Proper NMEA 2000 Installation
IBEX 2012 Session 813

Part I

Physical Installation

Dave Morschhauser, Mystic Valley Communications

Pete Braffitt, Gemeco

Overview

- What is NMEA 2000?
- What are its physical characteristics and limits?
- What makes a good NMEA 2000 network?
- What makes a good NMEA 2000 network fail?

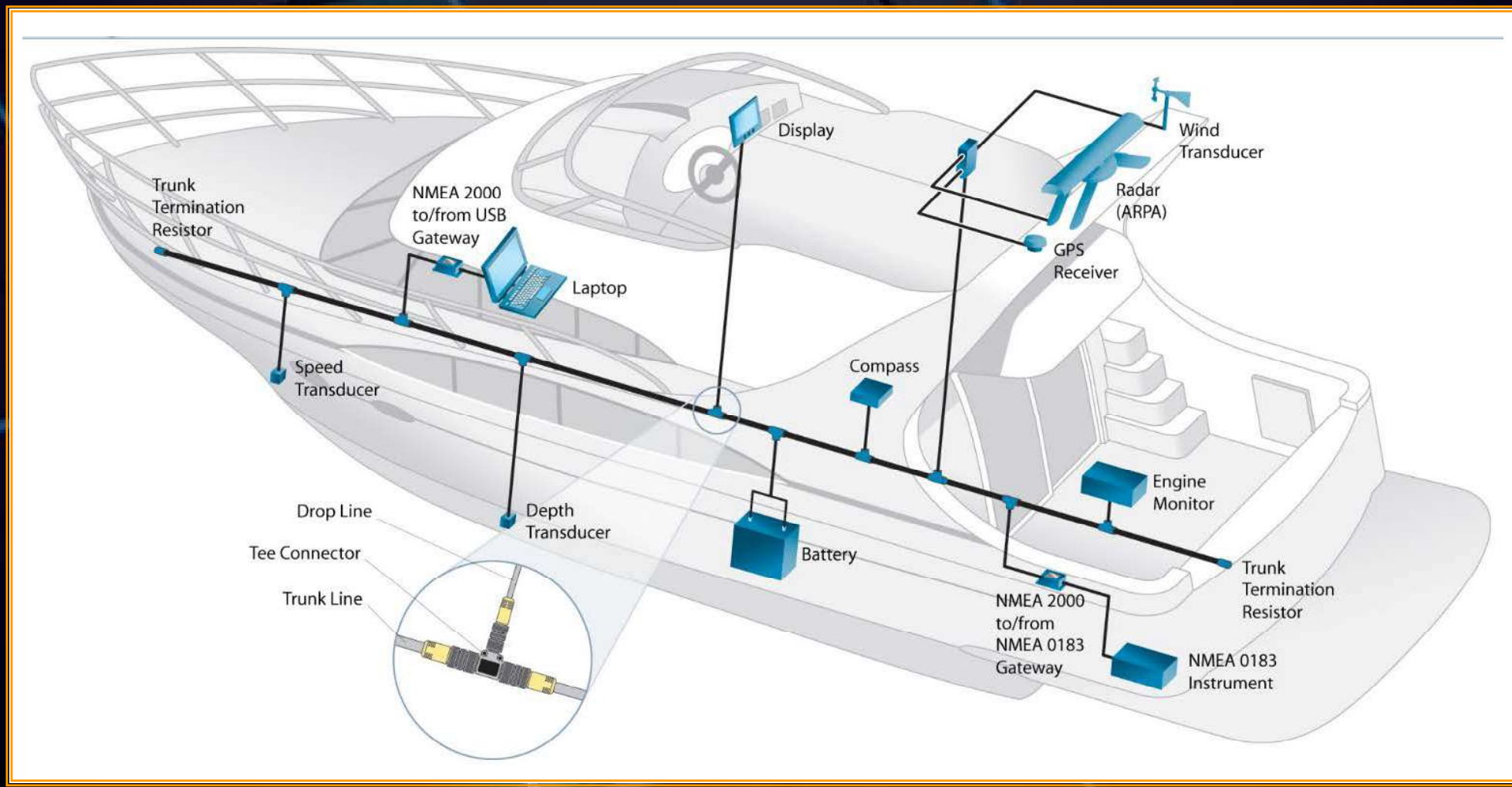
NMEA 2000

- Marine specific network for navigation, control, and monitoring
- CAN based, similar to J1939
- Uses industrial quality cabling originally developed for DeviceNET
- Certified products, based on standard certification tool

NMEA 2000 Certification

- First certification program applicable to recreational marine electronic products
- Over 400 products certified to date
- Purpose: ensure products communicate cooperatively (plug and play)
- Based on common certification tool
- Cabling components are also approved

NMEA 2000


Trunk
Termination
Resistor
NMEA 2000
to/from USB
Gateway
Laptop
Display
Wind
Transducer
Radar
(ARPA)
GPS
Receiver
Speed
Transducer
Compass
Drop Line
Tee Connector
Trunk Line
Depth
Transducer
Battery
Engine
Monitor
Trunk
Termination
Resistor
NMEA 2000
to/from
NMEA 0183
Gateway
NMEA 0183
Instrument

Typical Tee

MALE Backbone Connection

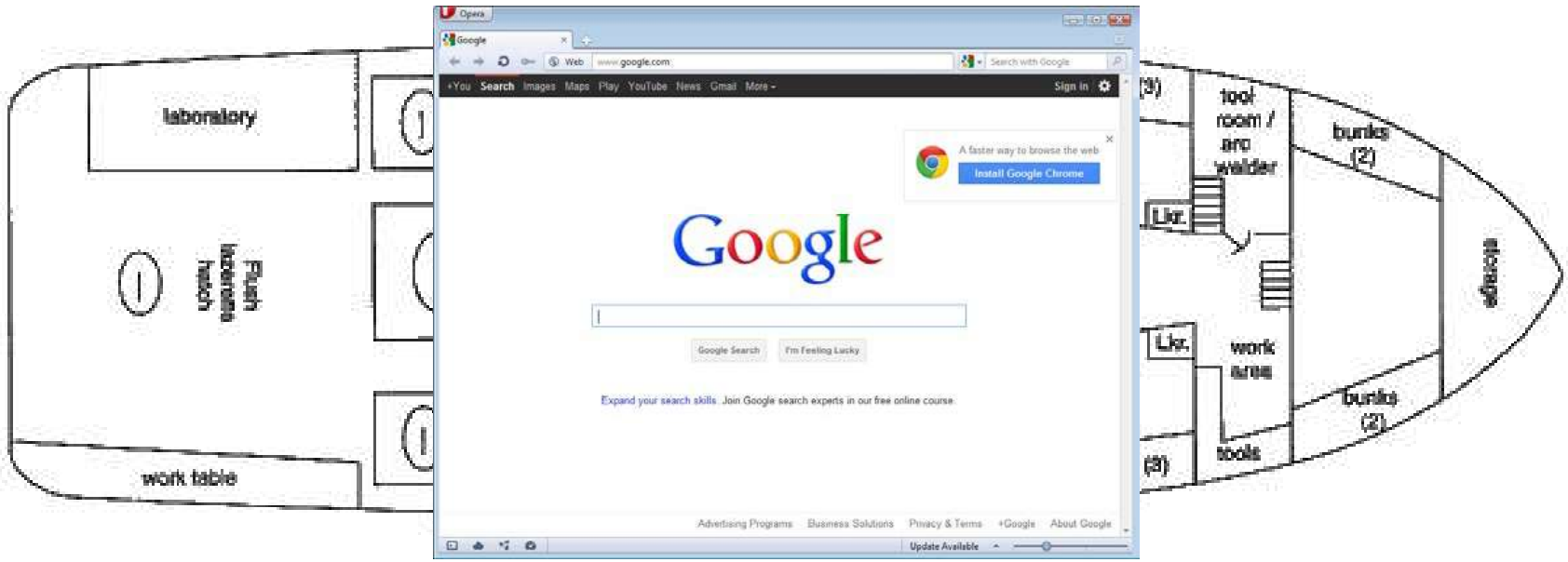
FEMALE Backbone Connection

Drop Connection to device (FEMALE)- Accepts drop cable.

