

## Internet Access from the Rail

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### Introduction

Knowledge and planning have always been key factors in all forms of sailing, from the Polynesian catamarans to Nelson's victory at the Battle of Trafalgar to the Volvo Ocean Race. With the explosion of the Internet, access to information is easier and quicker than ever. However, that information has been difficult for the sailor to access while at sea. Recent innovations have enabled the sailor to access the Internet, but those solutions typically have been slow and expensive. Fortunately, travelling professionals have similar problems accessing information on the go, so many companies have focussed their efforts to improve the speed and cost of wireless internet access.

Another problem facing sailors is situational awareness. In the past, it was usually necessary to go below to the nav station to use the on-board computer for Internet access. If the tactician or on-deck navigator was forced to do this, it typically meant taking that person out of the decision-making group while they accessed the needed information. There was also typically a "catch-up" period when they came back on deck and re-acquired their bearings. The ideal solution would allow access to the Internet from above deck without the need to go below. Until recently, the technology was not mature enough to support such a solution. With recent innovations in hardware and communication services, access to the Internet from an on-deck PDA is possible on a sailboat utilizing several commercial off-the-shelf (COTS) devices. The solution described in this paper utilizes a PDA connected through a WiFi router to a laptop PC with a shared Internet connection on a cellular data service. For those boats with the Ockam Eye system installed, many of these components are already in place.

### Equipment

The key component to this system is the cellular data modem. The major cellular carriers each offer several cards for access to the cellular network. It is important to note that since the market is entirely tilted to mobile computing, the card modems are only available in PCMCIA cards. Most cards now have integrated antennas, but a card with an external connector is preferred if available. The external connector allows connection to an above-deck antenna (such as those made by Digital Antenna or GAM) for increased range. Alternatively, most cellular handsets have the ability to act as modems. However, it is worth noting that additional software and cabling is required to use a handset as a modem. Also, some cellular carriers (most notably Verizon) disable data modem service unless you subscribe to their data plan. Many handsets (such as those from Motorola) also have provisions to connect an external antenna and/or have car kits available. Most proficient marine electronics firms should be able to install the hardware for external antennas or car kits.

Also required is a PC (preferably a laptop) with a PCMCIA slot (if using the card modem) and a wired LAN port. The separate wired LAN port is necessary when using the cellular card because most laptops do not have the space to handle a cellular card and a WiFi card. It is possible to install a PCMCIA slot on a desktop system, but this typically adds a layer of complexity and hence a failure point. Therefore it is highly recommended to use a laptop PC for this application. Cellular handsets typically use USB to connect to a PC, so some of

these concerns are moot if connecting with a handset. Windows XP Professional is the preferred OS for this application, as it has utilities that make Internet connection sharing easy. It is possible to use another OS such as Linux, but support for such an installation typically requires rigorous technical attention, and there tends to be a lack of third-party applications.

The PDA that will be used on deck must have WiFi capability as well as a web browser or other program to access the Internet. Most modern PDAs provide such functionality. The WiFi connectivity can be achieved through an expansion card, but built-in support is desirable for simplicity and robustness. There are a variety of operating systems for PDAs, but PocketPC (a.k.a. Windows Mobile 5.0 in its most current incarnation) seems to be steadily gaining in popularity judging by the amount of third-party applications.

Finally, a wireless router is required to tie the system together. The router should be configurable to act as a DHCP server and to run in infrastructure mode. The DHCP server allows multiple network devices to attach to the boat's local network without the need to worry about configuring each device's network connection. Running the router in infrastructure mode allows the router to be placed for optimal wireless reception throughout the boat. Infrastructure mode also prevents the connection problems that may be encountered with ad-hoc networks when close to other wireless network devices (such as found on other boats). It is strongly advised that WEP be used to prevent unauthorized connection to the boat's wireless network.

#### Cellular Service

The major cellular networks all offer data services. Those using EV-DO (Verizon and Sprint) offer significant speed advantages, but as of Q4 2005, the coverage of the EV-DO network is not as extensive as the more common 1xRTT network found on these carriers. GPRS and EDGE are similar to 1xRTT in data rates, but those carriers using this protocol (Cingular, AT&T, and T-Mobile) have had less extensive coverage historically. Users can expect maximum data rates of up to 2.4 Mb/s on an EV-DO network, 144 Kb/s on 1xRTT, 171.2 Kb/s on a GPRS network, and 384 Kb/s on EDGE networks. These are maximum data rates; practical data rates are usually quite a bit lower due to error correction and network traffic. The practical data rate is usually around 50-70% of the maximum value, depending on network and location.

