Welcome to the NMEA Gateway session

Sanibel Island, Florida

Wednesday October 8th 1:30 pm
Thursday October 9th 10:15 am
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Managing Director, Active Research Ltd.

Actisense intelligent sensors and interfaces

The NMEA Specialists
I started out in Aerospace as an avionics engineer

In 1990 I moved to Poole on the south coast of England and worked for Echopilot where I designed their ground-breaking forward looking sonar system

In 1997 I formed Active Research Limited, which as a design consultancy created many designs for leading marine electronics corporations

The Actisense brand name was registered in 2001 to create new products for the marine market.

Actisense is a member of the NMEA 2000 and OneNet standards meetings.
What is a Gateway?
A network gateway is an inter-networking device capable of joining together two networks that use different base protocols.

A gateway can be implemented completely in software, completely in hardware, or as a combination of both.

Because a gateway, by definition, appears at the edge of a network, related capabilities like firewalls tend to be integrated with it.

An extended definition includes analogue “protocols”, which are often defined by a simple relationship between a value and a voltage or current that represents that value.
On home networks, a broadband router typically serves as the network gateway converting to ADSL or cable protocols.

In addition devices such as Network address translation gateways act as intermediaries in internet connections.
This presentation will focus on various NMEA 2000 gateways that allow NMEA 2000 networks to interact with other systems.

The following slides show a quick roundup of the main NMEA 2000 features.
NMEA 2000 is an ‘open’ network system based on “CAN” bus (Controller Area Network)

CAN is used in the automotive industry

CAN is a robust, error resistant protocol with automatic re-transmissions and fault tolerance

CAN has embedded Messaging Priority

CAN enables the exchange of data between multiple devices simultaneously
NMEA 2000 added the following specifics:

- Marine manufacturers collaborated to create an ‘open’ network environment
- Requirement for certification
- Data rate of 250 Kbit/s (50x NMEA 0183) and standard connectors and cabling
- Power and isolation in the interfaces was added to prevent ground loops
- No need for multiplexers as used in NMEA 0183 – the bus itself is the multiplexer
Raymarine Seatalk NG – uses NMEA 2000 protocol but has proprietary layer running alongside and proprietary connectors.

SimNet – Simrad have some products that use a different connector system but NMEA 2000 protocols, this is called SimNet.
Just like the general gateways described previously, an NMEA 2000 gateway operates on the edge of the NMEA 2000 network.

As the NMEA 2000 network has specific timing requirements in the network management layer, it is a requirement that NMEA gateways are provided as certified hardware devices on the bus.

This means that software running on a Personal Computer using a standard CAN interface cannot be used directly on the bus as a gateway, as the tight timing requirements could not be met.

No need for multiplexers as used in NMEA 0183 – the bus itself is the multiplexer.
Who makes gateways?

Actisense make three kinds of gateways:

- NMEA 0183 to NMEA 2000 gateways
- NMEA 2000 to PC gateways (Third party gateway)
- NMEA 2000 to Analogue (EMU-1)

There are many other gateways on the market that cover the above and the other gateways mentioned here.

Maretron, Chetco, Nobletec, Rosepoint/Coastal Explorer, FW Murphy, MasterVolt, BEP Marine, Empirbus, Raymarine, Mercury, Cummins
NMEA 2000 Network Overview

**NTA-1 (In Development)**
- Drive analogue devices from NMEA 2000 data
- Show digital readings on analogue gauges

**QNB-1**
- Reduces installation costs
- Ideal for areas of high instrument density
- Fuse protected power entry

**NGT-1-USB**
- Allows you to see the data on the NMEA 2000 network
- Compatible with industry leading chart plotters

**NGW-1-ISO**
- Converts NMEA 0183 to NMEA 2000 & vice-versa
- Allows NMEA 0183 devices to be used with NMEA 2000 network

**ATN-1 (In Development)**
- Converts analogue signals to NMEA 2000
- New and existing devices can work together

**EMU-1**
- Converts engine analogue signals to NMEA 2000
- Share engine data on the network

Battery Supply

12v
This presentation will cover the following gateway types:

- NMEA 2000 “Third party gateways”
- NMEA 2000 to NMEA 0183
- NMEA 2000 to Analogue
- NMEA 2000 to TCP/IP
- Other protocols
NMEA 2000 Third Party Gateways (TPG)

Making the NMEA 2000 network available to personal computer software
The “Third party” here is the software running on the client PC

A TPG acts as a “dongle” to allow a PC full access to the NMEA 2000 bus

It implements rules to prevent PC software from sending data too quickly and flooding the bus

Provides an addressed port on the bus which identifies the software
Why use a TPG?