NMEA 2000

- Single backbone cable snakes throughout the vessel
- No active network infrastructure to fail
- Standardized message structure and format
  - both generic and system specific messages
- Links vessel systems together
  - engines, navigation, power distribution, water & waste, etc.

NMEA 2000 = Vessel Database

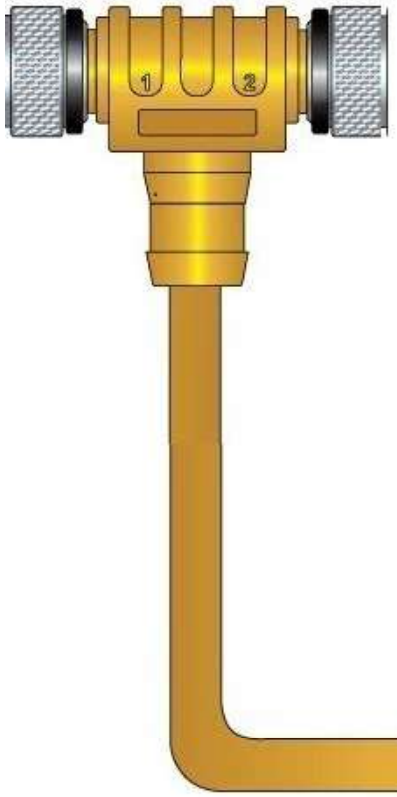


What can you do with NMEA 2000?

Physical Construction

- Building Blocks
- Characteristics
- Power Availability
- Other considerations

NMEA 2000 Building Blocks



Power Tee(s)

Tee Connectors

Termination Resistors

Backbone & Drop Cables

NMEA 2000 Building Blocks

Mini to Micro Adapter

Mini Backbone w/ Micro Drop

Gender Changer

Field Installable Connectors

NMEA 2000 Characteristics

Overall:

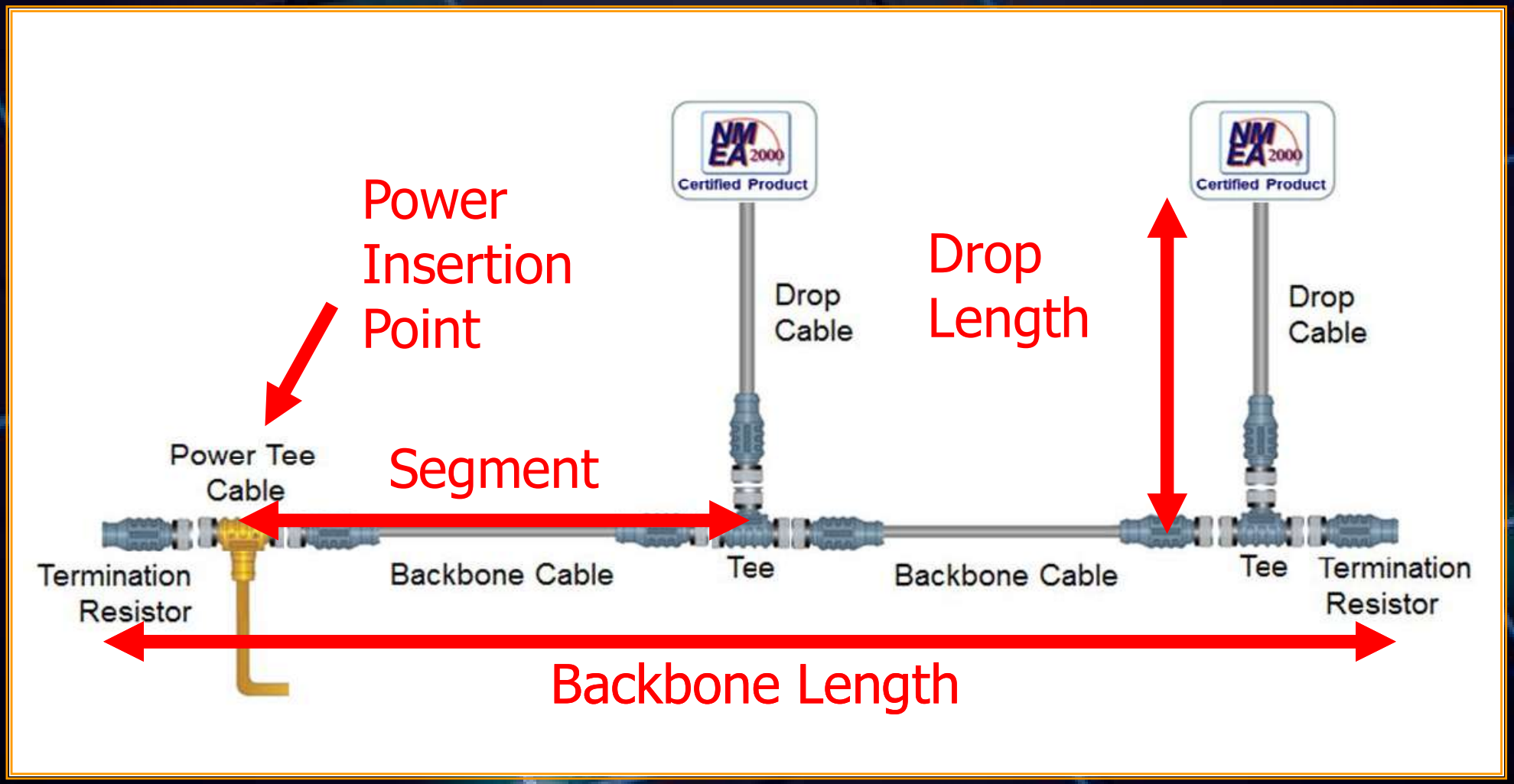
- Capacity - 250K bits-per-second
- Interface operating range - 9 to 15 volts
- Logical network identities - 252
- Minimum node separation - 0 meters
- Maximum bridged backbones - 10

NMEA 2000 Characteristics

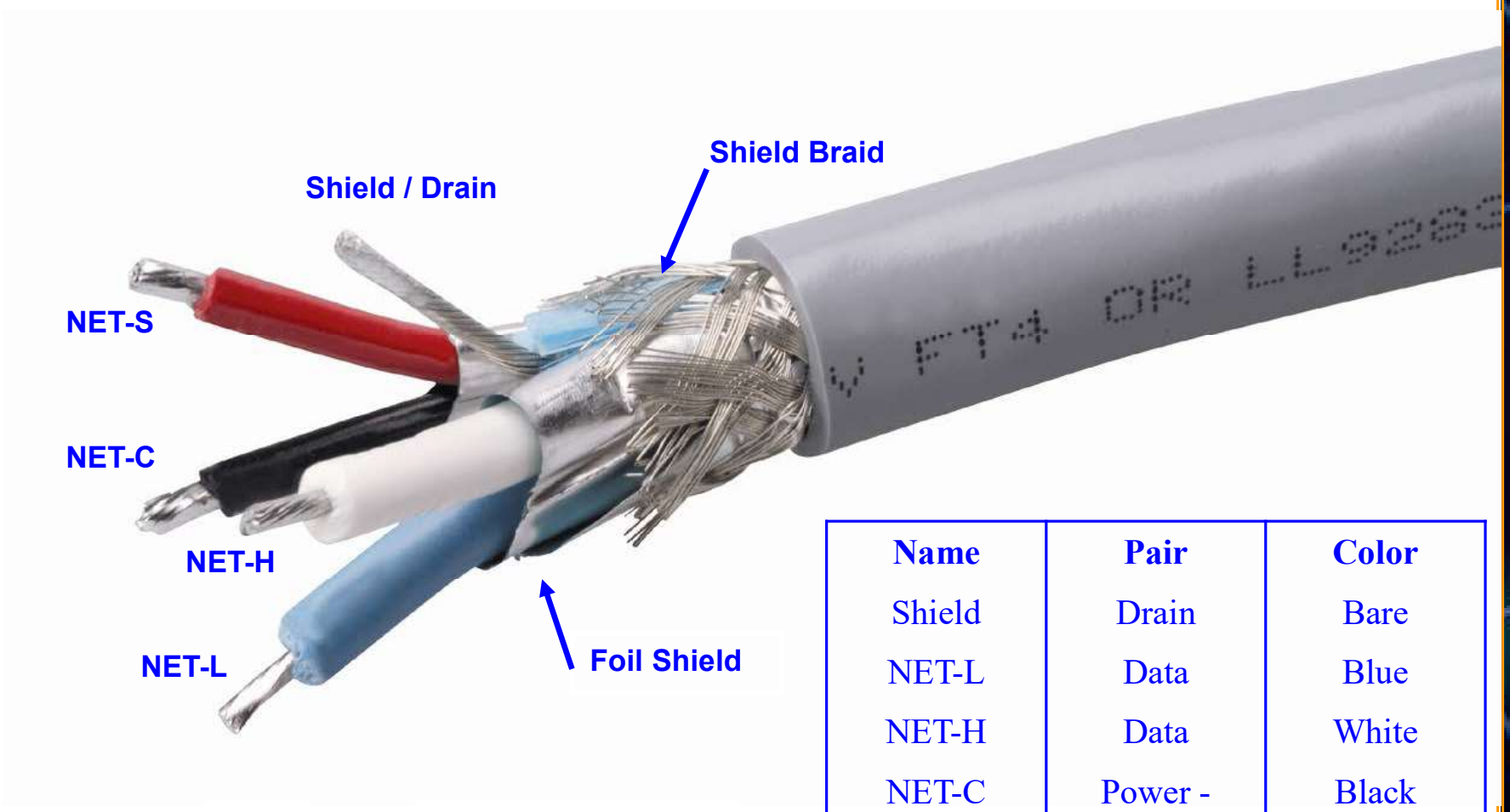
Each backbone:

- Length - 200 meters
  - 100 meters when using light cable
- Connected products - 50
- Drop cable
  - 6 meters per drop
  - 78 meters total of all drops
- Power - limited by cable size and the number of power insertion points

NMEA 2000 Terminology

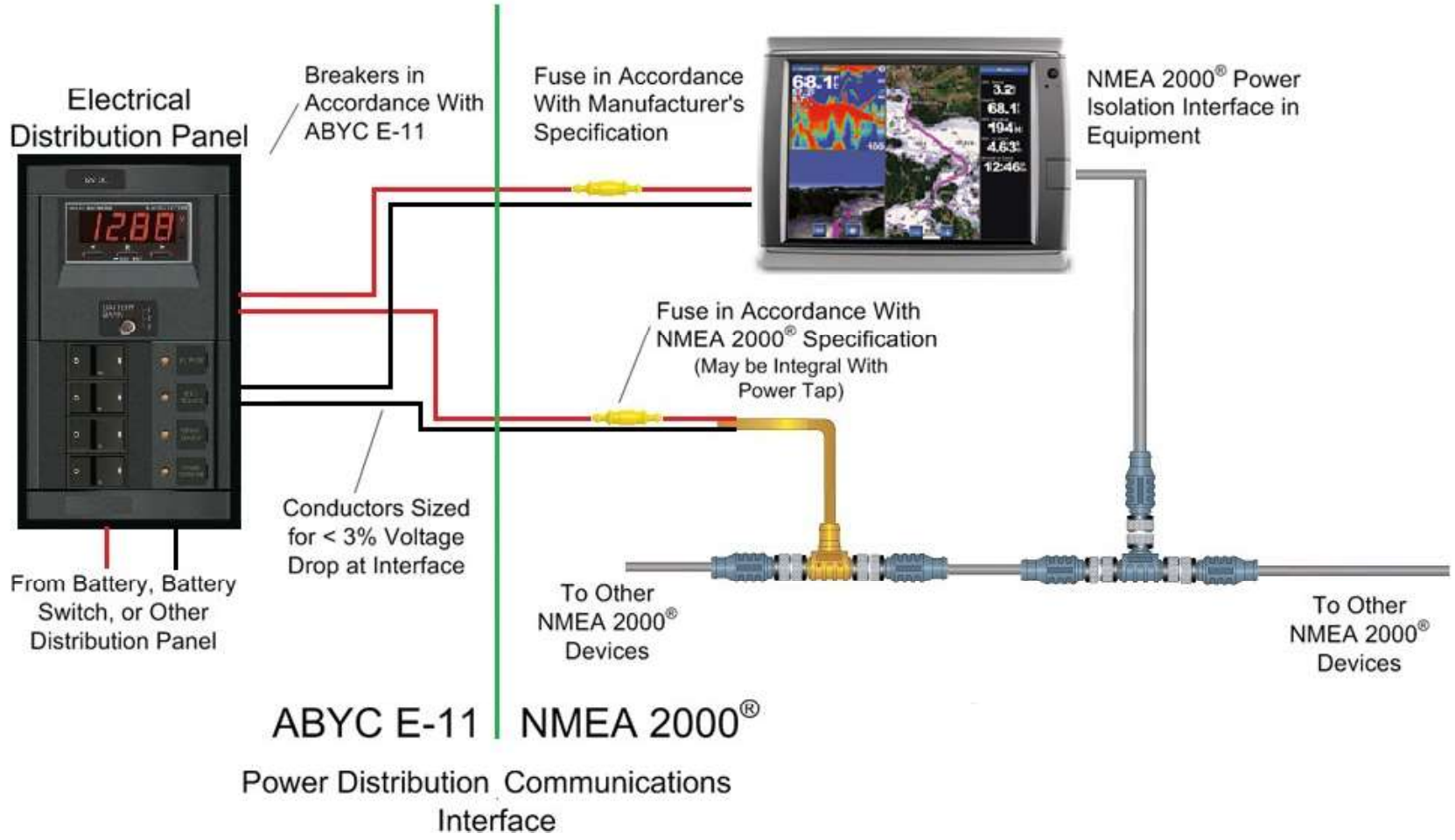


Cable Construction



Name	Pair	Color
Shield	Drain	Bare
NET-L	Data	Blue
NET-H	Data	White
NET-C	Power -	Black
NET-S	Power +	Red