In the early days of cellular service, antenna towers were not very numerous and tended to be far apart. Because of this, transmission power tended to be fairly high, and it was not uncommon to get good reception several miles offshore. As the amount of towers increased to accommodate increased network use, the transmission power of individual towers dropped, and the distance one could expect reception offshore shrank. Currently, handset reception on deck is acceptable for voice up to around 8 miles offshore from an area with excellent cellular coverage on land. The range of the modem cards is similar, although it tends to be reduced due to the below-decks location.

The addition of an external antenna greatly increases the range. There have been reports of reliable data connections at least 10-15 miles from shore. As is usually the case, the higher the antenna is placed, the better the range will be. For maximum range, the antenna would be placed on the masthead. This option is rarely practical because of the limited space there, so the cellular antenna is frequently placed on the stern pulpit or lower spreaders of sailing yachts. When selecting an antenna to use, the frequent temptation is to use a very high gain antenna to get the most range. While this may be practical for a static

installation, the heel angle and constant motion of a sailboat renders the high gain antenna nearly useless since its sensitivity is tightly focussed in a plane. A lower gain antenna should be used, as it will be less sensitive to heel and motion.

In addition to external antennas, there are also signal amplifiers available. These amplifiers tend to be expensive (US\$500), but can increase range up to 50 miles. Amplifiers cannot be used in every instance as they tend to have complex installation issues, but they are certainly worth investigating if extreme range is desired or required for cellular data service.

#### Laptop Configuration

The preferred laptop configuration uses a PCMCIA cellular modem card, a wired LAN connection, and Windows XP Professional.

A cellular handset using a USB connection can be used instead of a modem card, but it is far less reliable than the PCMCIA card. Some handsets can act as cellular modems through Bluetooth, but users should be aware of the increased power consumption (and lower battery life) this may cause. Carriers also sometimes disable the Bluetooth modem profile in their handsets.

The wired LAN connection allows the fastest data rate possible to the wireless router, and also helps prevent any packet collisions that could occur when using wireless networking. Also, when using the card slot for the cellular modem, it is often not possible to fit a WiFi card if it is required.

Windows XP Professional makes sharing an Internet connection quite simple, and even provides the ability to produce setup disks to configure other PCs to share the connection. Other flavors of the Windows operating system allow Internet connection sharing, but XP Professional is by far the simplest to use. Other operating systems can be configured to share an Internet connection, but it is typically far more difficult to accomplish.

#### Router Configuration

Any router used should be able to support at least the 802.11b wireless protocol. Most modern wireless devices are backward compatible to this standard. The router should also be able to act as a DHCP server to simplify network configuration, and have WEP enabled to secure access to the network against outside interlopers.

The router should also be able to run off the boat's battery voltage to simplify the power connections. It is typically not desirable to run off an inverter, as this introduces an additional point of failure for the system. The router should be placed on some sort of DC protection system to prevent harm from under and over volt conditions.

#### PDA Configuration

The PDA used for on the rail Internet access should be capable of running a web browser or other Internet-enabled program. PocketPC a.k.a. Windows Mobile is supported by more applications than the Palm OS and seems to have a more solid future, so it is the OS of choice for this application. The OS also enjoys good support for programming, so making new applications is relatively easy, as evidenced by the amount of third-party programs available.

WiFi access for the PDA should be built-in to the device if possible. This eliminates a possible point of failure for the PDA, as well as keeping the expansion slot clear for another device, such as expanded memory. Built-in WiFi is very rigorously tested and is usually very reliable when compared to external add-ons.

#### Conclusion

With current technology, it is much easier to provide above-deck Internet access than it has been in the past. The configuration described above allows for reliable, relatively inexpensive near-shore data access using commonly available hardware and services. Those making tactical and navigation decisions while sailing can have much easier access to the wide variety of information available on the Internet, enabling them to make the most informed decision possible while maintaining situational awareness.