Allows NMEA 2000 data to other computing devices, allowing much expanded computing capability and extended functions such as wide area network / internet connectivity.

Compatible software products such as MaxSea, Fugawi Marine, Coastal explorer etc. can all read PGN data from the bus and also write back data such as autopilot commands through the gateway.

Low certification costs are required for software using a TPG, as most of the tests are done to certify the TPG.
NGT-1 Connects your PC software to an NMEA 2000 network

An NMEA 2000 CAN-Bus gateway for Windows, MAC or Linux that runs the NMEA 2000 stack

Transfers NMEA 2000 messages to and from the NMEA 2000 bus

Works with many brands of PC navigation software

DLL and source code software stacks available

Provides with the free **NMEA Reader** software to help diagnose an entire NMEA 2000 network

Other similar dongle devices are made by Maretron (USB100), Coastal explorer and Chetco, amongst others
### How to use a TPG

These devices require a programming library (dll or similar) which allows computer software to interact with the NMEA 2000 bus in a direct way.

All devices mentioned are plug and play, and simply plug into the PC – a USB or similar driver is provided by the manufacturer to allow hardware communication.

The NMEA can certify software using a TPG using a simplified test regime.

Many devices such as the NGT and the Maretron USB100 come with analysis software that allows network diagnostics to be performed.
NMEA 2000 to NMEA 0183 Gateways
<table>
<thead>
<tr>
<th>In NMEA 2000:</th>
<th>In NMEA 0183:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A binary encoded message structure is used, using “PGNs”, which identify for data packets sent over the bus</td>
<td>NMEA 0183 is an ASCII “Text” based standard using formatters and talker ids</td>
</tr>
<tr>
<td>Baud rate is 250,000 bits/s</td>
<td>Baud rate is 4800 or 38400 bps</td>
</tr>
<tr>
<td>All devices have electrically isolated interface circuitry</td>
<td>There are many legacy devices without isolated interfaces</td>
</tr>
<tr>
<td>Data can be sent from any node – all data is shared on the bus</td>
<td>Data is transmitted from <em>Talkers</em> - Only one <em>Talker</em> is allowed on a data connection</td>
</tr>
<tr>
<td>The bus itself is the multiplexer</td>
<td>To <em>combine</em> data from multiple <em>talkers</em> together, a <em>multiplexer</em> must be used to concentrate the data.</td>
</tr>
<tr>
<td>Data can be received by any node - all data receivers can see all data providers</td>
<td>Data is received by <em>Listeners</em></td>
</tr>
<tr>
<td></td>
<td>An NMEA 0183 data connection can have multiple <em>Listeners</em></td>
</tr>
</tbody>
</table>
Why use an NMEA 0183 to NMEA 2000 gateway?

For over 25 years, NMEA 0183 has been the standard method for marine electronic devices to share information with each other. There are a huge range of devices installed on boats that will continue to function effectively for many years.

An NMEA 0183 to NMEA 2000 gateway protects that investment, while allowing the adoption of the NMEA 2000 bus as the primary data backbone during a major refit.

NMEA 0183 gateways avoid the “all or nothing” headache of upgrading to an NMEA 2000 networked system.
An NMEA 0183 Gateway should convert NMEA 0183 sentences to NMEA 2000 messages and vice-versa.

However, as stated before, NMEA 0183 sentences are ASCII text based, while NMEA 2000 uses a binary protocol. This implies that a complex protocol conversion from NMEA 0183 data to NMEA 2000 data is essential.

This is not a trivial task, and there are a few pitfalls that can cause problems in the translation process.
An NMEA 0183 gateway will try to convert all the NMEA 0183 sentences it receives into NMEA 2000 PGNs.

This means that the ideal use case for an NMEA 0183 gateway is to connect a single NMEA 0183 talker to the NMEA 2000 bus.

However, it may be likely or desirable to connect the NMEA 0183 gateway via a multiplexer to multiple talker devices.