Product Power Sources

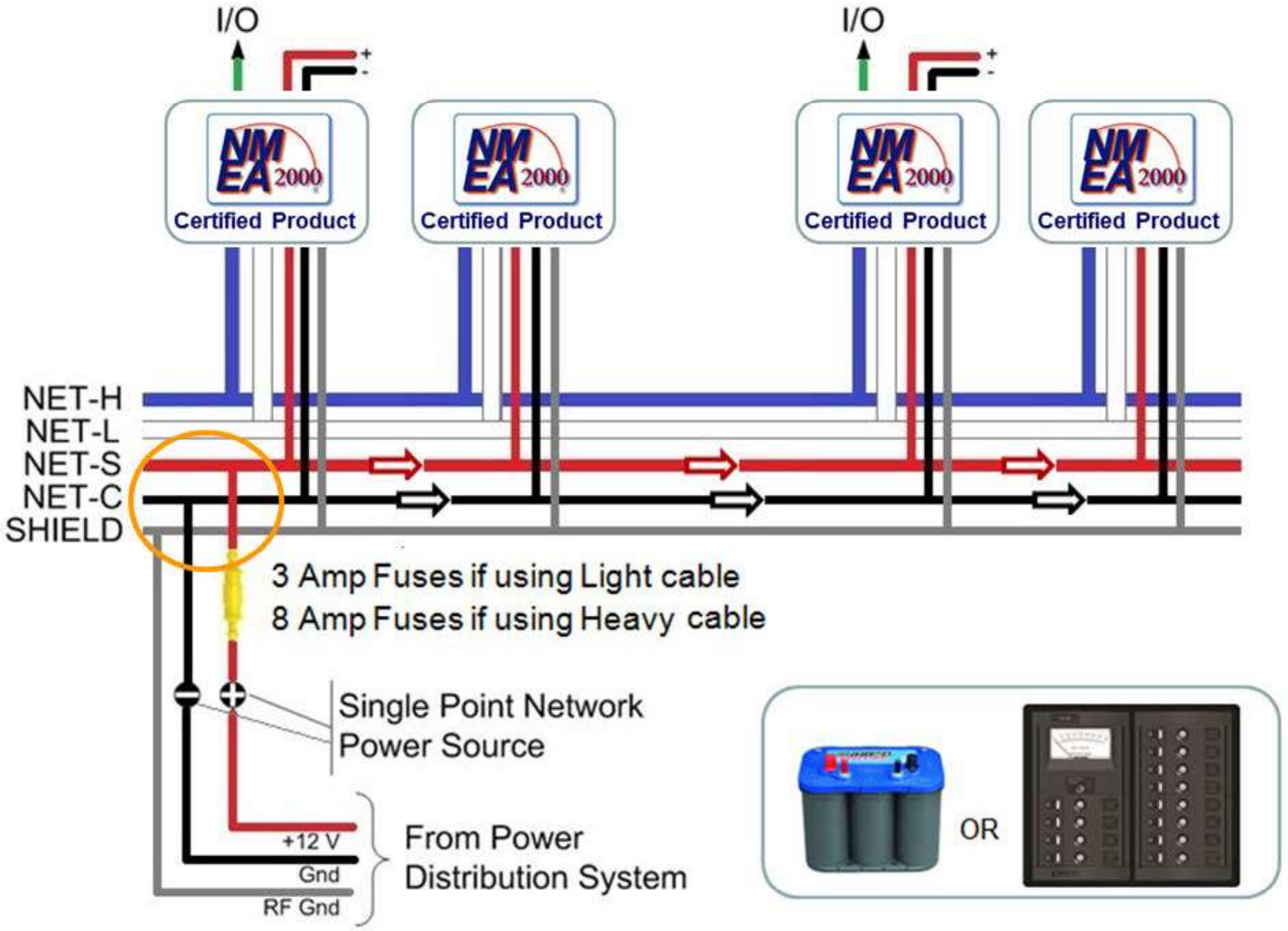


Cable Types

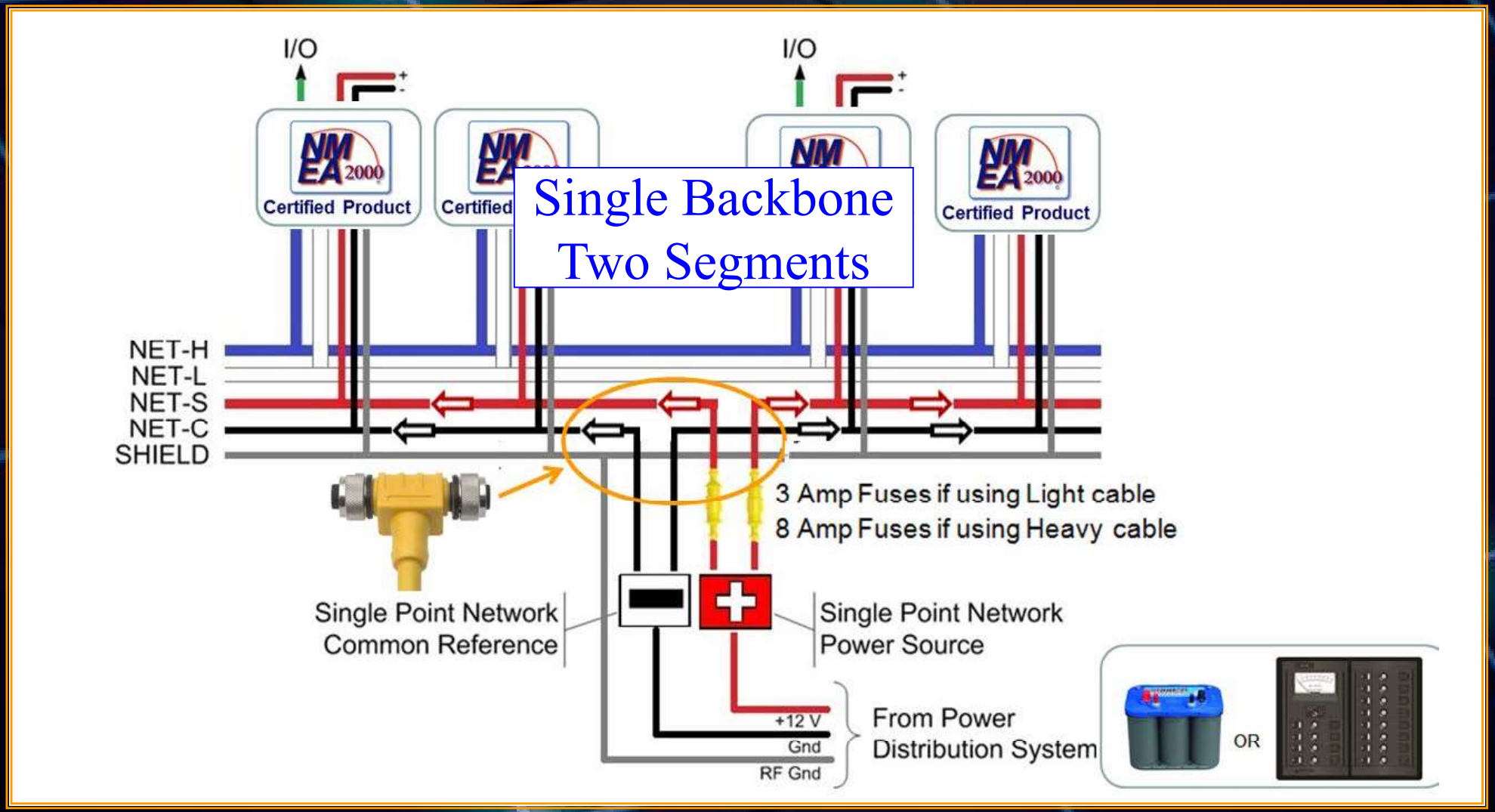
Style	Light	Mid	Heavy
Connectors	Micro	Micro/Mini	Mini
Max Length	100 meters	200 meters	200 meters
Capacity	3 amp*	4/8 amp*	8* amp
Signal Wire Gage	24 AWG	20 AWG	18 AWG
Power Wire Gage	22 AWG	16 AWG	16AWG

* Maximum power per backbone segment

NMEA 2000 Backbone



NMEA 2000 Backbone



Power Sources

- Battery (nominally 12.0 VDC)
  - Allowed voltage drop = 1.5 VDC
- Typical power supply (13.8 VDC)
  - Allowed voltage drop = 3.0 VDC
- Maximum power supply (15 VDC)
  - Maximum allowed voltage drop = 5.0 VDC

Other Considerations

- Products may be added to or removed from the backbone while operational
- No daisy-chaining ensures backbone remains intact when removing equipment
- Two terminators required, one at each end of the backbone

Making the Right Selections

Network Design Drivers

- Network power distribution
  - Segment voltage drop limit
  - Add power insertions points as needed
- Network topology
  - Keep it pure

