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SYSTEMS INTEGRATION BASICS FOR YOUR BOAT

Creating a NMEA 2000 network on board your boat.

Presenter: Georgia Hilton

INTRODUCTION

- Introduction

- NMEA Background

- Basic Network Implementations

- Setting up Your Network

- Configuring Your NMEA Network

- Connecting Your NMEA2000 Devices

- Adding WiFi , Smart Devices & Computers

- Adding Other Networks to NMEA2000

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Introduction

Why network?
Why I should network
My sailboat's network as an example

NMEA Background
A brief overview of NMEA , NMEA 2000 and how it works

Basic Network Implementation
NMEA and various Manufactures implementations
NMEA2000 / SeaTalk(ng) / NMEA0183 / SeaTalk I

Setting up Your Network
Parts and Pieces / Gateways and Bridges
Sensors / Network devices /MFDs and Chartplotters

Configuring Your NMEA Network
Designing, Installing, Powering your Network

Connecting Your NMEA2000 Devices
Manufactures Network design and differences

Adding WiFi, Smart Devices and Laptops
MFD Wifi
NMEA2000 WiFi Gateway
NMEA2000 Ethernet Bridge

Adding Other Networks to a NMEA2000 Network
RAYMARINE SeaTalk(ng) , SeaTalk I , NMEA0183

Basic Networking

WHY NETWORK

- Situational Awareness

- Safety

- Boat management

- Navigation Assistance

- Ease of Operation

Integration

Integration through sharing information between devices on board your boat can make a world of difference in **managing your environment** and providing you with a more integrated world view and **enhanced situational awareness.**

SITUATIONAL AWARENESS

Most of the new instruments, **MFDs**, and **ChartPlotters** for boats are now coming out with **NMEA 2000** as the preferred method of connecting various devices on a boat, making it significantly easier to network devices and share information. When it comes to networking there are some basic versions out there that all revolve around the **NMEA 2000 ISO convention**.

Rhapsody On Blue

MY BOAT

- **NMEA 2000 Backbone**

- **NMEA0183 Legacy Network**

- **Multiple Manufactures**

- **Multiple MFDs**

- **Laptop Integration**

- **WiFi via MFDs**

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Rhapsody On Blue

On my boat, I have an MFD in the Cockpit and 2 smaller MFDs at the NAV station. I want all my info sent to all 3 of these devices. On my boat, as I sail the East Coast of the US, I have some basic *Navigation and Safety data being collected* by various devices on board.

My Location and status (GPS, speed, heading)
Environmental Data (Wind, Depth, Barometer, Weather)
Traffic Data (AIS and RADAR)
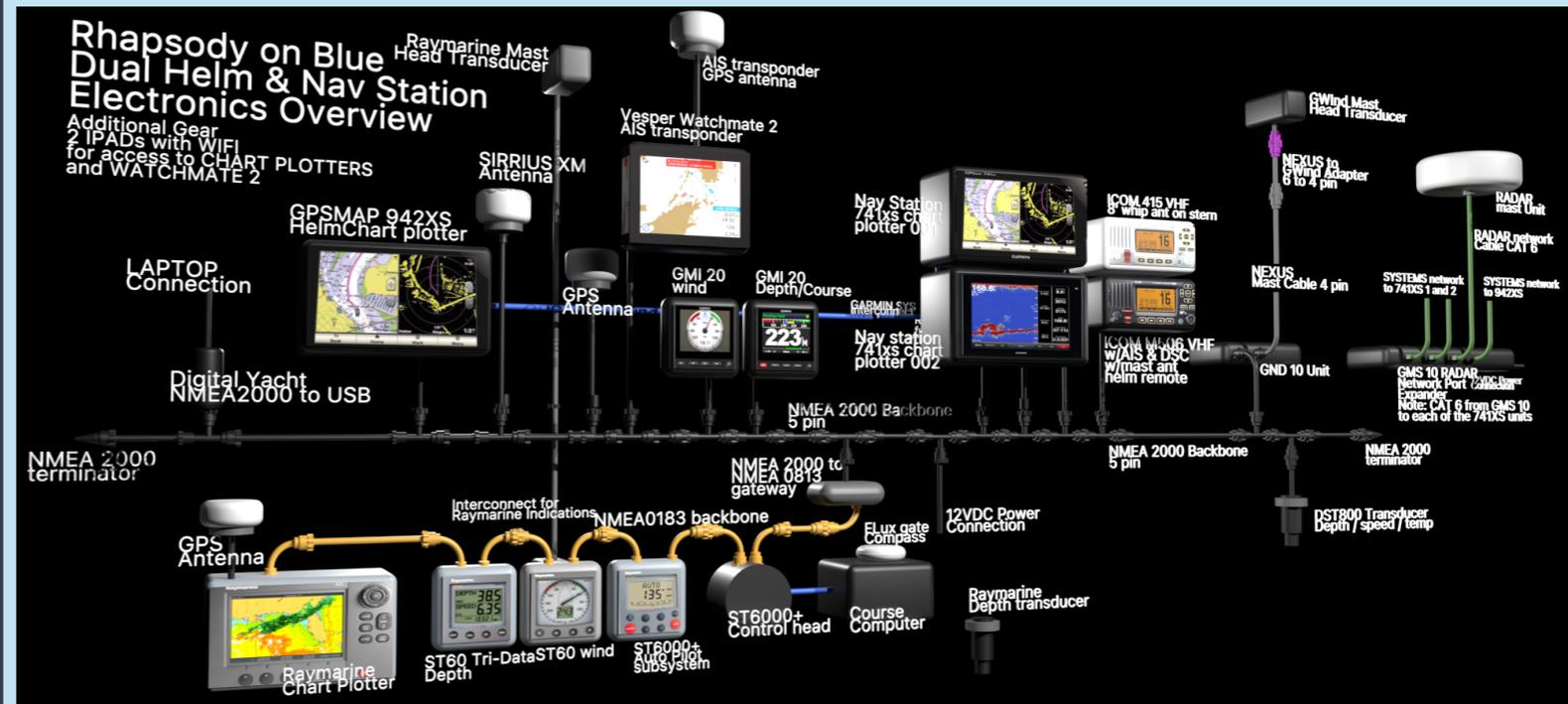
NMEA2000
BACKGROUND

