



National Marine Electronics Association



NMEA 2000®

Past, Present and Future



National Marine Electronic Association

NMEA



*Serving the Marine Electronics Industry Worldwide
Operational Safety is Our Highest Priority*

- Global non-profit marine industry member organization
 - Technical dealers, manufacturers, distributors, sales reps, retailers, associate members
- Dedicated to serve the public interest
 - Facilitate the public interest in the interconnection and interchangeability of equipment
 - Minimize misunderstanding and confusion between manufacturers
 - Assist purchasers in selecting compatible equipment
- Has provided product standards since late 1970's
- Collaborates with other standards organizations worldwide



NMEA 2000 Summary



- Industry Open Marine Networking Interface Standard
 - Developed by more than 40 academic , industry and international collaboration
 - Academia - Kansas and Oklahoma State
 - Networking and computer industry
 - Marine electronic companies
 - U.S. Coast Guard Research & Development
- Beta tested 18 months under NMEA guidance
 - U.S. Coast Guard
 - Marine electronics manufacturers
 - Furuno USA, JRC, Litton Marine, Navionics, Northstar, Raymarine, Simrad, Teleflex, Trimble, Wood Freeman
 - CAN Manufacturers
 - Kvaser, Vector Can Tech



NMEA 2000 Summary



- Key Requirements

- Message prioritization
- Proven, robust, safe
- Data creation simplified
- Certification testing
- Standard cables and connectors
- Bi-directional, multi-talker + multi-listener
- Multi-master, no single controller
- Single channel serial bus
 - 250 Kbits/sec (50 times faster than 0183)



NMEA 2000 Summary



- CAN (Controller Area Network) was chosen as the fundamental protocol
- Developed in 1983 by Robert Bosch GmbH and Intel.
- Proven, robust, noise immune, distributed real-time communications
- Bus arbitration
 - Priority messaging
- Adopted by SAE J1939 (Society of Automotive Engineers) in 1986
- Adopted by ISO 11783 for agricultural machinery



NMEA 2000 Summary



- 8 documents comprise the NMEA 2000 Standard
 - Main Document
 - Appendix A Version (Application Layer)
 - Appendix B Version (Database of Messages)
 - Appendix C Version (Certification Criteria and Test Methods)
 - Appendix D Version (Application Notes)
 - Appendix E ISO 11783-3 Data Link Layer
 - Appendix F ISO 11783-5 Network Management
 - Appendix G ISO 11898 Controller Area Network



NMEA 2000 Summary



- NMEA 2000 Standards Committee and TC 80 Working Group6 jointly developed IEC 61162-3 with specific rules for SOLAS class vessels
- NMEA 2000 defines all of layer s the ISO/OSI model
 - NMEA 2000 commonly refers to other international standards to maintain harmonization
 - *Physical Layer.* Fully defined by the standard, including signaling voltages, cables, and connectors.
 - *Data Link Layer.* Defined by ISO 11783-3 with additional requirements specified by the standard.
 - *Network Layer.* To be defined in future versions of the standard.
 - *Network Management.* Defined by ISO 11783-5 with additional requirements specified by the standard.
 - *Application Layer.* Fully defined by the standard and includes a provision for manufacturer's proprietary messages.

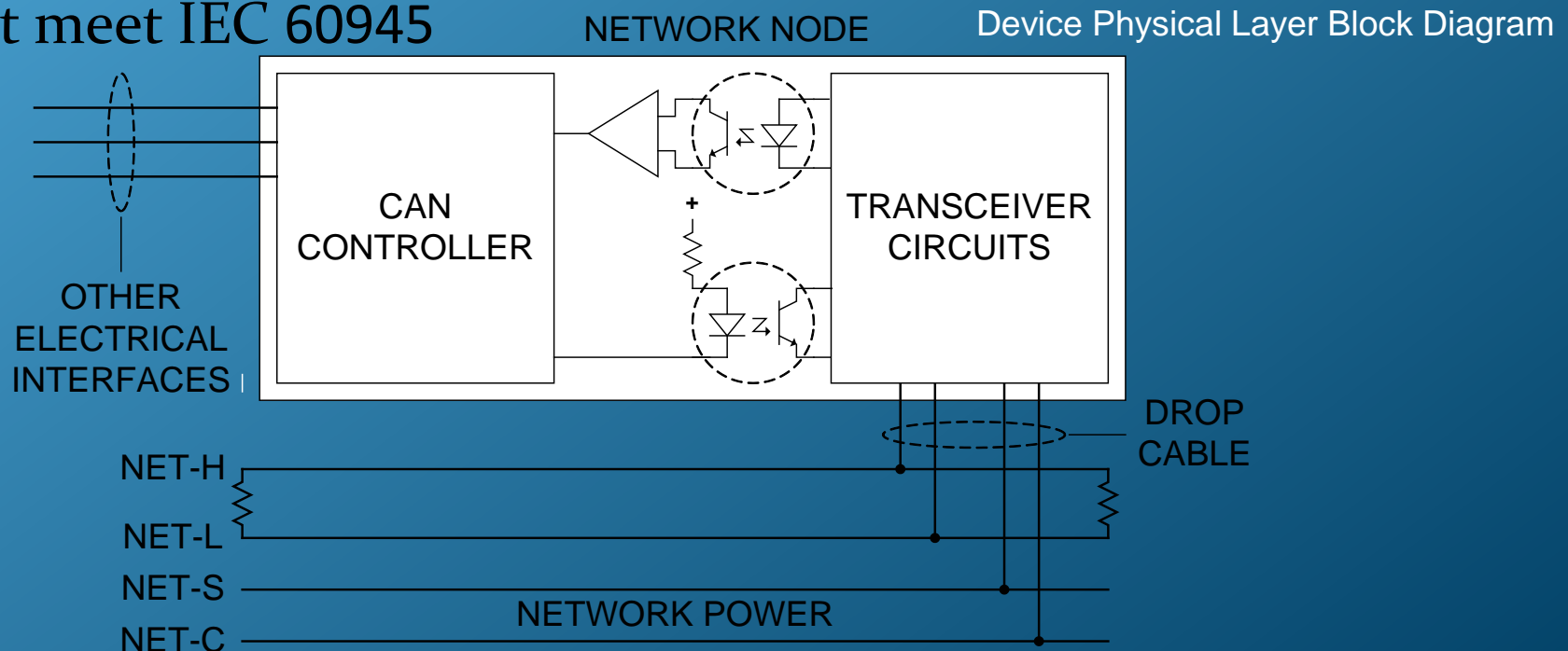


NMEA 2000 Summary

The Physical Layer



- Media Access as defined by ISO 11898
- Opto-isolation required
- Common single point reference
- AC and DC isolation is required
- Must meet IEC 60945





NMEA 2000 Summary

The Physical Layer



- The maximum length of the network is controlled by the CAN requirement
 - 1,000 kbits/second - 25 meters
 - 500 kbits/second - 75 meters
 - 250 kbits/second - 200 meters – NMEA 2000 Standard
 - 125 kbits/second - 500 meters
 - 62.5 kbits/second - 1100 meters