It is essential that only one type of each device is connected to the gateway - if a gateway receives two GPS GLL sentences from two GPS receivers, the GPS position on the NMEA 2000 bus could continually switch between the two sources as the gateway converts the data.
An NMEA 0183 gateway will come preconfigured with a range of sensible NMEA 2000 to NMEA 0183 conversions.

A NMEA 0183 gateway will try to convert all the NMEA 2000 PGN data it receives into NMEA 0183 sentences.

Because of the baud rate differences, this can lead to complete overload of the bandwidth on the NMEA 0183 side, meaning that the rate of sentences will slow down if it is trying to send all the data available.
For best results, the baud rate of the NMEA 0183 side of the gateway should be set to 38400 baud.

This increases the available bandwidth, and is particularly important where AIS data is present or required on the NMEA 0183 output.
Some data cannot be translated between NMEA 0183 and NMEA 2000.

This is because there may be no appropriate NMEA 0183 sentence for a particular PGN (or vice-versa).
On Actisense gateways, and potentially on other gateway makes, the received PGN list should be configurable.

This allows the user to turn off default received PGNs that are in its “out of the box” configuration.

By turning off PGNs, less NMEA 0183 conversions will take place and the bandwidth required on the NMEA 0183 side reduced.

The Actisense software “NMEA reader” can be used to do this job.
Analogue to NMEA 2000 Gateways

Allow data points from analogue sensors to be converted to an NMEA 2000 digital value – e.g. engines, trim tabs, tank levels etc.
EMU-1: Engine Monitoring Unit

Analogue to NMEA 2000 - EMU-1

Share analogue engine information on the NMEA 2000 bus

Converts engine and other types of analogue signals into NMEA 2000 PGN messages

6 Gauge/Sender inputs, 4 Alarm inputs, 2 Tach inputs and 2 flexible auxiliary inputs (for future expansion)

Configurable to suit the engine it is working with

Configuration Tool allows setting of Gauge/Sender type, engine speed / Tach ratio, Alarm trigger voltage and the PGN field association

Supports a range of PGNs such as Transmission (Gearbox) Parameters, Battery Status, Alternator Potential and Fluid Level
Analogue gateways require some level of configuration.

The conversion from analogue value to NMEA 2000 needs to be specified—knowledge of the basic voltage, current or other quantity must be known versus the intended data output.

For example, a pressure gauge provides a voltage where a particular voltage “means” a particular pressure. This can be presented as a conversion curve.

In the case of the EMU, these curves are stored in the configuration tool and uploaded to the EMU via the NMEA 2000 bus.
Using an analogue to NMEA 2000 converter – under the hood

Analogue Fuel level voltage

Database conversion lookup curve

<table>
<thead>
<tr>
<th>PGN</th>
<th>Instance</th>
<th>Fluid Type</th>
<th>Fluid Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>127505</td>
<td>0 (0..15)</td>
<td>0 = Fuel</td>
<td>50.0 (%)</td>
</tr>
</tbody>
</table>

PGN sent to NMEA 2000 bus
Many manufacturers specialise in providing analogue adapters

Maretron have a wide range of tank and level adapters as well as dc and ac monitoring instruments. They also have gateways that specifically monitor alarms.

Chetco digital specialise in the field also

Offshore systems specialise in tank level monitoring
There are a number of gateways supporting internet protocol and the TCP/IP stack.

These gateways allow NMEA 2000 data to be shared over the internet and accessed from anywhere in the world.

For now, all these gateways use their own proprietary method to send NMEA 2000 data.
NMEA 2000 to TCP/IP – e.g. Maretron IP100

Multiple Wired and Wireless Devices Running N2KView®
And N2KView® Mobile
Vessel Monitoring and Control Software

Remote Wired and Wireless Devices Running N2KView®
And N2KView® Mobile

Maretron Cloud Services
Internet

Maretron
Vessel Monitoring & Control Systems

Reproduced courtesy of Maretron
“OneNet” Gateways
OneNet is a standard by the NMEA built upon internet protocol IPv6

The standard is still in draft

Actisense is working on a OneNet gateway, designated “NOG-1”

OneNet has the advantage of making all devices on the NMEA 2000 bus addressable in the wider internet address space
And finally...any questions?

Checkout our comprehensive website for more details.

In particular we are producing some how-to guides for marine interfacing to enhance our website – please let me know if you have any suggestions or areas of “maximum pain” that often cause you the biggest issues.