- National Maritime Electronics Association

- Mission Critical Capable

- CS/MACD

- Network Layers

NMEA background

NMEA stands for National Maritime Electronics Association

- International **Open Standard**

- **Mission-critical data with multiple priorities**.

- **Multiple message priority levels.**

- **Carrier-Sense/Multiple Access Collision Detect** (CS/MACD)

NMEA 2000 network Layers

Physical Layer - the actual pieces: cables, connectors, terminators, power and electrical characteristics.

Data Link Layer. Defined by ISO with additional requirements specified by the standard.

Network Layer. How the network operates.

Network Management. Defined by ISO with additional requirements specified by the standard.

Application Layer. Fully defined by the standard and includes a provision for manufacturer's proprietary messages.

NMEA2000
BACKGROUND

- **NMEA 2000 is a set of Rules & International Standards**

- **Up to 50 Devices on a NMEA network**

- **All devices and Send and Receive**

- **LAN based CAN Network**

- **250 Kb/sec**

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Multiple Methods of Networking by Different Companies

- Ethernet
- NavNet
- SeaTalk
- SmartCraft
- USB
- Wifi
- Garmin Marine Network
- CANnet

Garmin
Raymarine
Simrad
Furuno

NMEA 2000 and NMEA 0183 - A rule book. A set of International standards.

NMEA 2000 rule book specifies which wires and cables should be used.

NMEA 2000 allows as many as 50 different devices to be connected to a single backbone.

The NMEA 2000 transmits through a Controller Area Network (CAN bus).

NMEA2000 Is a multi-talker, multi-listener approach using serial data at moderate date rates (250 kb/s).

Basically NMEA200 is a backbone based Local Area Network (LAN)

NMEA2000 / NMEA0183

IMPLEMENTATION

- **NMEA2000 is a Controller Area Network (CAN)**

- **NMEA2000 is a LAN based Network**

- **NMEA2000 Multi Talker / Multi Listener**

- **NMEA2000 runs at 250 kb/sec**

- **NMEA2000 is 50 times faster than NMEA0183**

- **NMEA0813 has a Single talker and Multiple Listeners**

- **NMEA0183 is an Asynchronous Serial Network**

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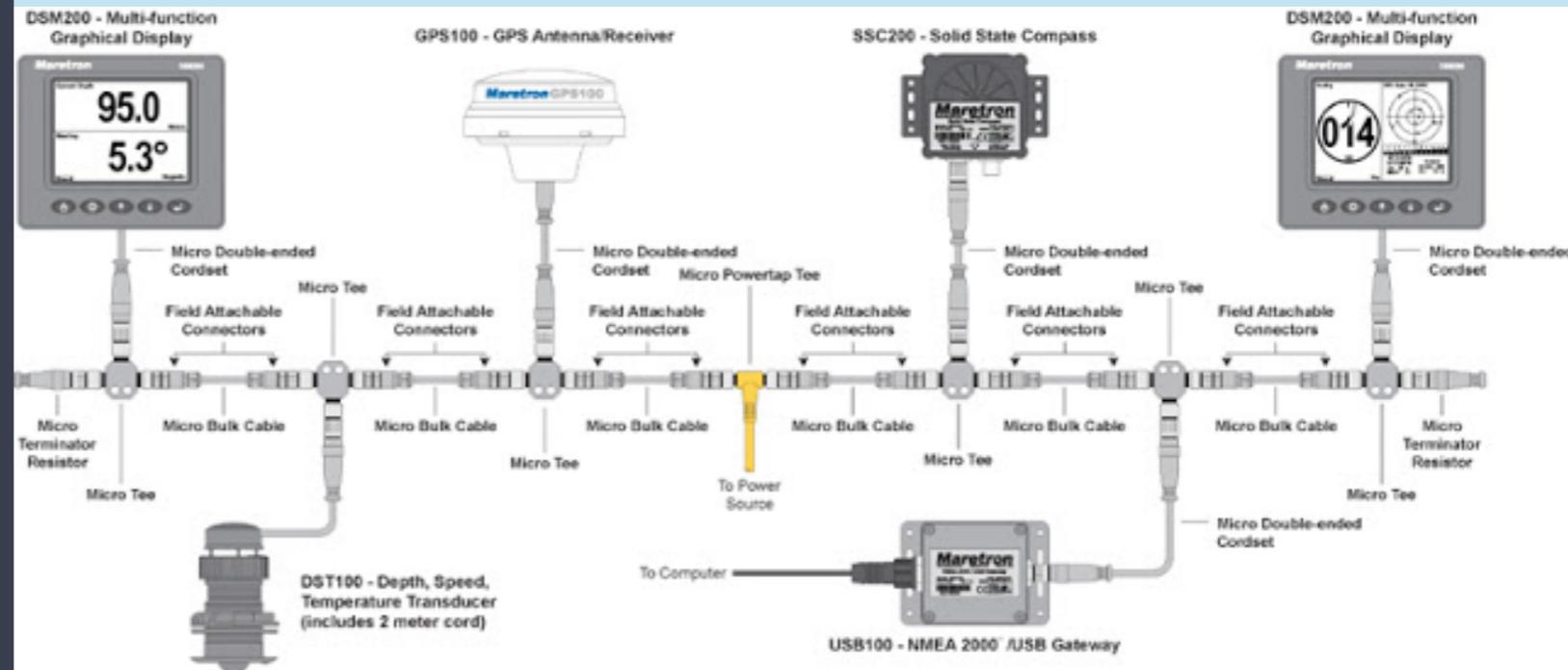
NMEA 2000 Network