NMEA 2000 Summary

The Physical Layer

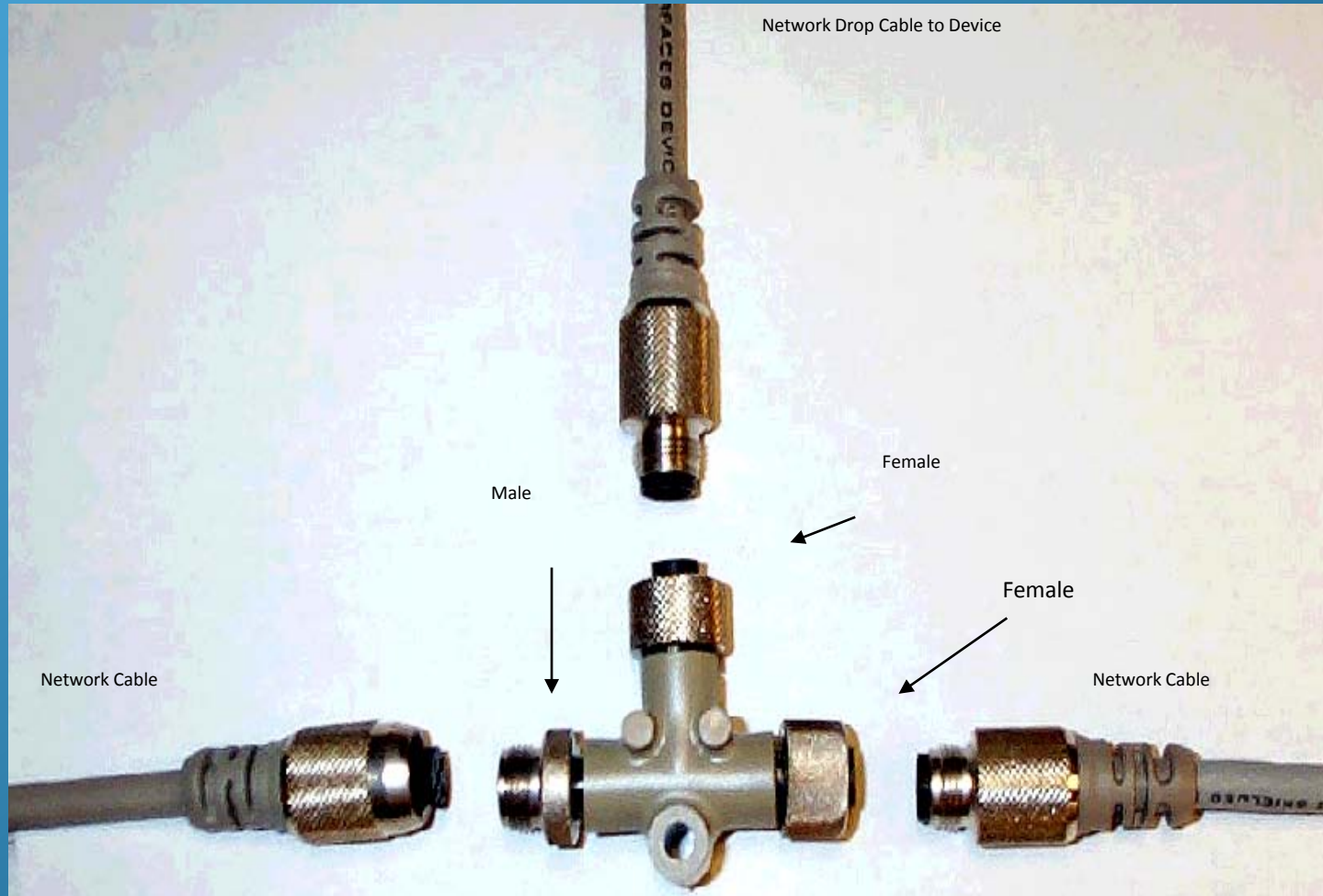


- Two Type of cables and connectors using Open Devicenet Vendor Association (ODVA) Specification
 - Heavy Cable (8 Amps)
 - Light Cable (3 Amps)
 - IP67 rated
 - 65 lb pull strength
 - Key screw-on connectors
 - Meets USCG regulated vessel-wiring requirements.
 - Meets USCG regulated vessel safety concerns.
 - Accepted by Lloyd's Register
 - Meets UL Class 2, UL 1677 oil resistance and NEC CL2 FT 4 flame rating specifications



