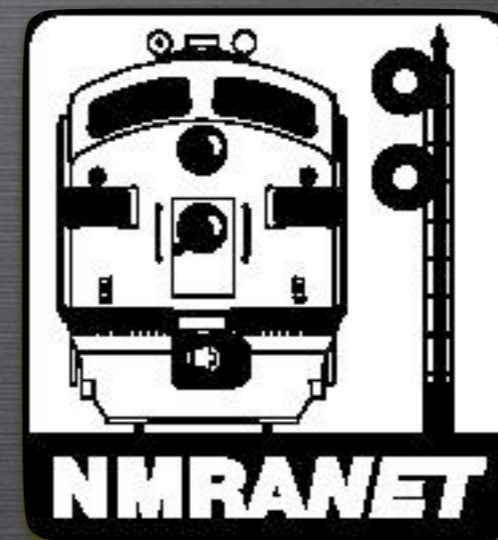
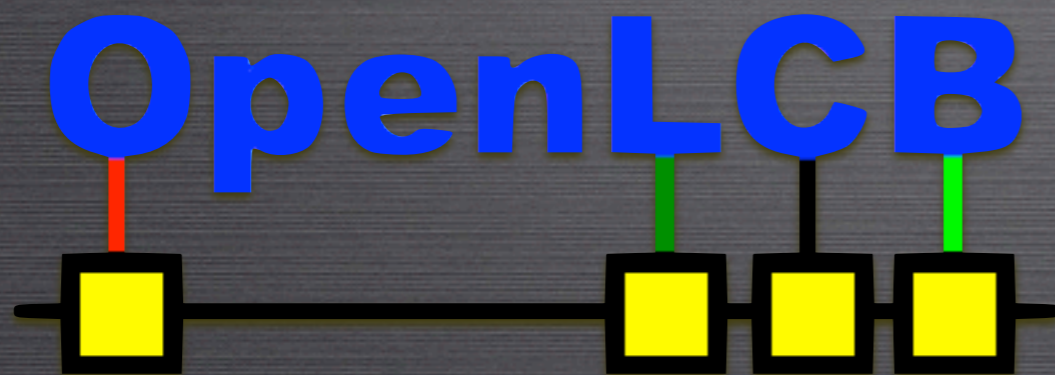


OPENLCB / NMRRANET S-9.7 FOR DEVELOPERS AND DIY



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OPENLCB / NMRRANET TECHNICAL OVERVIEW

- The OpenLCB Stack
- CAN Implementation
- Transport Protocols
- Application Protocols



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ASSUMPTIONS

- Have a vague sense of what OpenLCB is all about
- Understand Producer-Consumer model



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DEVELOPERS' TOOLS

- Reference Hardware
- Embedded Software
- iPhone / PC Software



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OPENLCB STACK

- Physical interface
- Data link layer
- Message / Network layer
- Event / Datagram / Stream Transport
- Application Layer