NMEA 0183 in "RS422" interface, single-transmitter/multi-receiver network for interconnecting marine electronic devices, also known as a "single talker/multiple listener" interface.   Basically Point to Point, or Hub based.

NMEA 0183 Network

Single Talker, Multiple Listener
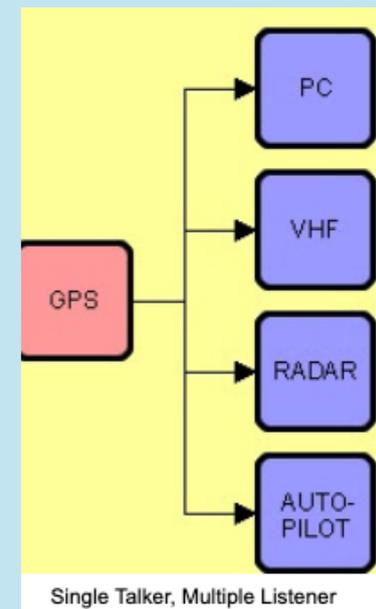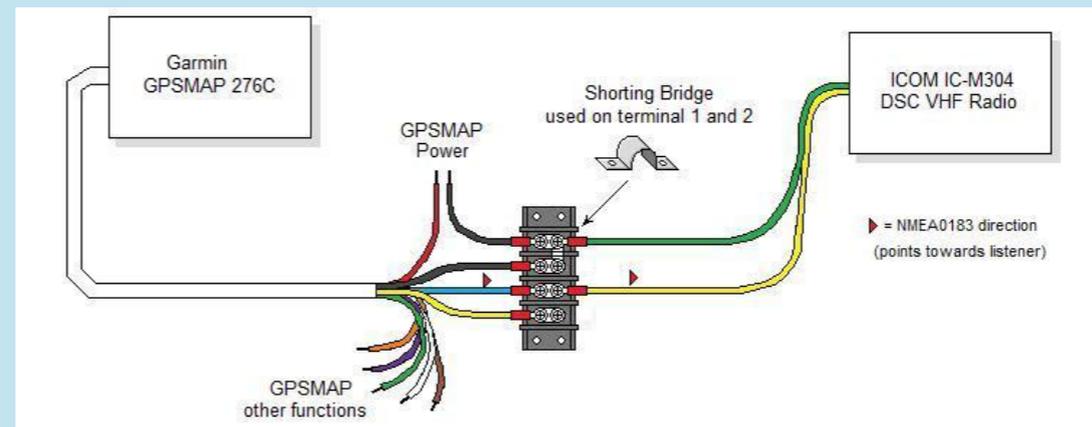
Manufacturers

IMPLEMENTATION

- Different Manufacturers implement NMEA2000 differently

- All NMEA2000 compliant gear will work on any NMEA2000 compliant network

- Some Implementations place additional applications onto the base NMEA2000

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Different Manufactures implement NMEA0183 and NMEA2000 differently.