Network Voltage Drop

- Straightforward application of Ohm's Law

$$E = I \times R$$

where

E = voltage drop

I = circuit current

R = wire resistance

Network Voltage Drop

- Wire resistance

R = 2 x Length x Power Pair Resistance / 100

- Network current

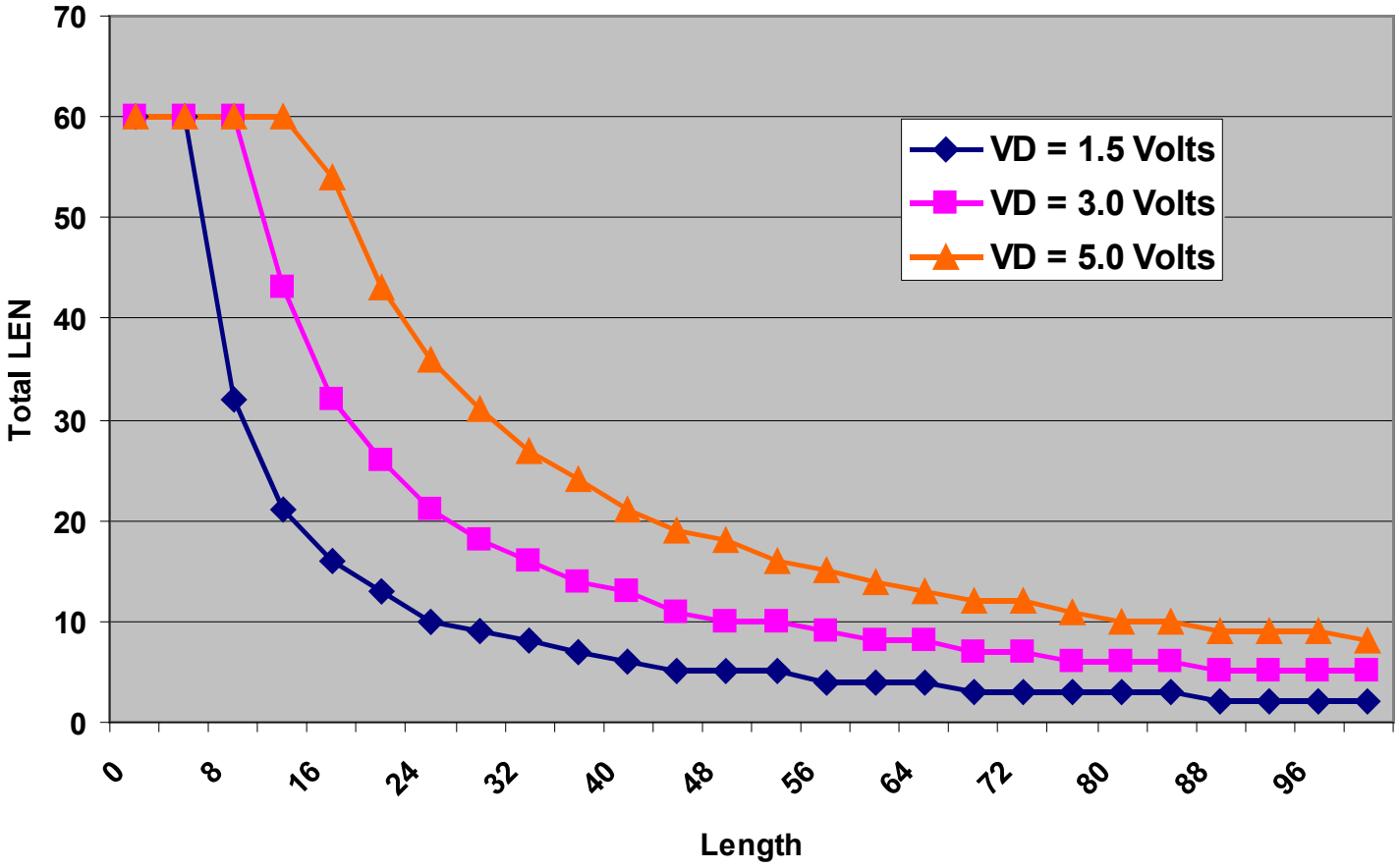
I = LEN x 0.050 amp

- All together

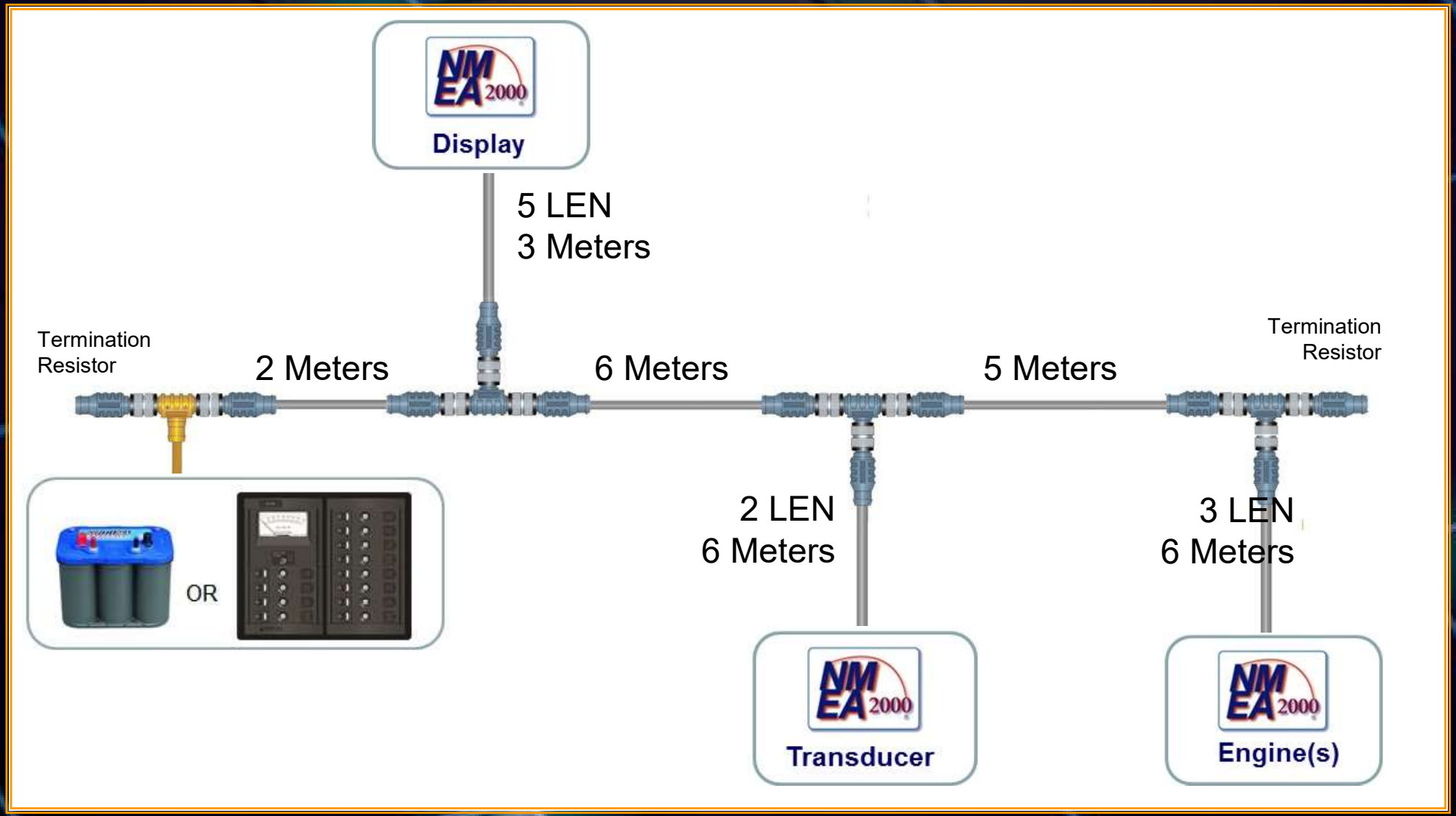
E = 0.1 x LEN x L x 0.057 (Light)

E = 0.1 x LEN x L x 0.016 (Mid/ Heavy)