NMEA 2000 Summary

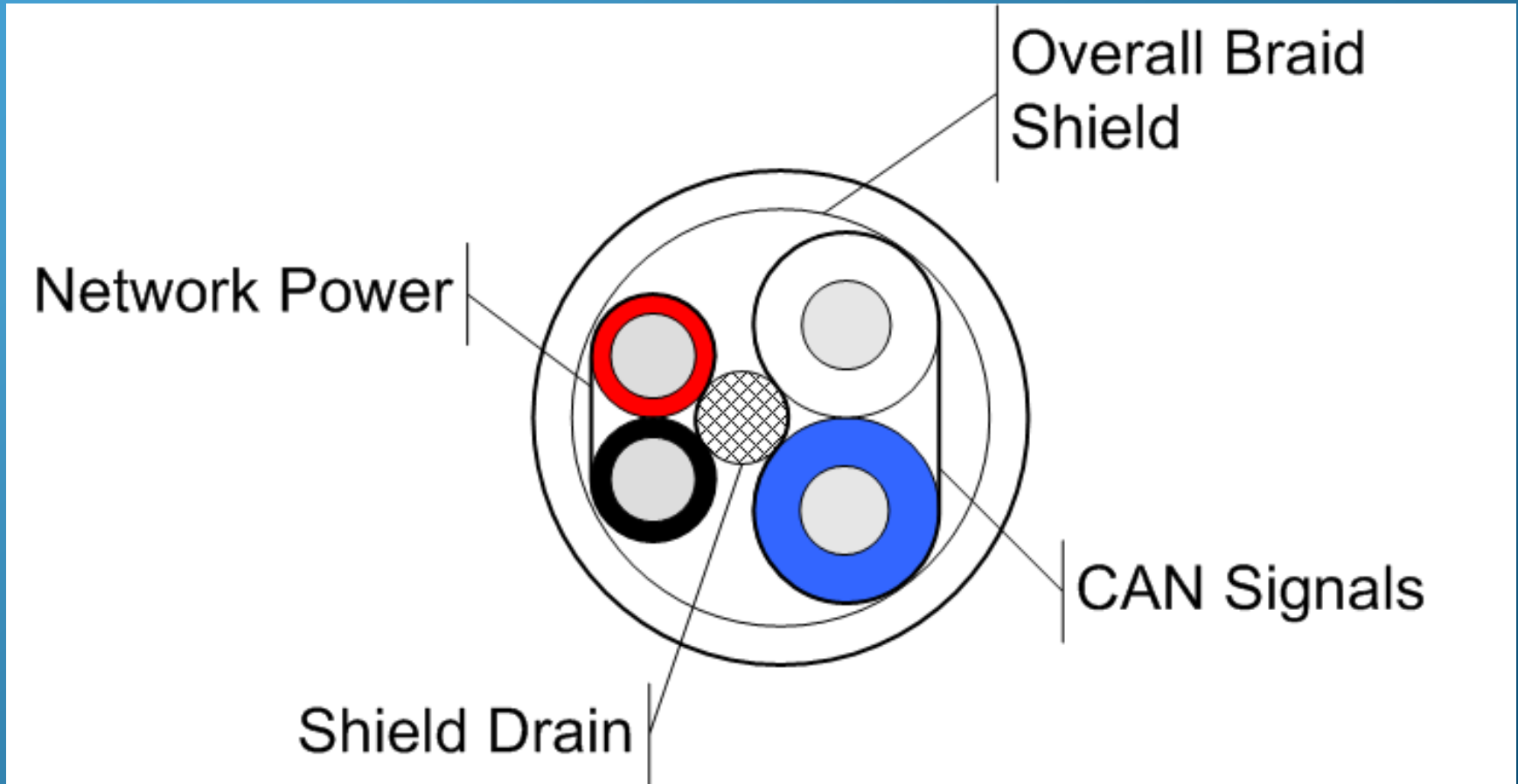
The Physical Layer





NMEA 2000 Summary

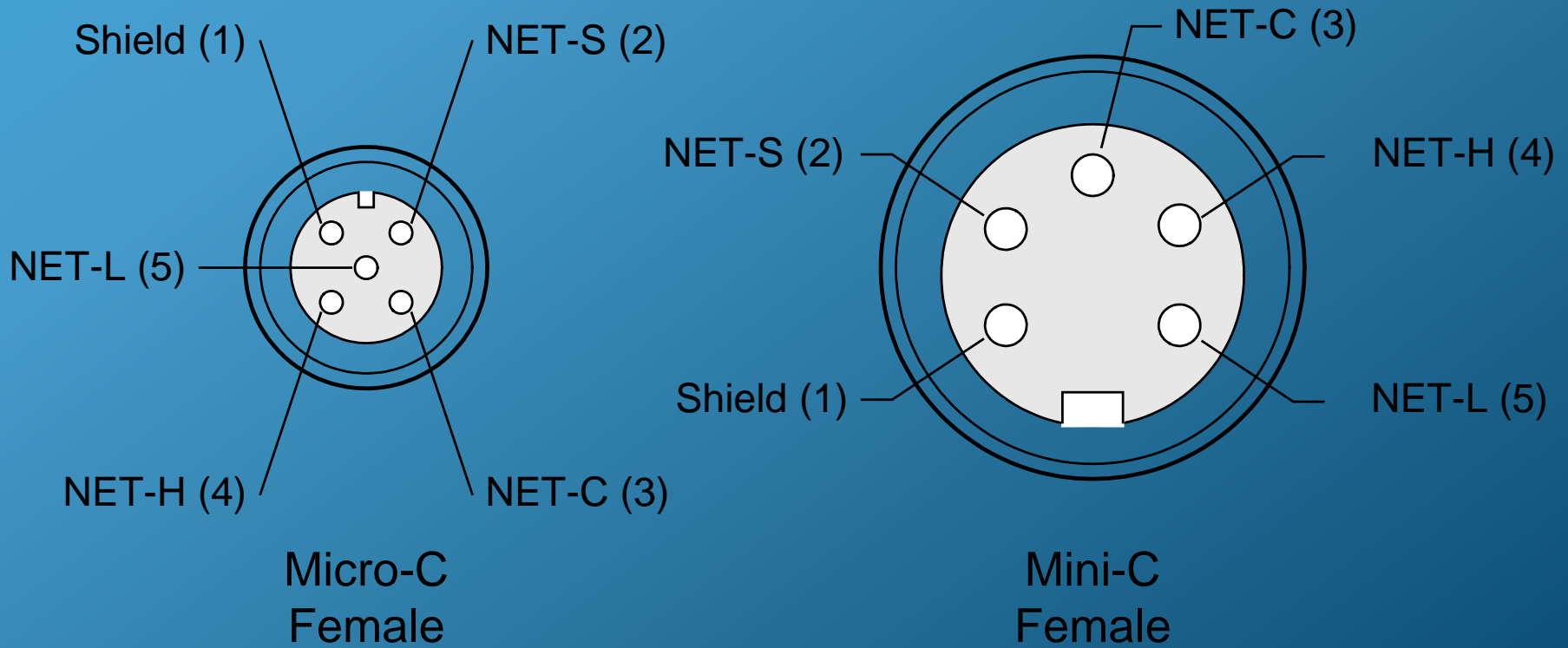
The Physical Layer





NMEA 2000 Summary

The Physical Layer



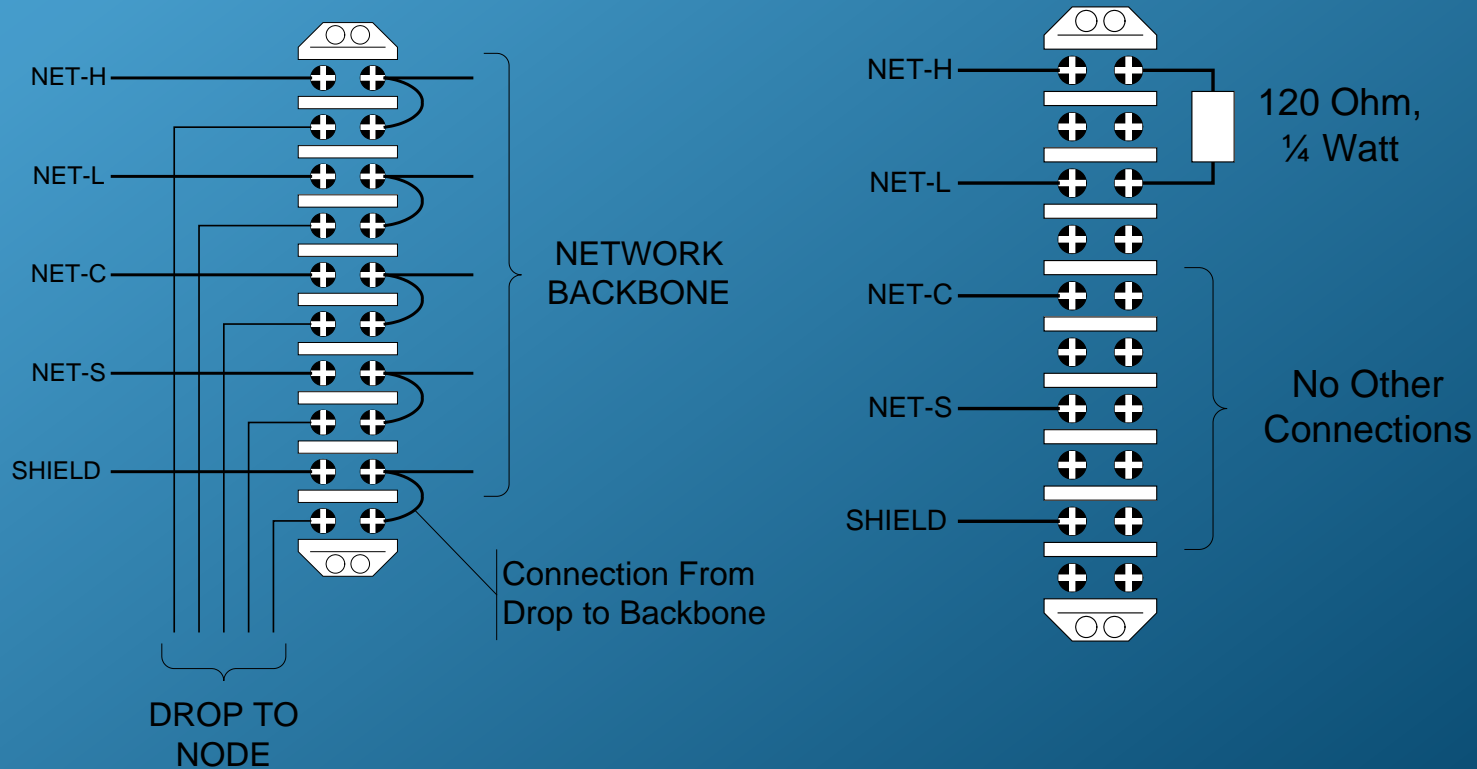


NMEA 2000 Summary

The Physical Layer



- Barrier strips may be used
 - Only in protected areas
 - Enclosure meets IEC 60945



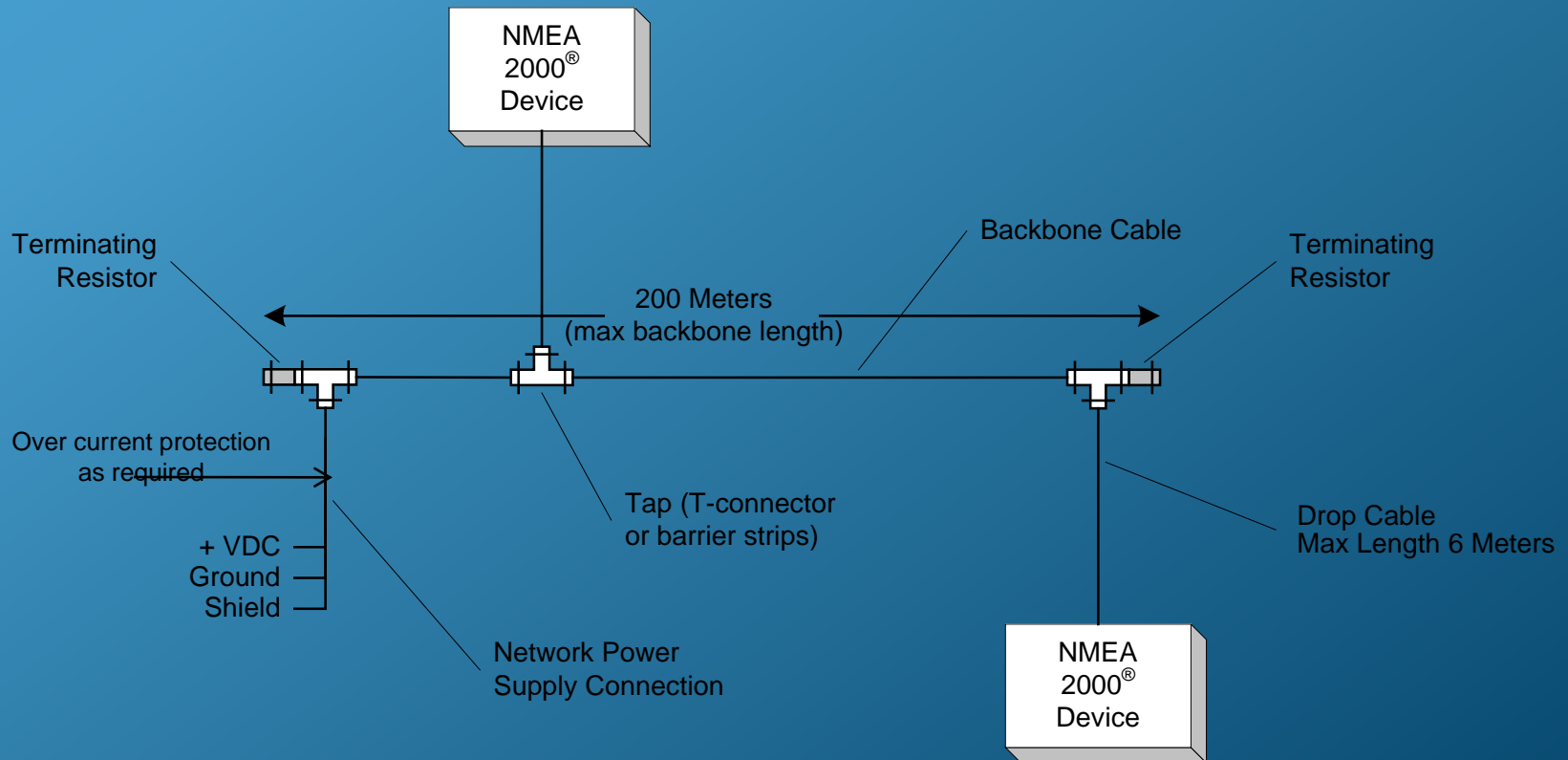


NMEA 2000 Summary

The Physical Layer



- General Topology
 - “Trunk and Drop”



Simplistic Bus Topology



NMEA 2000 Summary

The Physical Layer



- Backbone is a continuous linear form
 - 2 terminating 120 Ohm resistors at either end to reduce line reflections
 - Tees and Drop Cables
 - 0 – to 6 meter drops
 - Add and subtract products without network interruption
- NMEA 2000 single cable replaces wiring up to 50 NMEA 0183 interconnections
- Boat builder testimony
 - 1000 pounds less weight
 - 2 weeks faster to market