Furuno CANbus - Name for its NMEA 2000 system (electronically compatible with NMEA 2000 but with some differences in the way components can be connected

Furuno NavNet - Brandname for its Ethernet system

Garmin Marine Network - Brandname for its NMEA 2000 system

Raymarine SeaTalk I - Proprietary system NMEA0183 network

Raymarine SeaTalk HS - Brand name for its Ethernet system

Raymarine SeaTalk(ng) - Brandname for its NMEA 2000 system (electronically compatible with NMEA 2000 but with different connectors)

Simrad SimNet - Brandname for its NMEA 2000 system (electronically compatible with NMEA 2000 but with different connectors)

SmartCraft: Mercury/Mercruiser/Cummins' own system

Teleflex Magic Bus: Brand name for its NMEA 2000 system

Sensors and Equipment

SETTING UP YOUR NETWORK

- **Many Manufactures of NMEA2000**

- **All sorts of Sensors**

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There are also different Manufactures of NMEA2000 sensors and equipment

Digital Thermometers, Digital Barometers, Humidity Sensors

Water tank, Fuel tank, Grey and Black water tank sensors

Computer interconnects

USB to NMEA2000

WiFi gateways

WiFi Routers

Engine data Gateways / Exhaust Sensors

Cameras

NMEA 0183 to NMEA 2000 interconnects (gateways)

Control Circuits / Relays

Voltage and/or Current sensors

Alarms and horns

Voyage Recorders

Rudder Indicators

Text Displays

MFDs / Chartplotters

SETTING UP A NETWORK

- MFD - Multifunction Display

- Collection and Display

- Layers

- Data tracking / Logs

- Sharing Data

- Screen Management

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NMEA2000 Network Devices

Wind direction / Wind Speed Indicator (True/Apparent)

GPS Receivers
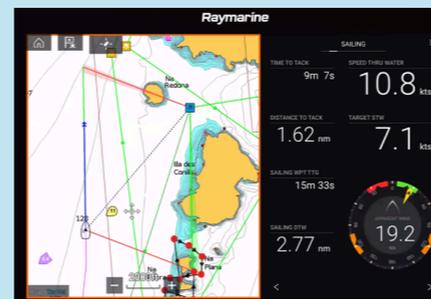
XMRadio Receivers

Depth Finder / Fish Finder

RADAR

Cameras (Standard, Thermal Imaging, Night Vision)

VHF / DSC

AIS Receiver / Transceiver

Auto Pilot / Helm Controls

MFD Display Examples

Configuring Your Network

CONFIGURATION

- **Linear LAN Topology**

- **Max length - 3000 ft**

- **MAX performance Length - 80 ft**

- **Max distance between T - 300 ft**

- **Max cumulative drop length - 256 ft**

- **Max devices / LAN - 50 units**

- **Hubs can be part of the topology**

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NETWORK TOPOLOGY

The distance between any two T-Connectors can not exceed 328 ft (100 m)

80 ft (25 m) is where you want to stop for best performance.

The standard minimum of 250 kb/sec will be easily met under 160 ft (50 m)

The Maximum cable length for a network is 3608 ft (1,100 m)

The Maximum number of devices on the network : 50

The Maximum length of a drop cable (between the T-Connector and a device is 20 ft (6 m)

The Maximum cumulative drop cable length must be less than 256 ft (78 meters)

You must have a power connection on the cable/hub for network powered devices (12 VDC)

It's critical to create a LINEAR network backbone.
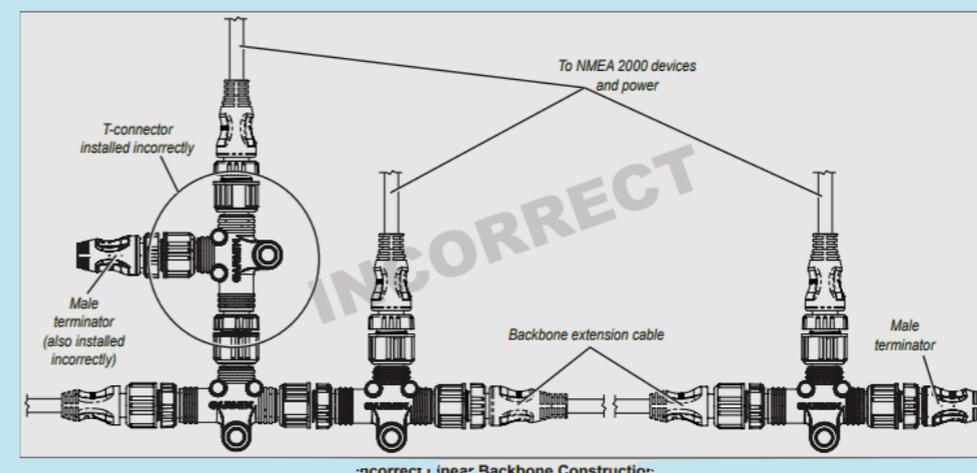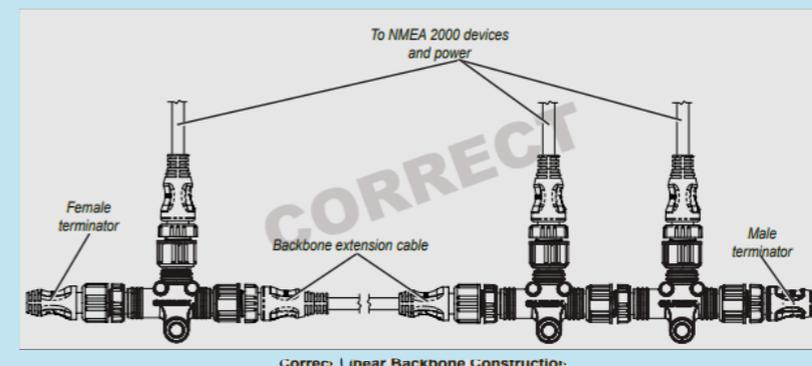
Powering Your Network

CONFIGURATION

- Network power tap required

- 12 V DC   (9 to 16 V DC)

- Switch in line for power

- Consider Voltage Drops

- Place Power in the center

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Proper NMEA2000 Network Power

NMEA 2000 networks require 12 VDC but must (based on standards) operate properly between 9 VDC and 16 VDC

The vessel's 12-volt battery may be connected via the vessel's DC supply system to the backbone power connections.