Estimated Length - Light



Example Network



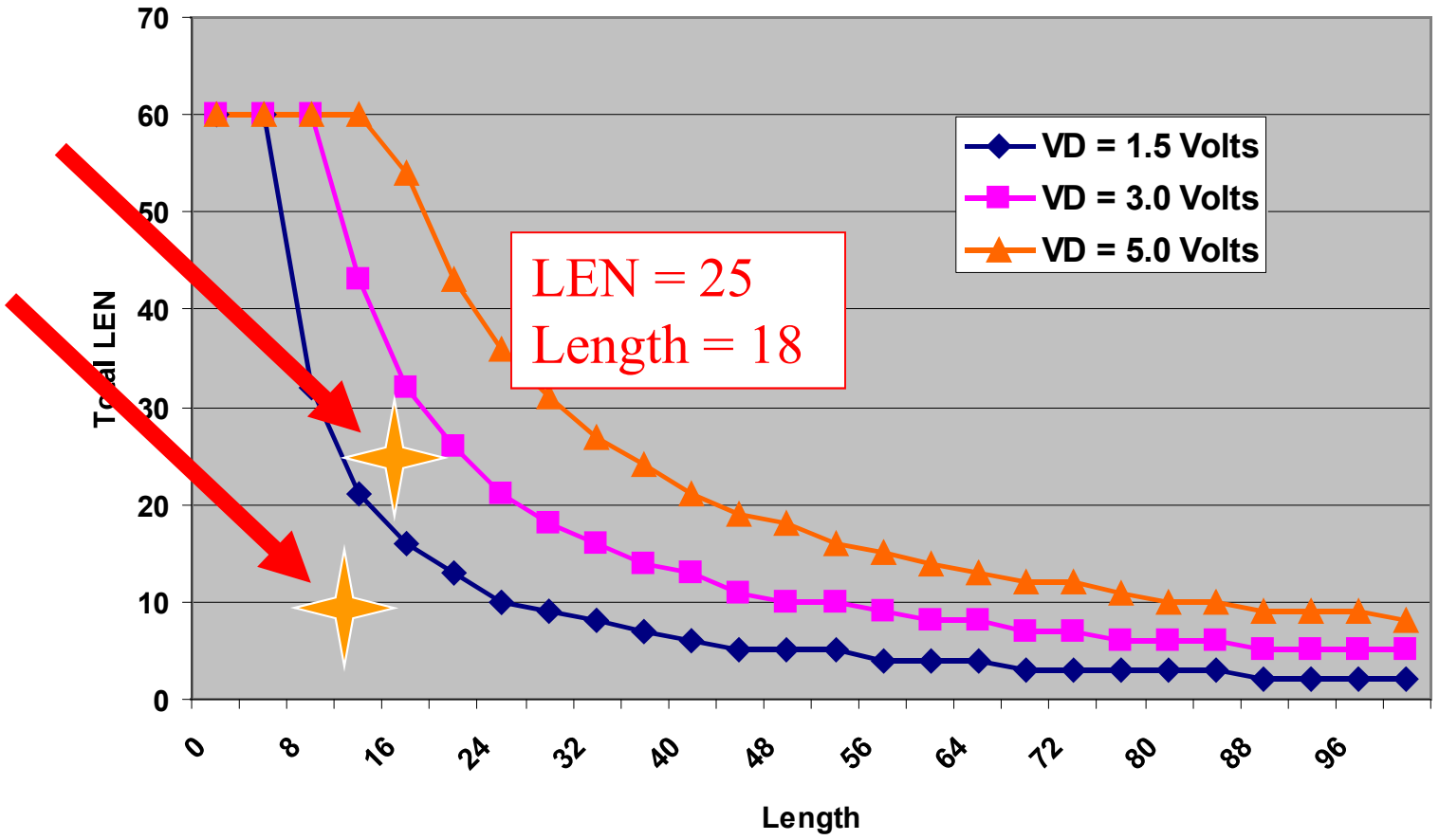
Example Summary

- Total load = 10 LEN
- Backbone length = 13 meters
- Using light cable
  - Power pair resistance = 0.057 Ω/meter

$$E = 0.1 \times 10 \times 13 \times 0.057$$

$$E = 0.74 \text{ Volts}$$

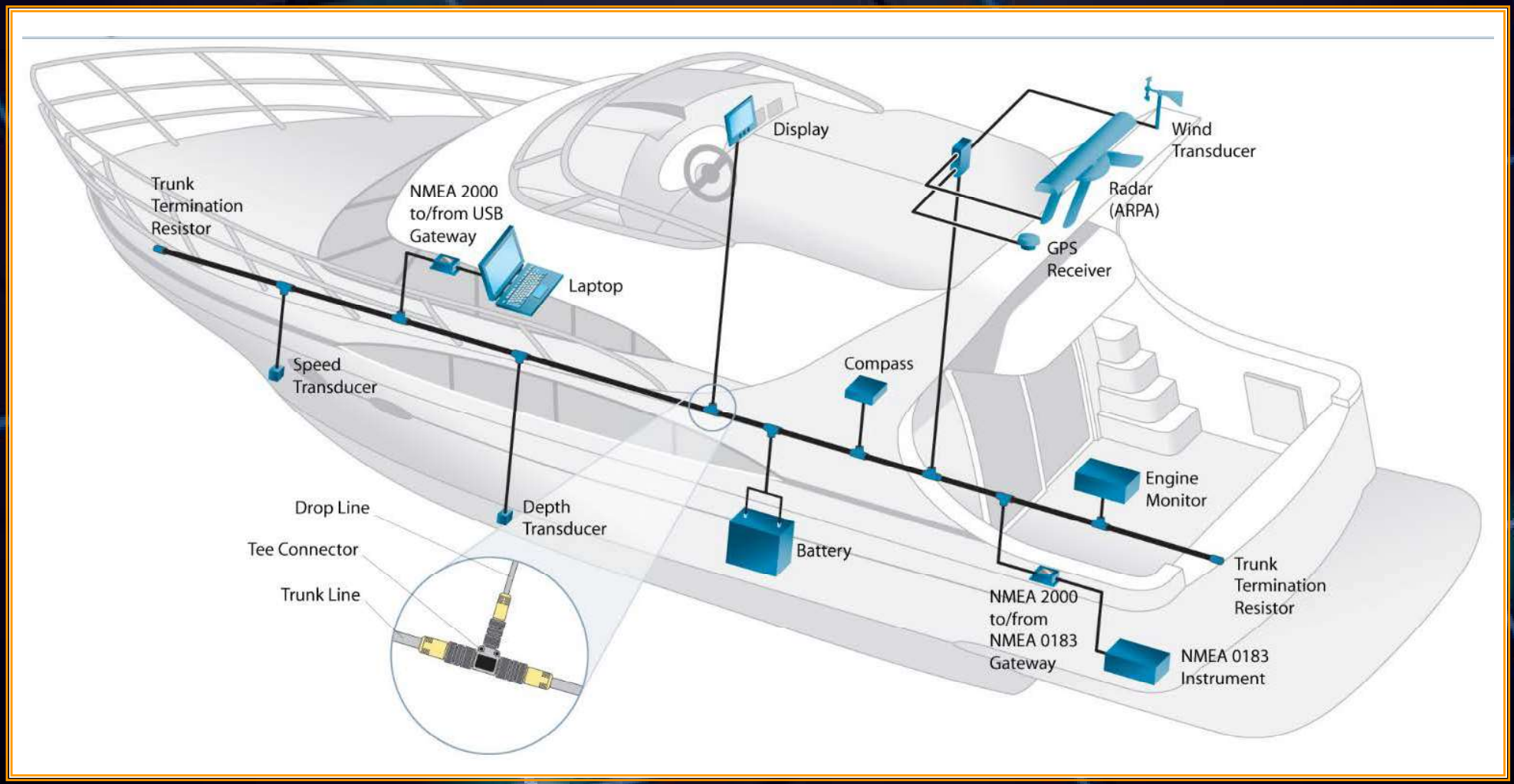
Estimated Length - Light



Network Layout

- 'Trunk and Drop' Topology
- Determine location for each product
- Determine path for trunk/backbone that:
  - Passes within 6 meters of each product
  - Total of all drops < 78 meters
- Determine number and location of power insertion points