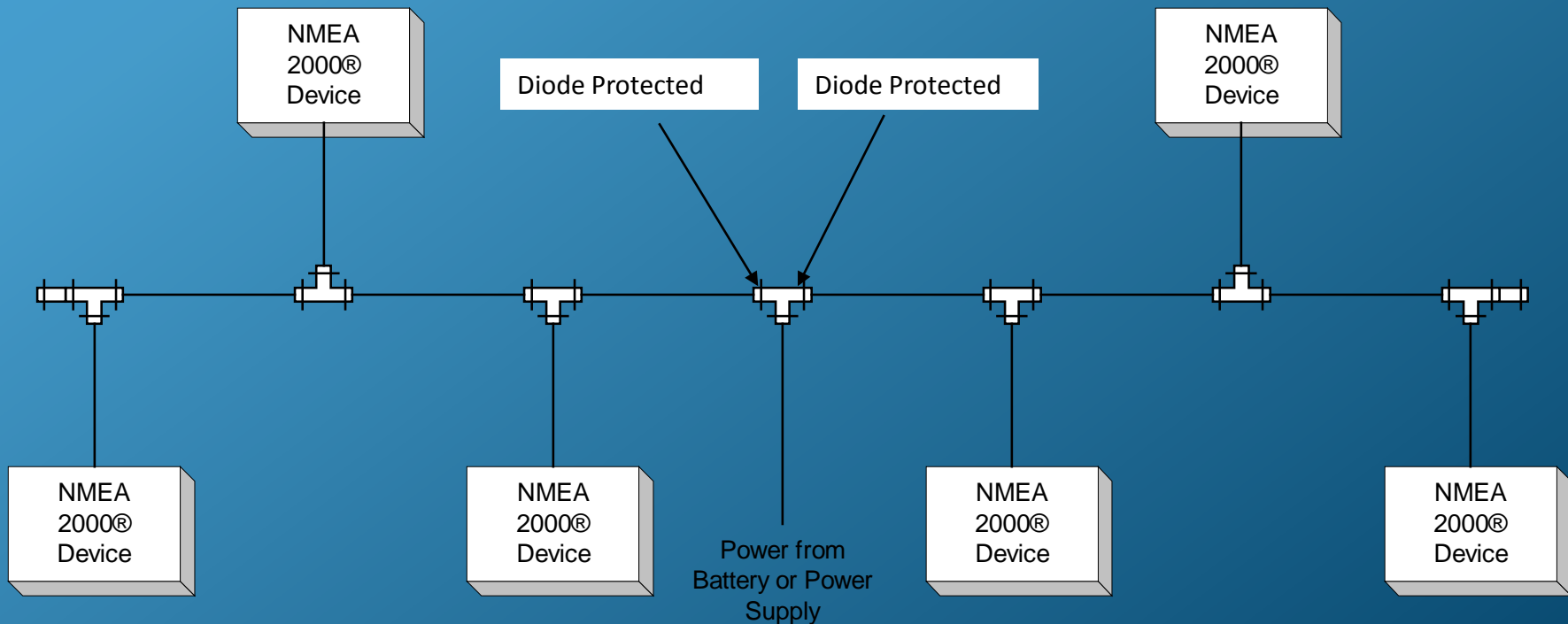


NMEA 2000 Summary

The Physical Layer



- Overcoming voltage loss
 - Can have multiple power insertions on the bus



Must be regulatory requirements

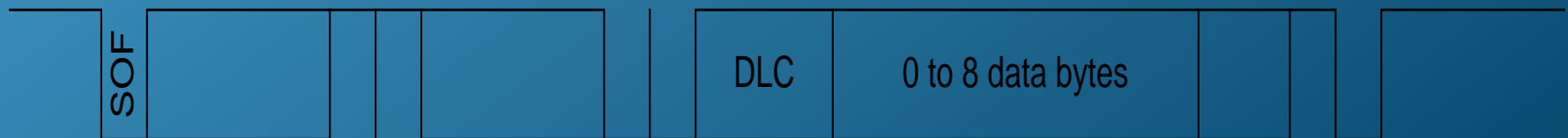
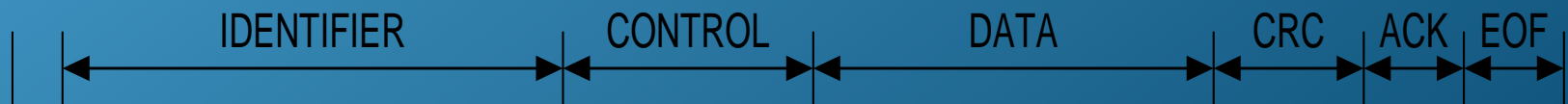


NMEA 2000 Summary

The Data Link Layer



- References ISO 11783-3 (SAE J 1939-21)
- Some requirements dictated by CAN
 - Bit-by-bit arbitration
 - Performs robust error checking
 - CAN will automatically take node off line with repeated errors
 - 8-byte data field and a 29 – bit identification fields





NMEA 2000 Summary

The Network Management



- References ISO 11783-5 (SAE J 1939-81)
- Responsible for
 - Claiming and assignment of addresses on the network
 - The identification of devices connected to the network
 - Network initialization at power-on
- Each device must have an address
- Each device must be self configurable and capable of claiming an address
- 252 addresses are available
- 252 – 255 are reserved



NMEA 2000 Summary

The Application Layer



- Defines approved messages
 - Network management and data messages
 - Organized by parameter groups identified by a Parameter Group Number (PGN)
 - Created in binary form (NMEA 0183 ASCII)
 - PGN is a specific data record
 - PGNs are defined in Appendix B of the NMEA 2000 Standard
 - Updated PGN list on www.nmea.org



NMEA 2000 Summary

The Application Layer



- Example of parameter group

ISO Acknowledgment

PGN: 059392

This message is provided by ISO 11783 for a handshake mechanism between transmitting and receiving devices. This message is the possible response to acknowledge the reception of a "normal broadcast" message or the response to a specific command to indicate compliance or failure. The application layer is responsible for determining when this message is desired, outside of network management requirements specified by this standard (e.g. response to ISO Request message). This message will always be sent with a destination address of 255.

Single Frame: **Yes** Priority Default: **6** Default Update Rate: **NA** milliseconds Frequency: **NA** cycles per second
 Destination: **Address** Query Support: ACK Rqmnts:

Field #	Field Name	Byte Field Size:	Bit Field Size:	Request Parameter	Original Reference ID # 64
1	Control Byte 0x00 = Positive Acknowledgment; 0x01 = Negative Acknowledgment; 0x02 = PGN supported but access denied; 0x03 to 0xFF = Reserved		8	No	
2	Group Function Value Group Function of PGN being acknowledged. This field identifies for a device the specific group function of a PGN being acknowledged or declined. This field is not used if the PGN being acknowledged or declined is not a group function PGN.		8	No	
3	Reserved Bits Variable number of reserved bits, all set to logic "1"		resv 24	No	
4	PGN of Requested Information 24-bit Parameter Group Number (PGN) expressed in binary, LSB is transmitted first		24	No	



NMEA 2000 Summary

The Product Certification



- All products are certified
 - Minimum mandated requirements to interoperate properly
 - Behave in a known and predictable manner
 - Proper behavior ensures safe and accurate communication
 - Expose any flaws or weaknesses in the protocol implementation
 - Share data with other disparate devices
- Certification tool
 - Hardware: CAN interface device for a PC
 - Software : implements test procedure as outline in NMEA 2000 Appendix C
 - 40 manual test
 - 60 automated test in 25 functional categories



NMEA 2000 Summary

The Past



- NMEA 2000 Standards Committee established in 1994
- Multi-national marine electronics committee under NMEA guidance
- 5 years in development
- Determined the basic ground rules
 - OSI model, no network master, self organizing devices, no external setup procedure, ground isolation, etc.
- Early existing industrial network systems models : Hart Communications, Echelon, DeviceNet, VAN and FieldBus
- Trimble Navigation familiar with J 1939