Only one connection is provided, which may be located at either end of the backbone or at any point along the backbone.

 You may also power it from as 12 VDC isolated power supply running from an AC power system.

Voltage Drop = .053 (cable resistance) x (the distance for each piece of backbone cable added together) x (network load (device usage added together)) x .01

or   Voltage drop = cable resistance x cable length x device load x .01
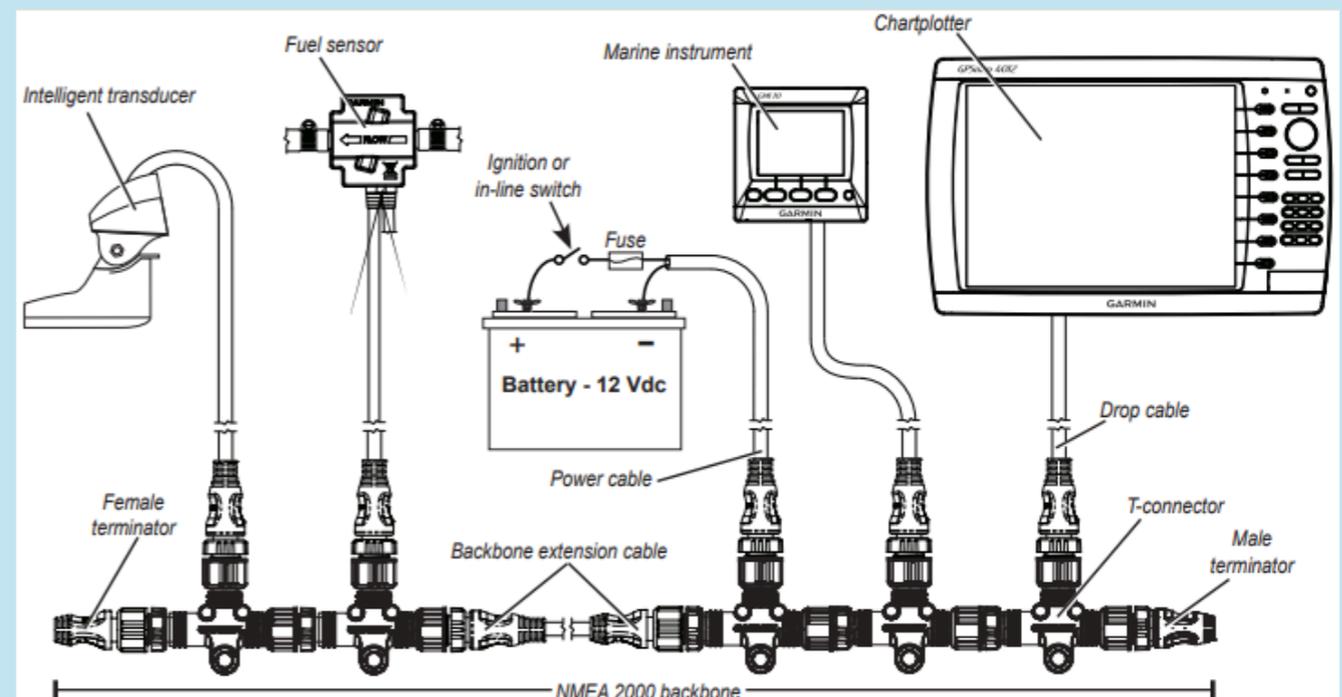
NMEA2000 Checklist
CONFIGURATION

- Check Your Configuration

- Watch your Distances / Lengths

- Properly Power your Network

- Add a Switch for Power

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NMEA2000 Network Check List

1. Is the Network configured in a Linear fashion?
2. Is the overall network cable length less than 3000 ft (1,000 m)?
3. Is the distance between any T-connectors less than 300 ft (100 m) ?
4. Are all drop cables less than 20 ft (6m)?
5. Did you install terminators on both ends of the network?
6. Is the network properly powered (12vdc)
7. Did you install a switch between boat power and the network?
8. Did you ground the network properly ?

Mast height issues

Your sailboat mast is way longer than 20 ft (6 meters)….
Most Wind sensors are on the top of your mast.

To overcome this issue, you can run a NMEA2000 backbone cable up the mast and terminate it at the top of the mast. Make sure that the terminator is within 20 ft (6 m) of the last device (your wind sensor).

Run the backbone own to a T-Connector at the base of the mast inside your boat. From there continue the NMEA2000 throughout your boat.   (be aware of your manufacture cable configurations as some manufactures install terminator resistors on cables longer than 20 ft.)