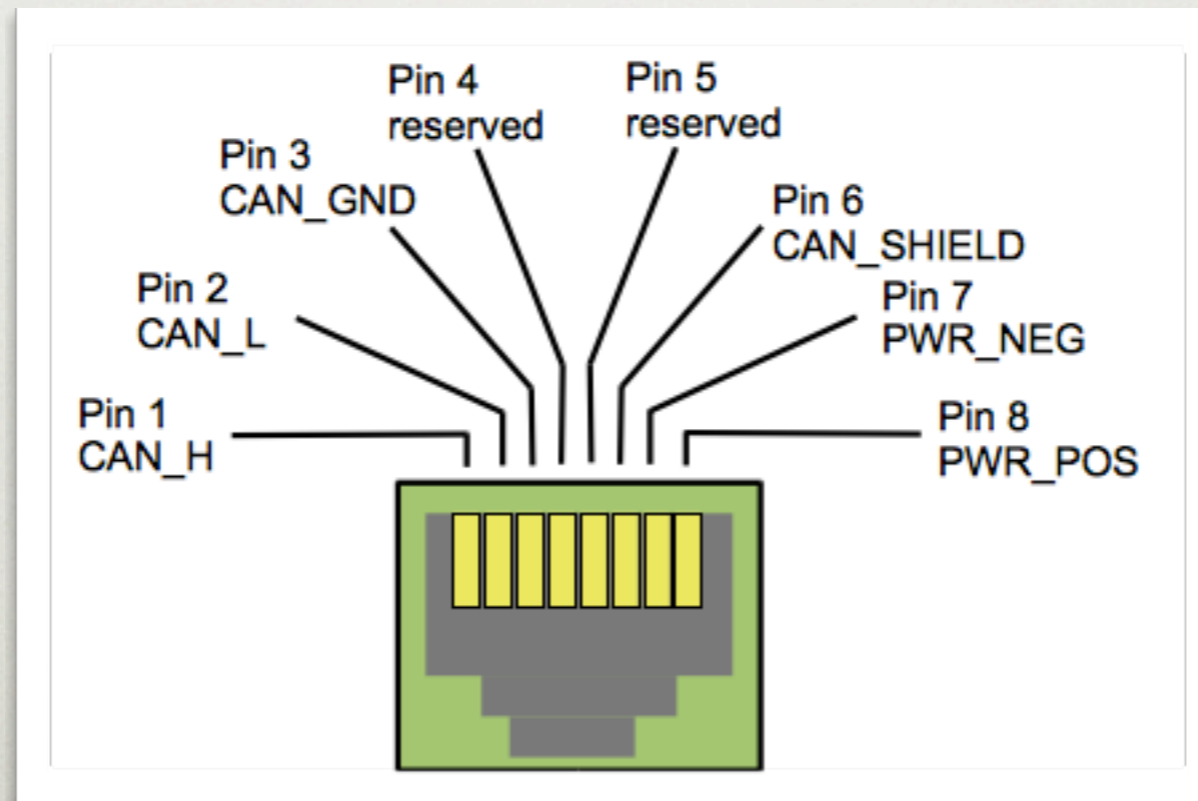


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PHYSICAL INTERFACE

- CAN interface defined by NMRA S-9.7.1
- RJ45 + CAT3 (or better)



UNIQUE IDENTIFIERS

- Each node is permanently assigned a globally unique 6-byte NodeID
 - AA.BB.CC.DD.EE.FF
 - Individuals, organizations, and manufacturers may apply for blocks
- Error for two nodes to share an ID



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DATA LINK LAYER

- Protocol is specified in abstract terms
- Can be implemented with nearly any communications technology
- CAN Implementation is complete
 - 29-bit header
 - 0–8-byte payload



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DATA LINK LAYER

- 29-bit header format:
 - 1-bit priority / frame type
 - 1-bit reserved
 - 3-bit message type
 - 12-bit MTI or destination alias
 - 12-bit source alias



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ALIAS?

- Tricky to fit a 6-byte NodeID in a 29-bit header
- Trickier to fit two NodeIDs
- Over individual CAN segments, Nodes acquire a dynamic 12-bit alias
- Robust protocol to ensure uniqueness
- Transparent to higher levels



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DATA LINK LAYER

- Two Frame Types
 - CAN
 - Used mainly for alias allocation
 - OpenLCB



DATA LINK LAYER

- CAN Message Types
 - Check ID (CID)
 - Reserve ID (RID)
 - Alias Map Definition (AMD)
 - Alias Map Enquiry (AME)
 - Alias Map Reset (AMR)



DATA LINK LAYER

- OpenLCB Message types:
 - Global Message
 - Addressed Message
 - Datagram Fragment (only / first / middle / last)
 - Stream Fragment



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DATA LINK LAYER

- MTI format:

bits	meaning
10:11	Priority
5:9	Type within Priority
4	Simple Protocol
3	Dest Alias Present in Payload
2	EventID present in Payload
0:1	Type Modifier