Network Layout



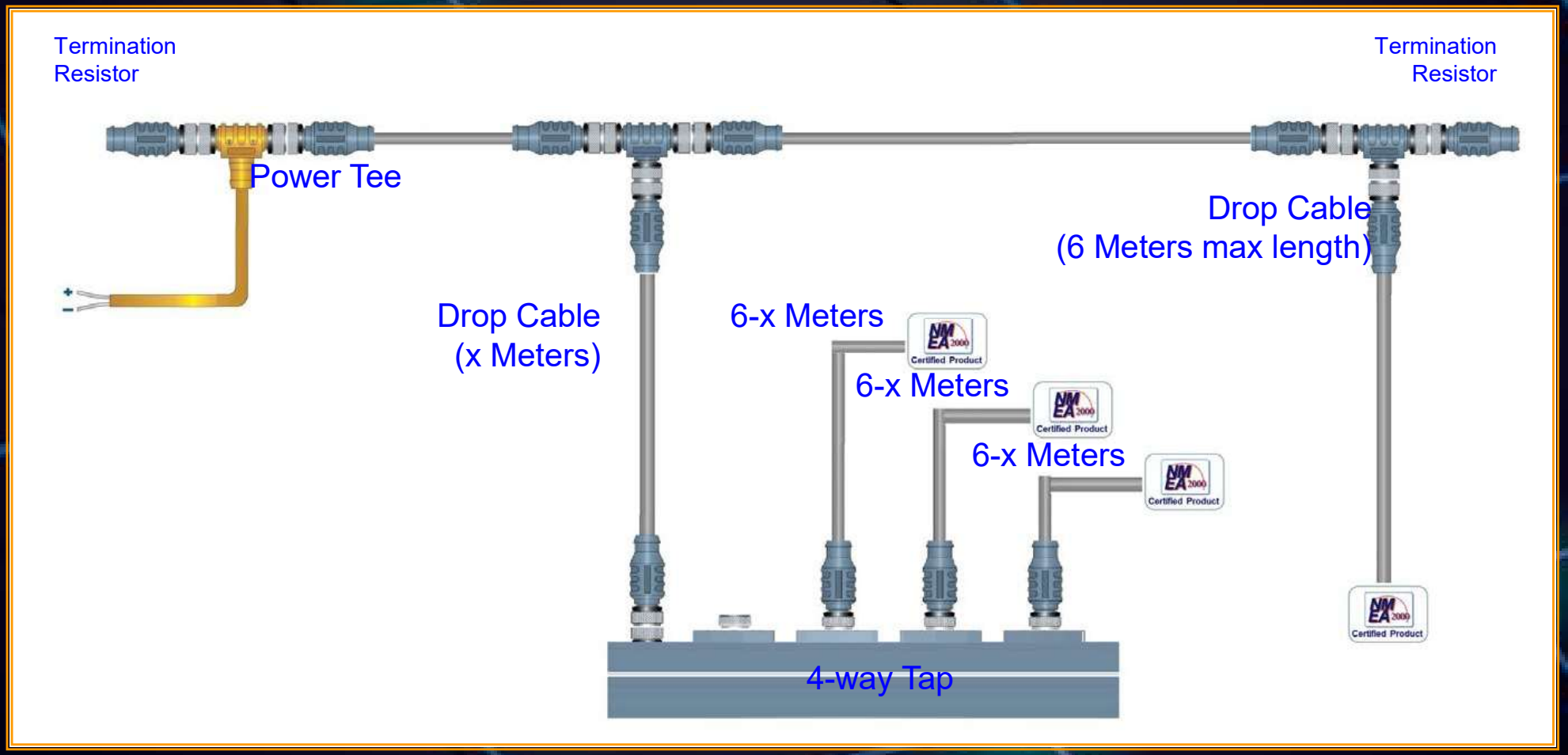
Layout Issues

- Multiple connections in confined spaces
- Sailboat masts & powerboat towers
- Gateways to other protocols
- Multiple backbone configurations

Multiple Connections in Confined Spaces

- Multi-tap tee is used just like multiple tees
- Multi-drop splitter has some limitations

Multi-tap Drop



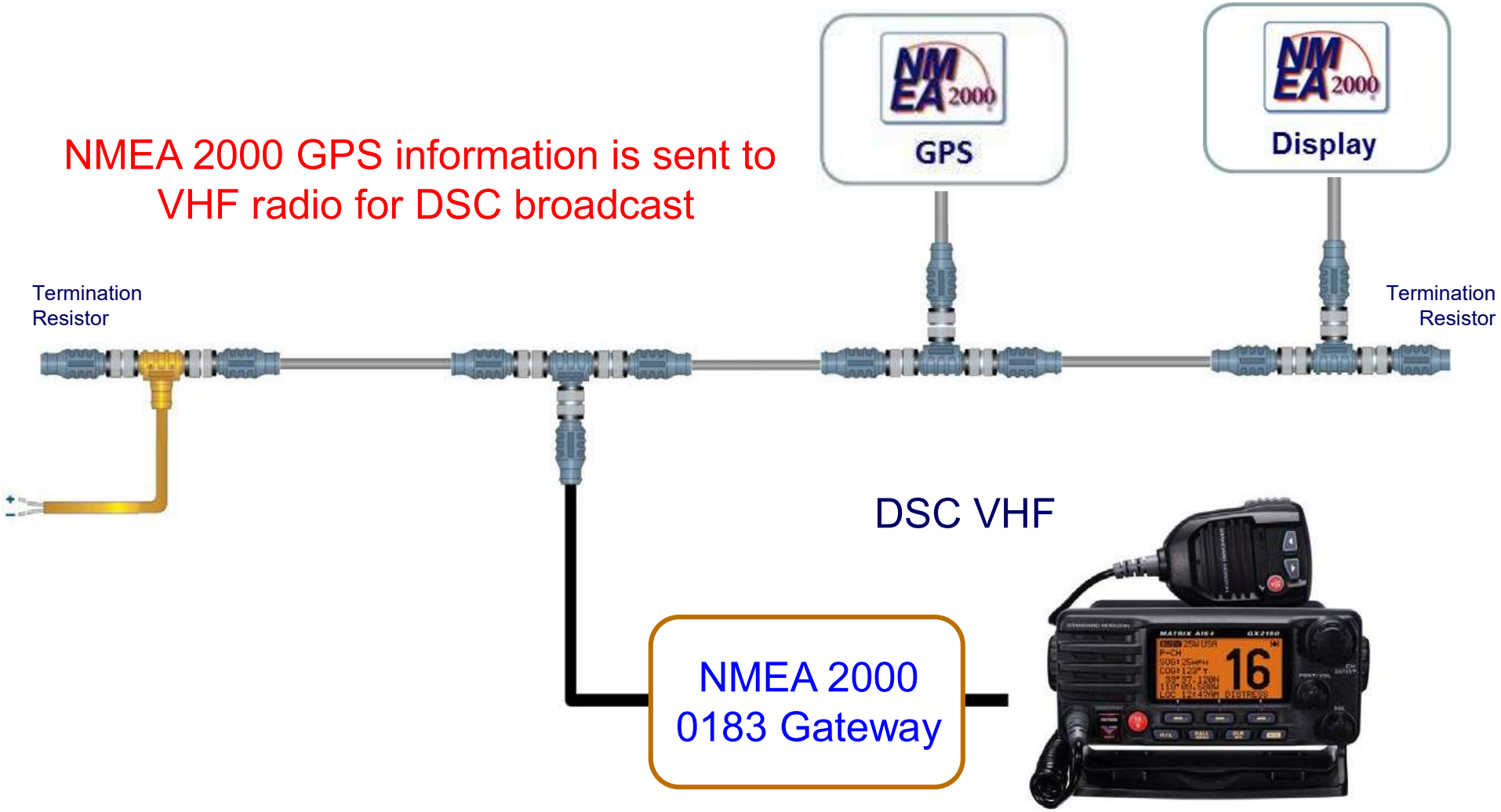
Max length of each drop must be reduced by the length of the drop cable between the Tee and the multi-tap

Sailboat Masts

- Most masts are greater than 6 Meters
- Backbone termination at the top of the mast
- In-Line termination resistors are used
- Must be within 6 meters of last device
- Some manufacturers have a built-in termination resistors on cables > 6 meters