Raymarine SeaTalk(ng)

CONNECTING YOUR DEVICES

- **SeaTalk I is based on NMEA0183**

- **SeaTalk(ng) is based on NMEA2000**

- **Raymarine MFDs are NMEA2000 certified**

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SeaTalk(ng)

SeaTalk(ng) - Raymarine

Small diameter cable connectors are used throughout the system to make installation easier.

There's a wide range of cable lengths, all with over-moulded plugs, so there is no need to cut or splice cables.

Spur cables connect individual SeaTalk(ng) products to the SeaTalk backbone.

All current Raymarine MFDs are NMEA2000 certified.

SeaTalk(ng) Network
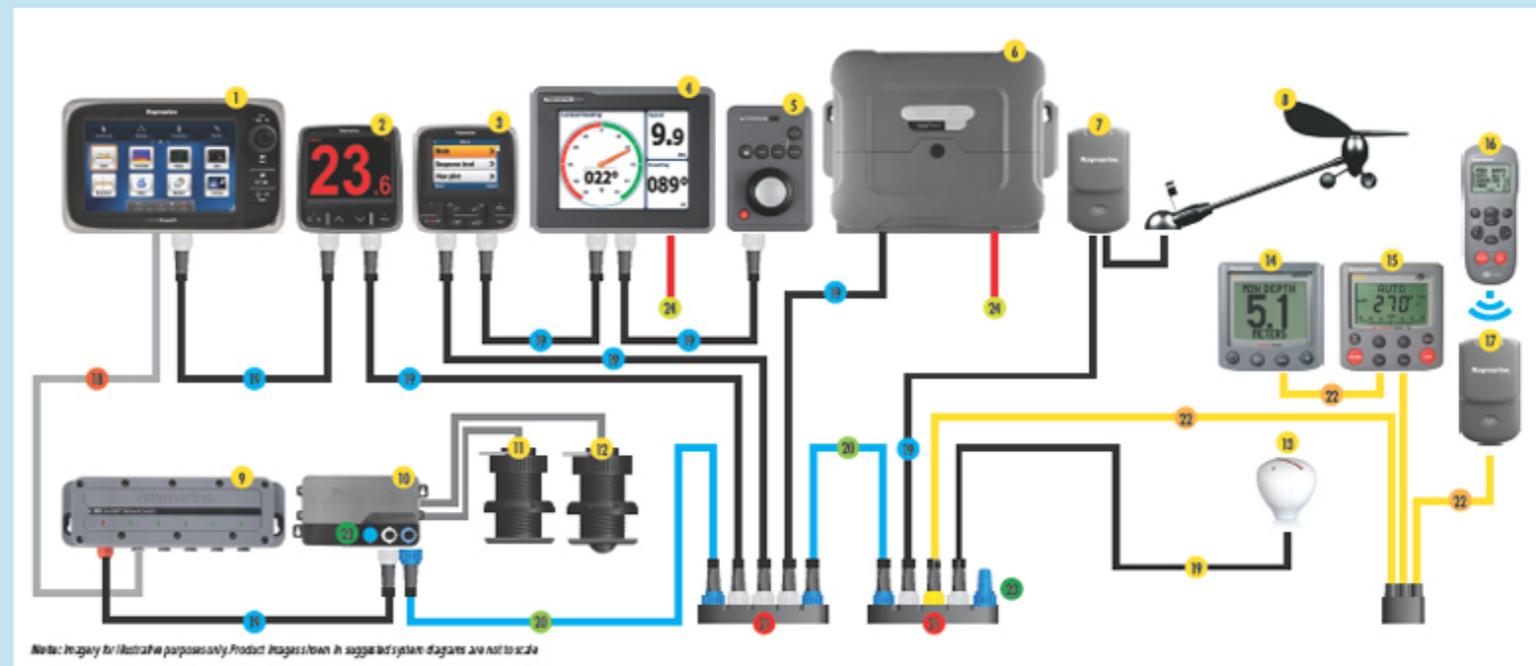
Garmin Marine Network

CONNECTING YOUR DEVICES

- Uses NMEA2000 standard

- Garmin devices are NMEA2000 compliant

- RADAR uses special RADAR port or Hub

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Garmin Marine Network

GARMIN uses a standard NMEA 2000 network backbone

Note: Garmin requires a specialized network unit (GMS 10) to connect RADAR to multiple Chartplotters/MFD units.

Garmin Marine Network

SIMRAD SIMNET

CONNECTING YOUR DEVICES

- **HIB based**

- **Requires a specialized RADAR network**

- **Specialized cabling**

- **Can interconnect with NMEA2000**

- **Some Gear is daisy chained to the hub**

- **Some gar can be directly connected to HUB**

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SIMRAD SIMNET

SIMRAD uses SIMNET a propriety network using serial connections which can be connected to a standard NMEA 2000 network backbone, but requires adapter cables.

SIMRAD also requires a specialized unit (SIMRAD Ri10) to feed RADAR data to multiple chart plotters.