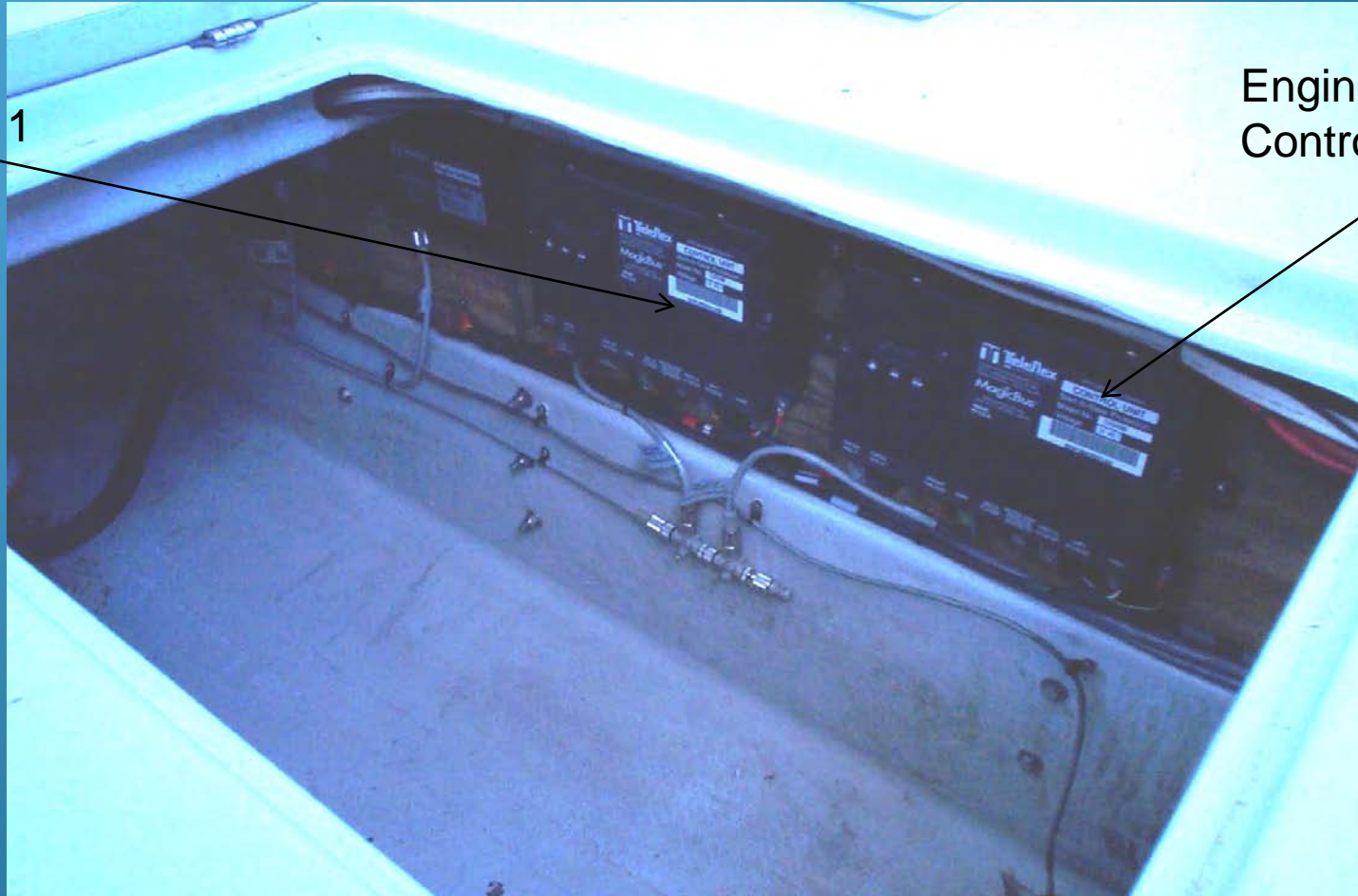
NMEA 2000 Summary

The Past



- 2001 Teleflex Installation on Law Enforcement Vessel

Engine
Controller 1



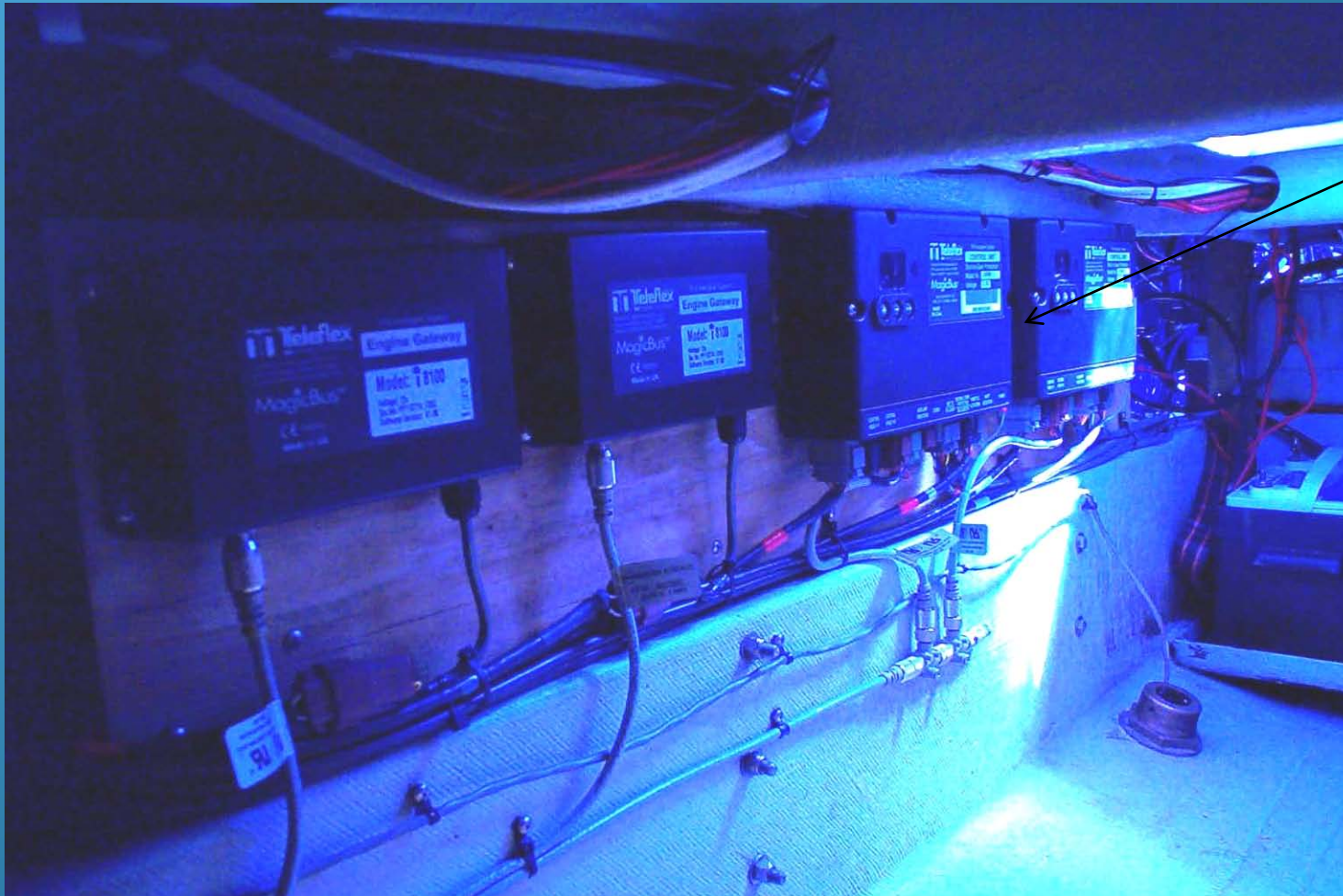
Engine
Controller 2



NMEA 2000 Summary *The Past*



- 2001 Teleflex Installation on Law Enforcement Vessel



Engine
Interface
Units

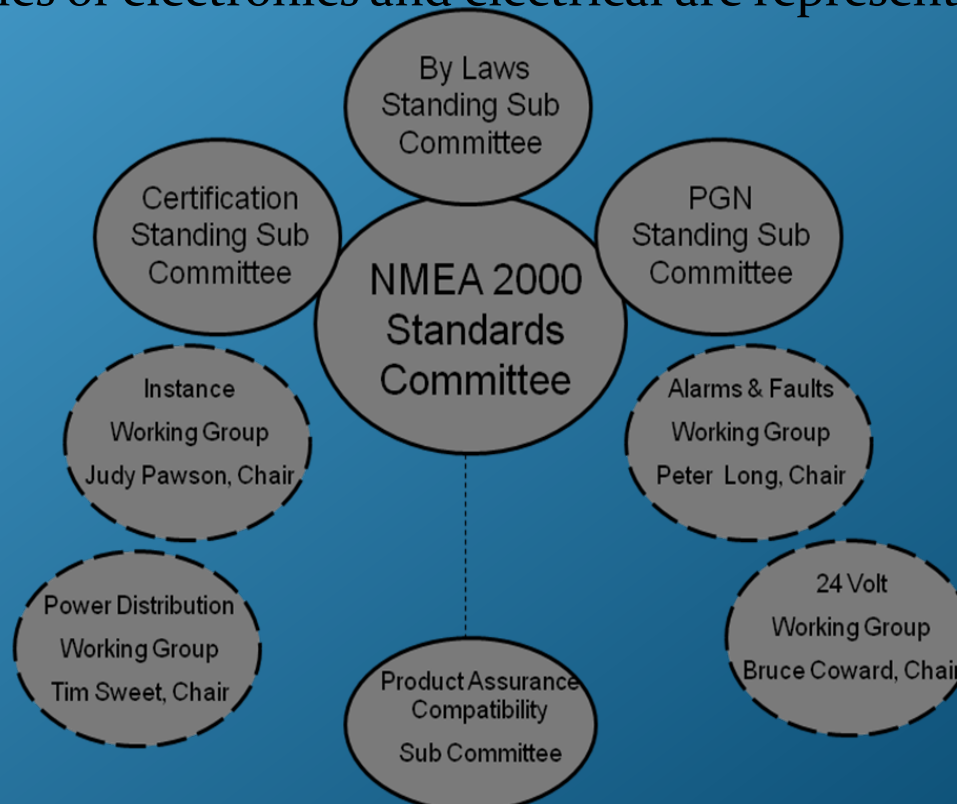


NMEA 2000 Summary

The Present



- NMEA 2000 Standards Committee
 - Over 100 companies worldwide
 - Europe, Asia, Australia/New Zealand, U.S.
 - All categories of electronics and electrical are represented





NMEA 2000 Summary

The Present



- Updating firmware and hardware on NMEA 2000
 - Laboratory experiment results:
 - 98% bus load – reprogramming of software over the bus – highest priority engine PGNs were first to be transmitted
 - Real-life results
 - Rich Gauer, President of Maretron, attested to the following:

“Maretron has been loading updated firmware/software into its products over the NMEA 2000 network since 2004. We have done tens of thousands of updates all over of the world through our dealer network using a PC and USB/NMEA 2000 Certified gateway (USB 100). The dealers simply jumps on the internet and downloads all the latest versions of firmware/software from our web page, then goes to the boat and plugs the USB 100 onto the network, starts the program which identifies which devices need updating automatically, and when the user is ready, the update takes place on a live operating NMEA 2000 network.”



NMEA 2000 Summary

The Present



- IEC 61162-3 and NMEA 2000
- NMEA and TC 80 Working Group 6 collaborated to assure that NMEA 2000 would meet the SOLAS requirements of IEC
 - Dual networks, redundant network interface circuits
- Redundancy achieved in a number of ways (for example)
 - Class 1 devices (one interface)
 - Identical devices on two buses
 - Two buses with functions duplicated on each bus
 - Class 2 devices (two interfaces)
 - One device two interfaces on two buses
 - Two buses with function duplicated on each bus

