With CAN network across the seven seas

Stefan Palm

Author
Stefan Palm
Business Development Manager Embedded Computing
Moxa Europe
Einsteinstr. 1
DE-85716 Unterschleißheim

Links
www.moxa.com
www.nmea.org
www.odva.org

One of mankind´s oldest means of transportation and travel are ships and boats, used to cross the world´s rivers and oceans. While they have constantly been used thousands of years, their technology has always evolved to reinvent themselves and keep moving with the requirements arising from a changing world. The development continues since the demand for the transportation of goods and people by seaway is continually increasing. The very traditional marine industry that has developed over time is always looking to take advantage of technical development arising from other industrial sectors. Therefore all the technologies that triggered industrial revolutions can also be found onboard of modern ships. Shipbuilders have the same requirements as other industries to increase both the efficiency and effectiveness of their equipment to stay ahead of competitors.

Due to this fact, technical alliances were created to transfer the expertise from other industries into shipbuilding. For example, no ship manufacturer would build engines or engine control systems. This part would be outsourced to partners with the respective expertise and experience.

Usage of CAN

Leading engine manufacturers such as MaK, Caterpillar, Deutz, MAN Diesel & Turbo, Wärtsilä or Volvo Penta use CAN as quasi standard, which means that the IT (information technology) infrastructure onboard a ship must be able to handle both the protocol and the messages transmitted over it to efficiently control the security systems of the main engines and generators. Furthermore, CAN network is used to monitor the engine and ship functions, such as exhaust-gas-temperature averaging system, load state measurement, ballast tank monitoring systems, wake state system with engineer-call-function, display for fire control equipment, automation system, pump con- ▷

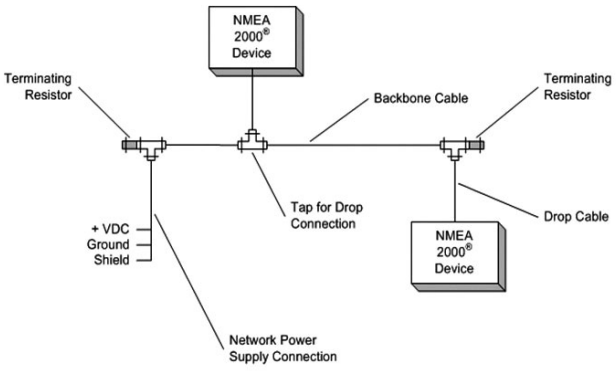

Figure 1: A simple network topology with NMEA 2000 devices (Source: NMEA)

Abstract
It is no secret that Controller Area Network (CAN), invented in 1983 by Robert Bosch, was originally designed to control engines in an extremely secure and reliable way in environments with lots of noise. Naturally, this kind of technology is used onboard ships as they house by far the biggest and strongest engines ever built.

NMEA association

NMEA was founded in 1957 by a group of electronic dealers to strengthen relationships with electronic manufacturers. After the incorporation of NMEA in 1969, the association began publish the association newsletter "NMEA News" in the early seventies. Publication of the news continues today as the Marine Electronics Journal, the Official Journal of the NMEA.
NMEA created the only uniform interface standard for digital data exchange between different marine electronic products back in the early eighties. The NMEA 0183 Interface Standard is widely accepted by manufacturers and is recognized by maritime agencies worldwide. Frank Cassidy was instrumental in having the standard adopted as the basis of an international standard by the International Electrotechnical Commission in Europe. The updating and expanding of the protocol and development of future standards is continued today by a committee of NMEA volunteers under the direction of Steve Spitzer, NMEA Technical Director.
In the early eighties, the CMET (Certified Marine Electronic Technician Program) was created. The purpose of the CMET Program was to assure the consumer that the technician working on his vessel had more than a basic knowledge of electronics in general. With this certification, the technician demonstrated a competency and familiarity with marine products. The CMET Program continues today, as the ever-increasing need for such a program exists.
The association provides a forum for its members through frequent communications from the national office, regional meetings and its annual conference. It also focuses on educating the public in safe and proper use of marine electronics and strengthening the association's presence in the marine electronics industry.
Source: http://www.nmea.org/content/join_the_nmea/history.asp

trol and door-bulkhead control. In relation to this, efficient control means decentralized acquisition, collection and aggregation of relevant data as well as grouping, formatting, delaying or suppressing of signals. Required is also individual display of data at the conning systems in the control room and at the bridge. All this effort is made to enable the crew to determine the overall state of the ship and the conditions of the equipment anytime, and to allow remote control and the automation of recurring processes.

