intervals and details on tasks to be performed for most major equipment. The difficult or time consuming part, however, can be tracking and manually entering the total run hours for a particular equipment. This is where integration of the maintenance program with the shipboard monitoring system can help by automating the running hour entry process since typically the monitoring system tracks the total run hours for major equipment. A simple maintenance program can comprise a screen displaying the total run hours along with the ability to specify the next scheduled maintenance setpoint. Once the engineers have performed the scheduled task, they can increment the setpoint to specify the next period. Integration of the maintenance program with a fuel flow monitoring program can make it possible to specify scheduled maintenance period intervals for engines based on gallons burnt as well as total run hours, whichever of the two is reached earlier. Such an approach may be preferable for the engines as it not only schedules maintenance based on the total hours run but also on how heavily the engines have been used.

Steward Call System: Computer based steward call systems comprise small screens installed in locations onboard where they are likely to be seen by the crew. A guest can press a pushbutton in their room to call a steward. The pushbuttons usually have an LED to provide feedback to the user to indicate that the button press has been recognized by the system. The button press causes the location of where the call button was pressed to show up on the steward call displays. These screens can display multiple calls and sort them by the time of request. Usually the displays also have a buzzer to make it easier to get the attention of crew members. When a crew member sees a steward call come in, they can press a button on the display to acknowledge and silence the buzzer. This can silence it simultaneously on all displays while at the same time making the LED in the guest's room change to a different color helping to notify the guest that their request has been received and someone is on the way. When planning for a steward call system, one must provide power to each display location. Most displays work on 24VDC but it is best to confirm with

the manufacturer. From a wiring standpoint, most displays require cabling to be daisy-chained from one display to the next. However, there are also other styles that require cabling to be home-run to a single location.

Bridge Switching System: There can be several sources of information in a yacht's bridge. These can include standalone computers for systems such as dynamic positioning, ECDIS, alarm monitoring as well as non-computer based images generated by devices such as CCTV cameras, thermal imagers and sonar. The number of screens for displaying these sources can be limited due to space restrictions. Since all sources may not need to be displayed simultaneously, a bridge switching system provides a flexible way of selecting which source is displayed on which screen. Usually a computer application is the main brains behind such a system. The computer application provides a user-friendly graphical interface that allows the user to drag a source and drop it on the desired destination display. Such systems when used with touchscreen displays or other pointing devices also provide the ability to switch the touch interface along with the video. The display screens can be either CRT or flat panel displays. A bridge switching system uses a matrix switch that has all the possible video images that can be displayed as inputs and the destination displays as outputs. Special video converters may be required to convert non-computer video signals so they can be displayed on computer screens. The quality of the final image depends to a great deal on the quality of the converter and the matrix switch used. When displaying images such as from a camera source, one must keep in mind that these may not look as good on flat panel displays in full screen mode. This is because flat panel displays usually operate best at a specific resolution and when the source resolution is lower than the display's native resolution, the image ends up being stretched, causing it to lose its sharpness.