Getting connected

Electronics expert Andy Haines explains why the ubiquitous, low-cost USB system of connectors isn't well suited for marine interfaces

QUESTION: 'Why are there competing different electronic buses on boating instruments? Surely USB is ubiquitous; faster and effective and 'universal'?
Mike Greenland, Wimborne, Dorset

That's a very good question and it's not the first time I've been asked to explain the different interface protocols used in the marine industry.

The good news is that although there are several protocols currently in use, these have come about mainly for historic reasons (more on that later) and over the next few years we'll see most disappear. These days NMEA 2000 dominates the market for sharing basic navigational data such as position, speed, depth, heading etc. However, this does not include video data, such as chart or radar displays, which requires a faster protocol such as Ethernet.

The NMEA 2000 interfacing standard is defined and controlled by the National Marine Electronics Association (NMEA), which is an independent body based in the USA. Manufacturers agree on NMEA rules and requirements, so that all compliant equipment will be compatible.

Why not USB?

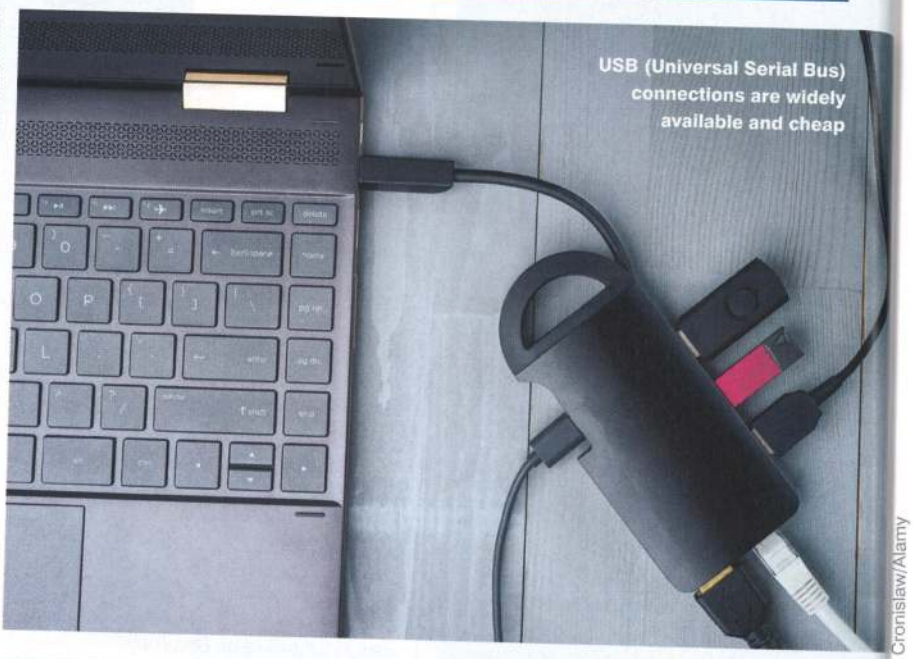
So why doesn't the marine industry use USB to link different products together?

USB came into being in 1996 to replace serial and parallel ports for connecting a PC to peripheral devices such as a mouse, keyboard, printers etc. More recently, because it uses a 5V power supply, it has become common for charging portable devices such as mobile phones and cameras. But there are several technological limitations:

- The PC is 'master' – everything is connected to the PC, not each other (ie the keyboard, mouse and printer communicate only with the PC, not each other).
- USB is not a true 'duplex' system – it cannot transmit and receive at the same time. It is effectively 'semi-duplex' which, like your VHF, can either transmit or receive, but not both at the same time.
- USB has a strict 'tree' topology – it is impossible for two hosts to communicate over their USB ports directly, although some extension to this limitation is possible through USB On-The-Go.
- A host cannot 'broadcast' signals to all peripherals at once – each must be addressed individually.
- USB cables are limited in length, as the standard was intended to connect to peripherals on the same table-top, not between rooms or between buildings. However, a USB port can be connected to a gateway that accesses distant devices.

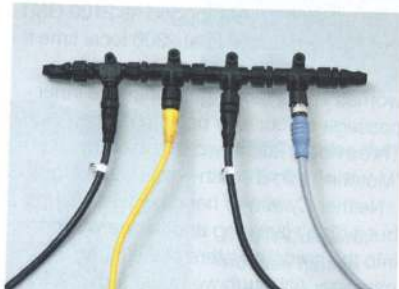
There are other limitations as well. Anyone who develops a USB device for public sale has to pay a fee and become a member of the 'Implementers' Forum' (USB-IF). This permits a company to use the USB logos which, in turn, should provide a guarantee that the product will connect to a system successfully. The marine industry being relatively small compared to the computer industry would have very little control (if any) over future development of the protocol.

And on top of everything else, shore-based equipment is not subject to the same stringent requirements as marine equipment. USB connectors aren't waterproof, whereas marine manufacturers generally use waterproof connectors. 'Office' computer equipment on board vessels will almost always be used in a relatively confined area, whereas marine interfaces, even on yachts, often involve cable runs of 20m or more.