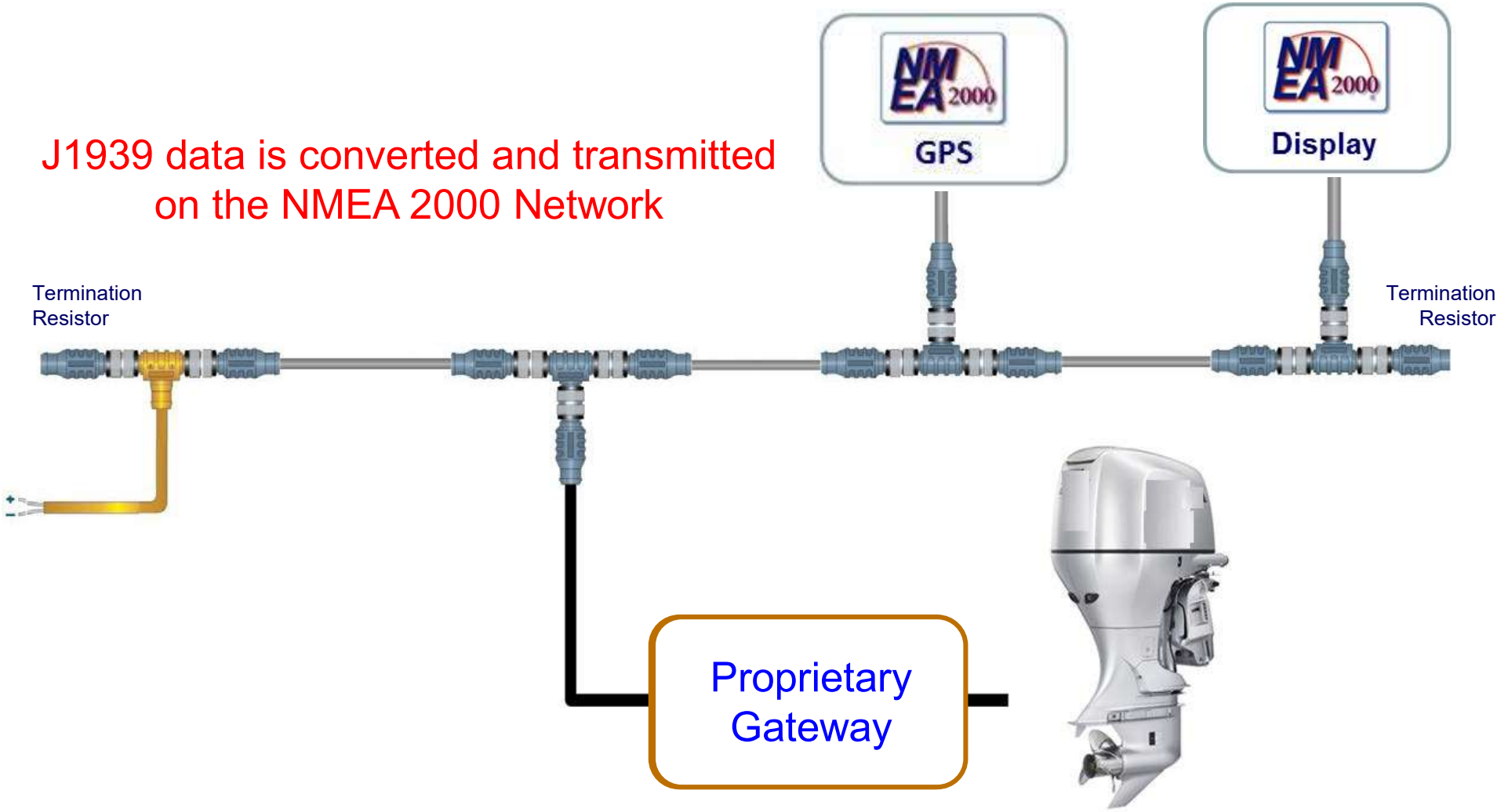
Gateways

NMEA 2000 GPS information is sent to VHF radio for DSC broadcast



Gateways

J1939 data is converted and transmitted on the NMEA 2000 Network



NMEA 2000 Network Bridge

- Connect two networks
- > 50 nodes
- Backbone > 200 meters
- Drops > 78 meters

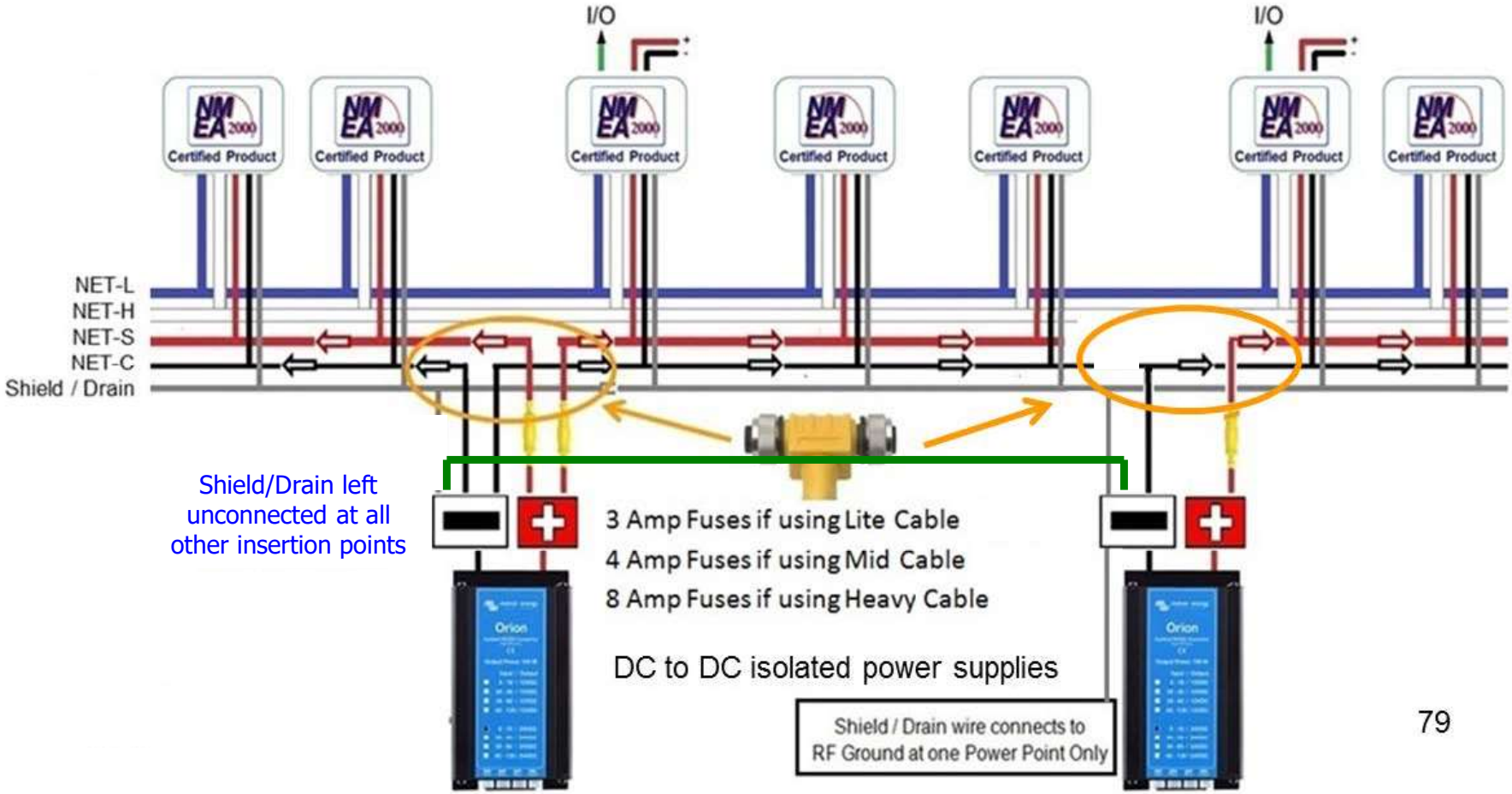
Useful For:

- Separate mast backbone from main
- Separate critical equipment
- Port/stbd redundancy

Power Insertion

- How many insertion points?
- Common reference point
- Connect shield to RF ground only once
- Each leg has only one power source – consecutive legs not connected
  - Risk of harmonics between power supplies
  - Risk of cumulative voltage drop exceeding common mode offset limits

Power Insertion



Power Insertion Building Blocks

Testing

Testing Checklist

- ✓ Loose connections
- ✓ Voltage fluctuations & data errors
  - Voltage consistent and > 9 VDC at all tees
- ✓ Correct termination
  - Approximately 60 Ω across data pair when power off
- ✓ No sustained error rate

Testing Checklist

- ✓ 50 connected products or less
- ✓ Drops 6 meters or less
- ✓ Total drops 78 meters or less
- ✓ Network 200 meters or less
- ✓ All power tap leads powered

Plug and Play Limitation

- Layout and power planning rules result in products communicating non-destructively
- Product configuration ensures data displayed is data intended
- Manufacturer configurability may vary
- New Label and Configuration messages will unify methods in use

Acknowledgements and Contact Information

Photos courtesy of Airmar, Actisense, Garmin, LTW, Maretron, Molex, Turck

Diagrams courtesy NMEA

Contact Information:
David Morschhauser
dave@netsavvy.com

MYSTIC VALLEY COMMUNICATIONS LLC

http://www.nmea2000solutions.com