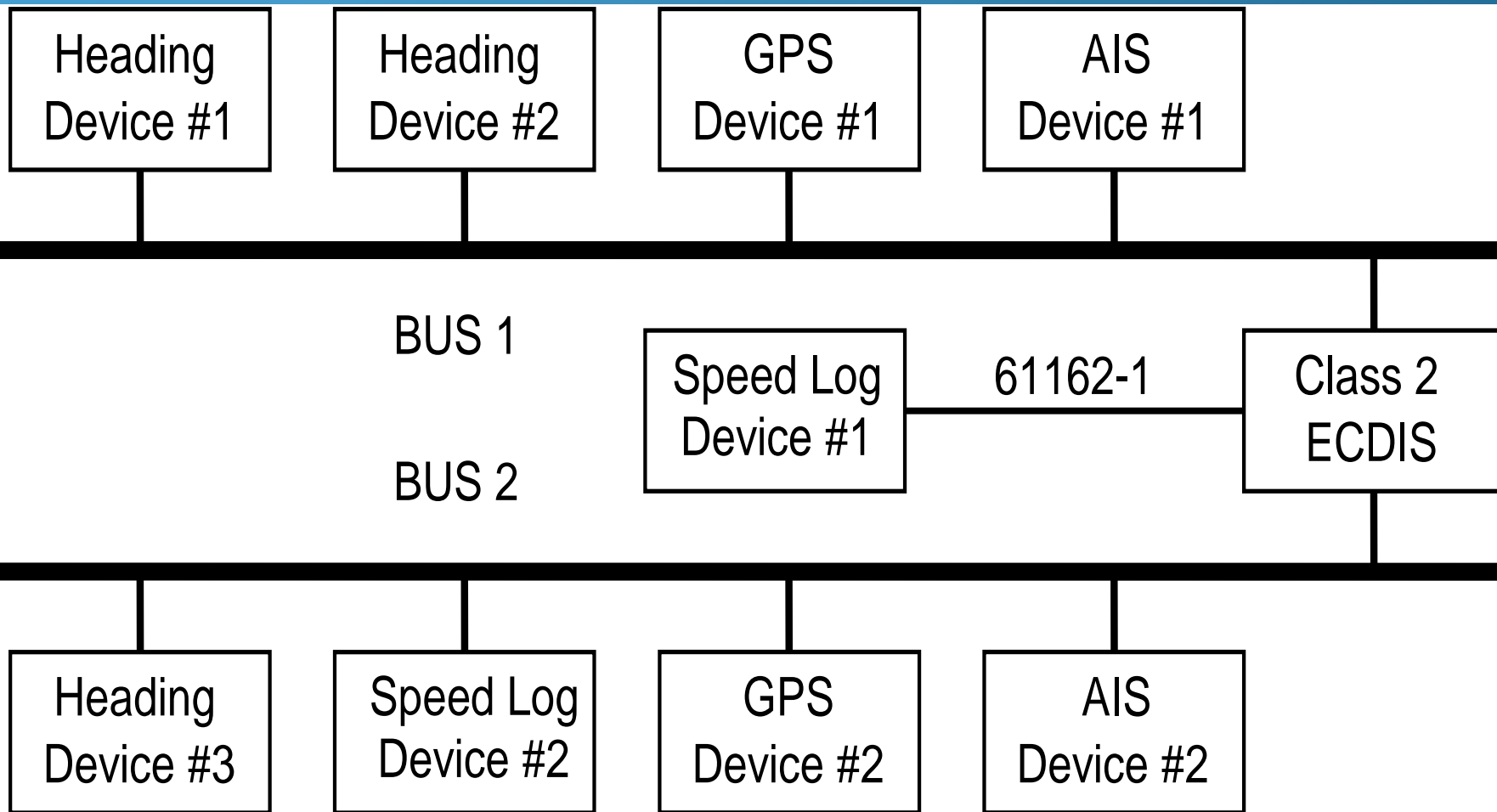


NMEA 2000 Summary

The Present



- IEC 61162-3 redundancy examples (1)



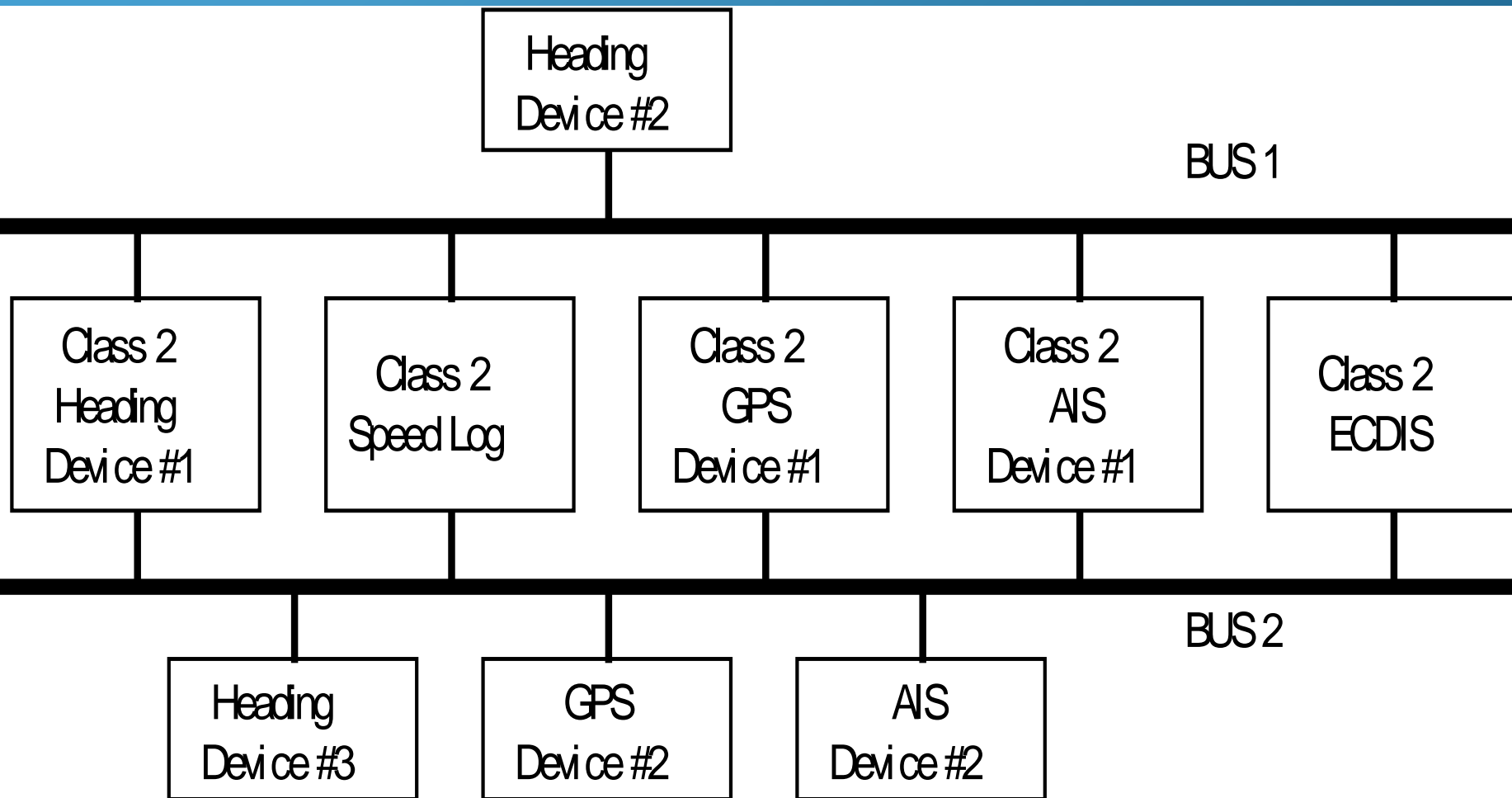


NMEA 2000 Summary

The Present



- IEC 61162-3 redundancy examples (2)





NMEA 2000 Summary

The Future



- Alarms and Faults – a set of tools for a suite of alarms and faults. This subcommittee has received input from the IEC INS group
- Power Generation – PGNs are being created for status and control of power generation devices, such as generators, alternators, inverters, hybrids, and shore power on ships
- Electrical Power Generation and Distribution – PGNs are being developed for the delivery of power on vessels; identifying loads, load sharing, and virtual breakers.
- 24-Volt Systems – There is a subcommittee studying adding 24 volt systems to NMEA 2000, defining the rules and requirements.



NMEA 2000 Summary

The Future



- Common Configuration – There has been a great deal of demand that manufacturer “X” devices on the network can configure manufacturer “Y” devices on the network
- Intelligent Gateways – Gateway that are “smart” and can communicate and recognize devices on both sides of the gateway and be able to transmit on the NMEA 2000 network status of the device on the other side of the gateway. Some companies today are in development of NMEA 0183 to NMEA 2000 Gateways.
- NMEA 2000 Bridges – the ability to “bridge” to other network protocols
- Galileo – have had discussions with Working Group
- E-Loran - have had discussions with Working Group



NMEA 2000 Summary



RTCM and NMEA

Thanks you for attending

NMEA

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