NMEA specifications

Besides this application, CAN is used in another less obvious environment – yet it is gaining more and more attention there, and it has already become a standard for smaller boats and yachts. CAN supports the communication infrastructure and the network backbone for the communication with marine equipment used for safe navigation. Such equipment as AIS, Gyro, Log, Radar, Speed, GPS etc., is connected to bridge systems via NMEA (National Marine Electronics Association) interfaces. NMEA is a combined electrical and data specification for communication between marine electronic devices.

While the standard NMEA 0183 (IEC 61162-1) is build on the EIA-232 interface, the next step of evolution has been made by creating the NMEA 2000 (IEC 61162-3) standard. NMEA 2000 connects devices onboard ships and vessels using the CAN technology. It is based on the SAE J1939 higher-level protocol, but defines its own messages. NMEA 2000 devices and J1939 devices can be made to co-exist on the same physical network.

The only cabling standard approved by NMEA for the use with NMEA2000 networks is the DeviceNet cabling standard, which is controlled by the Open DeviceNet Vendors Association (ODVA). Such cabling ▷

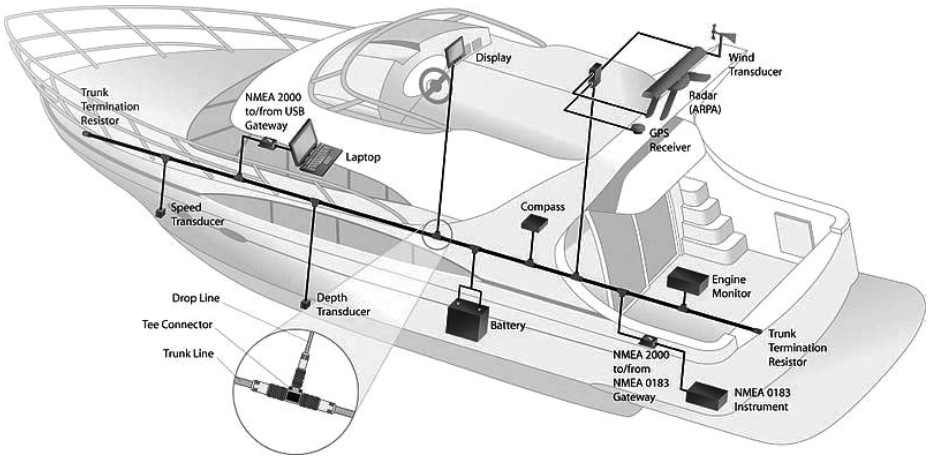

Figure 2: A typical NMEA 2000 installation (Source: NMEA)

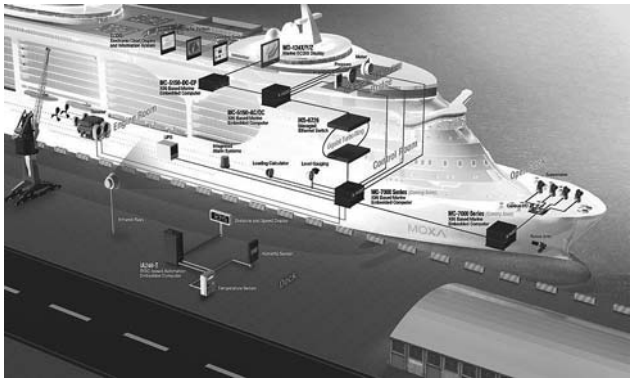

Figure 3: Networked ship control (Source: Moxa)

systems are permitted to be labeled as "NMEA 2000 Approved". The DeviceNet standard defines the levels of shielding, conductor size, weather resistance, and flexibility, all of which are not necessarily met by other cabling solutions marketed as "NMEA 2000" compatible.

NMEA 2000 was created to overcome the weakness of NMEA 0183, which is based on point-to-point communication requires complex wiring systems. NMEA 0183 also lacks on bandwidth, as the highest speed is 38400 bits per second. It was not designed to handle the current volume of traffic nor the integration of devices required by customers. The former standard has no certification process and does not specify physical layers (cables/ connectors). This makes plug-and-play functionality difficult to achieve.

In the last 10 years, NEMA 2000 has gained popularity and it is now widely used in small boats and yachts. It provides the advantages of CAN technology, multi-master capability, drive-by-wire function, real-time control and status information, autopilot control, navigation information, vessel monitoring as well as electrical system control and status. The network uses the bit-rate of 250 kbit/s (50 times faster than NMEA 0183) and is up to 200 m long. Up to 50 physical nodes and up to 252 functional nodes may be supported.

Conclusion

NMEA 2000 is an open CAN-based industry network standard that allows data sharing among disparate devices from different manufacturers. It accommodates real-time control and status information, and it has a standardized physical layer (cable and connectors). Devices can be certified to reduce or eliminate interoperability issues. The time behavior is deterministic to ensure that critical messages will reliably be put through. NMEA 2000 network protocol is industry-proof, open standard for marine electronics, engines, electrical data, and other data applications.