USB (Universal Serial Bus) connections are widely available and cheap

Cronislaw/Alamy



LEFT Why does the marine industry insist on a bespoke connectivity protocol rather than using the well known USB standard?

Marine electronics equipment must conform to a set of EMC (Electro Magnetic Compatibility) standards that prevent products causing interference with each other. Safety is the major reason for these standards, so cables used for marine interfacing are screened and use twisted pairs to isolate their signals and survive the sometimes rugged marine conditions.

Marine specialisation

However, the main limiting issue is the 'master-slave' scenario; in the marine industry we ideally want a 'master-master' set-up in which data can be input via multiple controllers and displayed on multiple screens. But how did we end up with all the different interfaces in the marine industry?

Since the late 1970s there has been a market for connecting devices made by different manufacturers, so it became advantageous to create a common protocol for use by all. By 1983 NMEA had agreed upon NMEA 0183 as the standard for interfacing marine electronic

Raymarine's Seatalk NG system is technically NMEA 2000 but the physical connectors are not industry standard

equipment. It's still in use today, although it has been gradually fading out during the last five to ten years since the introduction of NMEA 2000 in the early 2000s.

NMEA 0183 is a unidirectional system: in other words one pair of connections either transmits or receives data, not both. Example: product A may send (talker) data to product B (listener) and to product C (listener) as well. Product C may send (talker) data back to A (listener), but each would necessitate a separate pair of connections.

In this scenario product B has no idea what product C is doing and no data from product C is available to it. It is also relatively slow, so trying to send too much data in one go can cause issues.

Although the protocol is controlled by NMEA, manufacturers did not have to conform to the way the interfacing is connected. It could be described as 'open wire' connectivity: the manufacturer may provide their own plug and cable for their bit of kit, but it would just terminate in open-ended wires, so the installer makes his own connection. Over the years this has caused all sorts of problems.

Then in 1988/89 Autohelm (now Raymarine) introduced Seatalk. Seatalk is a bidirectional system on the same pair of wires, so in the above example products A, B and C all talk and listen to each other. There is no 'master' or 'slave' just a sharing of data. So if you connect a GPS/plotter, wind system, depth, speed and autopilot together on Seatalk, all that data is shared. The plotter knows the vessel's heading (from the autopilot), the wind knows the vessel's speed (from the speed/log), so it can now calculate true wind... and so on. All data on a bidirectional system is shared around the system. If you then added a multifunction display, it could repeat everything available on the system, such as position, speed through the water, speed over the ground, depth, waypoint data and more.

This was a huge step forward compared to NMEA 0183, so other manufacturers made their own bidirectional interface systems. The down side was none of the protocols were compatible with each other (eg B&G's 'Network' and Autohelm's 'Seatalk' couldn't talk to each other). They all made converters to convert their own systems into NMEA 0183 (and vice versa) so different manufacturers could still communicate with each other via NMEA 0183, but it was obvious that an industry standard was required.

This entry level Standard Horizon fixed VHF is NMEA 0183, but the more advanced models are compatible with both systems

So in the late 1990s the NMEA started developing NMEA 2000 and devised a system based on the following statement, which is copied directly from their website:

'The NMEA 2000 standard contains the requirements of a serial data communications network to interconnect marine electronic equipment on vessels. The standard describes a low-cost moderate capacity bi-directional, multi-transmitter/multi-receiver instrument network to interconnect marine electronic devices. It is multi-master and self configuring, and there is no central network controller. Equipment designed to this standard will have the ability to share data, including commands and status with other compatible equipment over a single channel. It is based on CAN (Controller Area Network). Although this standard is 50 times faster than NMEA 0183, it is not intended to support high-bandwidth applications such as video.'

NMEA 2000 is now the industry standard. Furuno, Garmin, Simrad, Lowrance, B&G, Icom, Standard Horizon and many more all conform 100% to NMEA 2000. The main exception is Raymarine (see below). There is still quite a bit of NMEA 0183 in use and it is a good, cheap, reliable option for straightforward instrumentation. Seatalk and other manufacturers' protocols still work with their own discontinued products. The cables and connectors for NMEA 2000 are standard so manufacturers that conform 100% to NMEA 2000 'must' use these cables and connectors. They are high quality, twisted pairs and screened.

Raymarine uses Seatalk NG, which is actually NMEA 2000 but with different cables and connectors. So Raymarine products conform to the specification technically, but cannot be called NMEA 2000 because they use different cables. NMEA 2000 cables are all black and the connectors are all the same, whereas Seatalk NG cables are colour coded, so you can tell instantly whether a cable is part of the backbone or a spur, making fault-finding much easier. Raymarine makes a 'device net' cable, which connects Seatalk NG to any other NMEA 2000 system.

So, in summary, despite Raymarine not conforming 100% (in terms of cables and connectors) NMEA 2000 is now the industry standard.

LEFT NASA wind instruments are still NMEA 0183 compatible, but you can buy a translator box to enable the data to link into NMEA 2000 system. RIGHT Raymarine's Seatalk system is effectively NMEA 2000