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DATA LINK LAYER

Reserved	11000xxxxxxxxxxxxx[src 11:0]	0-8 bytes data
Global Message	11001[MTI 23:12][src 11:0]	0-8 bytes data
Addressed Message	11001[MTI 23:12][src 11:0]	Dest Alias + 0-6 bytes data
Datagram-only	11010[dest 23:12][src 11:0]	0-8 bytes data
Datagram-first	11011[dest 23:12][src 11:0]	0-8 bytes data
Datagram-middle	11100[dest 23:12][src 11:0]	0-8 bytes data
Datagram-final	11101[dest 23:12][src 11:0]	0-8 bytes data
Reserved	11110xxxxxxxxxxxxx[src 11:0]	0-8 bytes data
Stream	11111[dest 23:12][src 11:0]	0-8 bytes data



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MESSAGE / NETWORK LAYER

- Initialization Complete
- Verify NodeID Number (Global / Addressed) (VerifyNID)
- Verified NodeID Number (VerifiedNID)
- Optional Interaction Rejected (OIR)
- Terminate Due to Error (TDE)



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EVENT TRANSPORT

- Event Reports announce state changes
- Produced in response to a layout event
- Trigger a consumer to take some action
- Contain a 8-byte EventID
- Most fundamental interaction



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EVENT TRANSPORT

- Producer / Consumer Event Report (PCER)
- Learn Event
- Identify Consumer / Producer
- Identify Consumer / Producer Range
- Consumer / Producer Identified
- Identify Events (Global / Addressed)



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DATAGRAM TRANSPORT

- Datagrams are addressed
- Datagrams contain up to 72 bytes of payload
- Datagrams longer than 8 bytes must be split across multiple CAN frames



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DATAGRAM TRANSPORT

- Datagram (only)
- Datagram (first fragment)
- Datagram (middle fragment)
- Datagram (final fragment)
- Datagram Reply



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DATAGRAM TRANSPORT

- Received OK
- Rejected
 - Permanent Error
 - Datagram Type Not Accepted
 - Buffer Full (resend datagram)
 - Out of Order (resend datagram)



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STREAM TRANSPORT

- For moving large quantities of data
- Recipient has flow control
- Not meant for real-time streaming (e.g. live audio)



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STREAM TRANSPORT

- Stream Initiate Request
- Stream Initiate Reply
- Stream Data Send
- Stream Data Proceed
- Stream Data Complete



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APPLICATION LAYER

- Protocol Inquiry Protocol (PIP)
- Memory Configuration Protocol
- Configuration Description Information (CDI)
- Simple Node Identification Protocol (SNIP)
- Ident Method
- Remote Button Protocol
- Display Protocol
- Traction Control Protocol
- &c.



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MEMORY CONFIGURATION PROTOCOL

- Primary method for node configuration
- Uses datagrams to read and write to node memory
- 255 distinct address spaces available
- 32-bit addresses
- 1,099,511,627,520 distinct addresses
 - 1 terabyte of addressable memory



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CONFIGURATION

DESCRIPTION INFORMATION

- Describes the memory layout
- Provides human readable descriptions of configuration options
- Tells configurators how to read/write those options
- Contained in static XML that can be read directly from the node



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SIMPLE NODE IDENTIFICATION PROTOCOL

- Fast way to browse contents of NMRAnet
- Provides:
 - Read-Only manufacturer name and description
 - Read / Write user name and description



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CONFIGURATION TOOLS

- JMRI currently supports:
 - SNIP
 - CDI
 - Memory Configuration



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WHAT WE'RE WORKING ON

- Zigbee implementation
- Better configuration tools
- NMRAnet-based bootloaders
- Traction Control Protocol
 - And recommended practices for interfacing with DCC
- Topology Autodiscovery
 - For piecing together modular layouts on the fly



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USEFUL LINKS



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QUESTIONS?



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