SIMRAD SIMNET Network

FURUNO NavNet

CONNECTING YOUR DEVICES
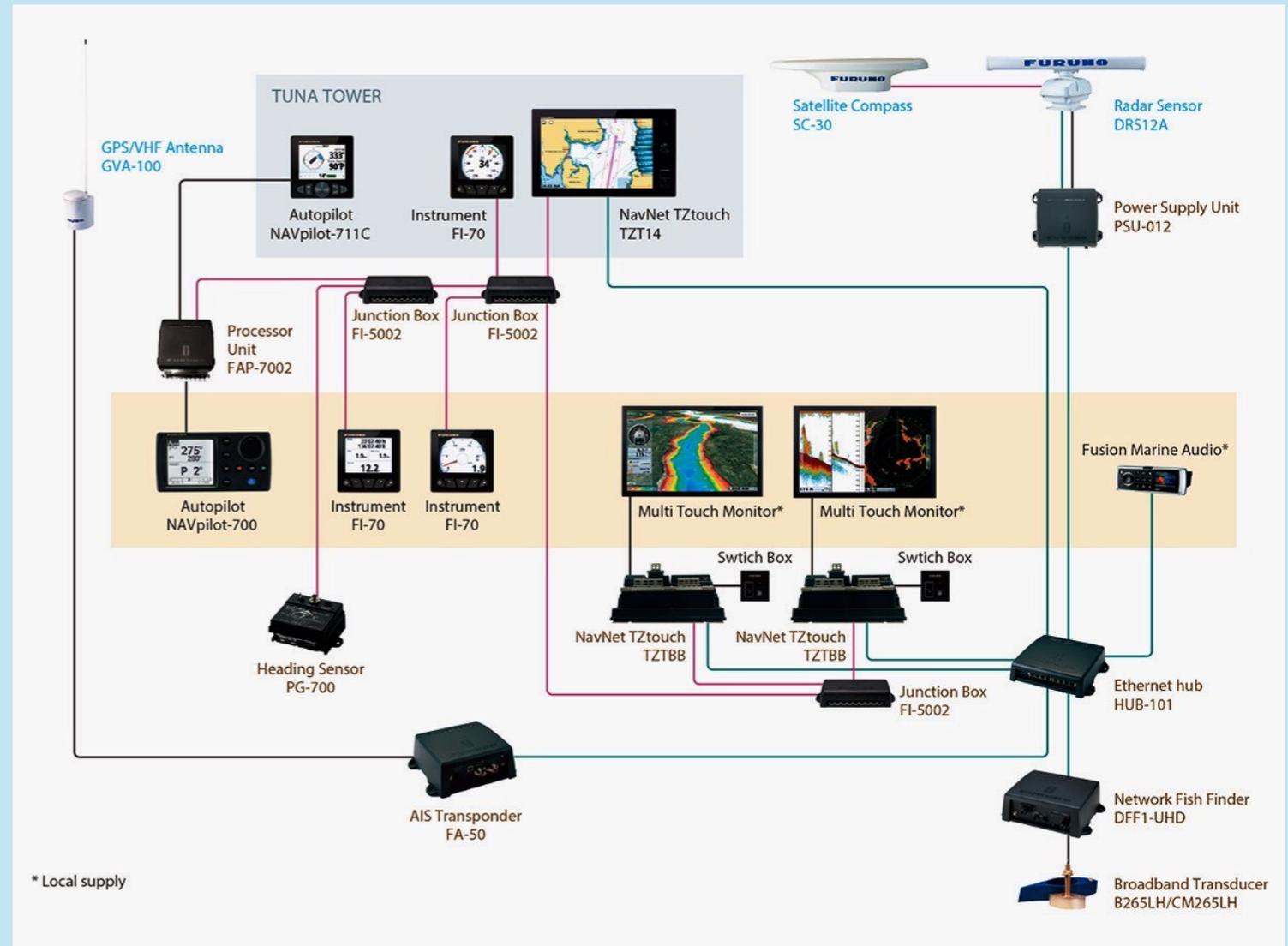
- Specialized Network Config

- Utilizes multiple Network systems

- Can Connect to NMEA2000

- One MFD per backbone

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FURUNO NavNet

FURUNO uses CANbus, NavNet 3D and NavNet a specialized network that connect to an Ethernet Hub which in turn can use a gateway to connect to a standard NMEA2000 network. NavNet 3D MFD units have one NMEA2000 connector Device Net style connector. You can only connect ONE Furuno MFD to a given NMEA2000 network.

FURUNO NavNet Network

GPS/VHF Antenna GVA-100

TUNA TOWER

Autopilot NAVpilot-711C

Instrument FI-70

NavNet TZtouch TZT14

Satellite Compass SC-30

Radar Sensor DRS12A

Power Supply Unit PSU-012

Processor Unit FAP-7002

Junction Box FI-5002

Junction Box FI-5002

Autopilot NAVpilot-700

Instrument FI-70

Instrument FI-70

Multi Touch Monitor*

Multi Touch Monitor*

Fusion Marine Audio*

Swtich Box

Swtich Box

NavNet TZtouch TZTBB

NavNet TZtouch TZTBB

Junction Box FI-5002

Ethernet hub HUB-101

Heading Sensor PG-700

AIS Transponder FA-50

Network Fish Finder DFF1-UHD

Broadband Transducer B265LH/CM265LH

* Local supply

WiFi Gateways

ADDING WIFI, SMART DEVICES AND LAPTOPS

- • Gateways are used to Connect
- • WiFi Gateway
- • May require some configuration
- • Apps available for almost all smart phones, tablets

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WIFI Gateways

Connecting WiFi …The NMEA 2000 Yacht Devices Wi-Fi Gateway allows you to see data from a NMEA 2000 marine digital network on a PC or smartphone.

Marine network data including vessel course, speed, position, wind speed and direction, water depth, AIS messages from vessels and aircrafts and other navigation data in popular software applications. his unit creates it's own WiFi network and allows you to connect to your NMEA2000 network via WiFi.

Most WiFi works within about 65 Ft (20 m) with a clear line of sight, but only around 15 or 20 ft if you flush mount your MFD at the NAV station.

You can then download APPs for your pad or smartphone that accepts NMEA2000 data.

Yacht Devices also offers a WiFi gateway, which works the same way offering access of your NMEA2000 data to smartphones and other WiFi devices for use with various Apps.

USB / Ethernet Gateways

ADDING WIFI, SMART DEVICES AND LAPTOPS

- Gateways are used to Connect

- USB Gateway

- Ethernet Gateway

- May require some configuration

- Software is available for both PC and Apple systems

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USB or ETHERNET Gateways

A USB or Ethernet gateway allows you to see data from a NMEA 2000 marine digital network on a MAC or PC, laptop or tablet with Microsoft Windows, Mac OS or Linux.

With it, you get marine network data including vessel course, speed, position, wind speed and direction, water depth, AIS messages from vessels and aircrafts and other navigation data in PC applications like OpenCPN, Coastal Explorer, Polar View, OpenSkipper, etc. The device works as a bi-directional gateway so it is also possible to send messages from PC applications to the NMEA 2000 network. That allows, for example, sending of AIS data from a PC USB receiver to a chart plotter, as well as control over the autopilot and the vessel's other equipment. It also supports using a PC as an 0183 to NMEA 2000 converter if you have some NMEA 0183 equipment connected to one of the other PC ports.

This unit can operate in NMEA0183 mode, NK2 mode, and RAW mode for NMEA2000 traffic.

Keep in Mind that most new Chartplotters/MFDs also offer both WiFi and Bluetooth connections, but tend to provide specific support based on the Manufacturer.

NMEA0183 to NMEA2000

ADDING OTHER NETWORKS TO NMEA2000

- May Require some configuration

- Allows two way data transmission

- taps off NMEA2000 network

- NMEA0183 requires conversion to NMEA01183 V2 then to NMEA2000

- Some MFD / devices offer both NMEA2000 and NMEA0183 interfaces and allow data transmission between both ports

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Adding a NMEA0183 Net to your NMEA2000 Network

Interconnecting an existing NMEA0183 to a new NMEA2000

Due to the difference between the single ended and differential interfaces implemented, older versions of NMEA 0183 prior to version 2.0 cannot be connected to equipment supporting NMEA 0183 version 2.0 or higher without proper interface circuitry.

Do not connect one of the signal wires of the differential interface to the common ground of the single ended interface.

- NMEA 0183 to NMEA 2000
- NMEA 0183 V2.0 to NMEA 2000

NMEA 0183 originally allowed "single-ended" drive, but was later updated to differential drive (RS-422). RS-232 is a bipolar interface and RS-422 is differential drive. There are four types of connections possible with differential and single ended.

- Differential > Differential
- Single ended > Single ended
- Single ended > Differential
- Differential > Single ended

The Actisense NGW-1 or AMEC NK-80 NMEA 2000 to NMEA 0183 Gateways are the easiest way to link between a boats old and new data networks. Either can convert NMEA 0183 data into NMEA 2000 data and vice-versa.

SeaTalk to NMEA2000

ADDING OTHER NETWORKS TO NMEA2000

- Allows two way data transmission

- Cannot directly connect SeaTalk I to NMEA2000

- You Can connect SeaTalk I to NMEA0183

- SeaTalk(ng) can be connected via an adapter to NMEA2000

- Not all data can be transmitted between SeaTalk I and NMEA2000

- May require some configuration

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Adding a SeaTalk I or SeaTalk(NG) to your NMEA2000 Network

My boat, like many others, has a SeaTalk network on board when I bought it. It works, it's fine, but moving forward, I installed all up to date NMEA 2000 systems. In order to convert a SeaTalk I network to talk to NMEA 2000, you need to first gateway to SeaTalk(ng). This is the kit required to get from SeaTalk 1 to SeaTalk ng. Part Number: E22158 from Raymarine.

Once this is installed you need a Raymarine SeaTalk(ng) to NMEA 2000 adapter cable. This cable allows you to connect to a T-Connector on your NMEA2000 network. Additional details get rather long winded so i'll save that for another day, or read the manual.

You can, however, Connect a SeaTalk I network directly to a NMEA0183 Network via the Digital Yacht ST-NMEA (ISO) converter. With this device you can go directly from SeaTalk I to NMEA0183.

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Q & A

Creating a NMEA 2000 network on board your boat.

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