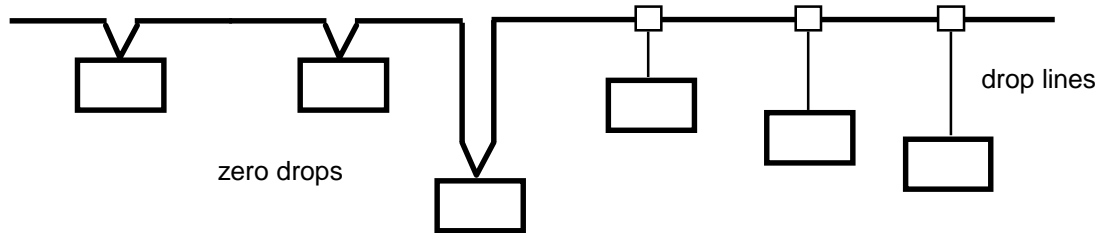


# CAN (Controller Area Network)

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- **CAN is open technology supporting multiple applications**
- **Chips available today from Intel, Motorola, Philips/Singnetics, NEC, Hitachi, Siemens**
- **Volumes from multiple industry usage insures downward price pressure** -over 5 million chips in 1995
- **Network has flexibility for now and future**
  - Master/slave, multiple master, and peer-to-peer
- **Currently in use in automobiles**
  - An excellent proxy for industrial applications
  - Temperature extremes, shock/vibration, high noise environment

# General Features



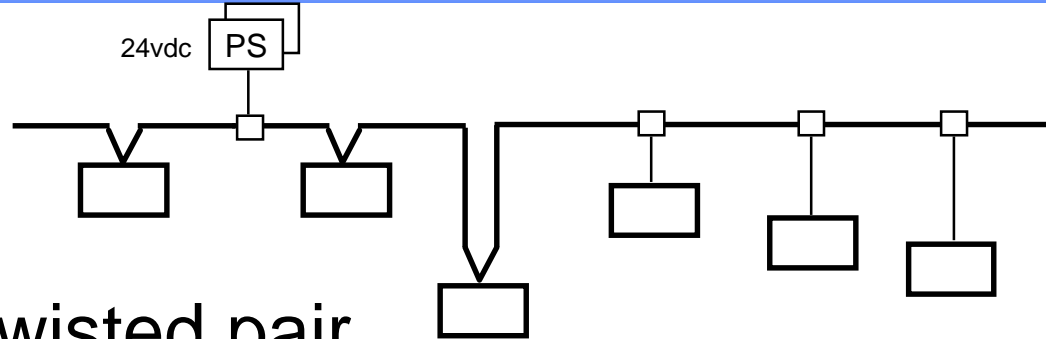
- Trunk line, drop line configuration
- Node removal without breaking trunk line
- Up to 64 addressable nodes
- Signal and 24Vdc Power in same cable
- Selectable Data Rates (125k, 250k, 500k)
- Both Sealed and Open-Style connections
  - zero node separation
- 121 ohm terminator at each trunk line end

# Speeds, Distances, and Drops

Data Rate	Trunk Distance (thick cable)	Drop Length	
		Max drop	Cumulative
<b>125K</b>	<b>500m (1640 ft)</b>	<b>6m (20 ft)</b>	<b>156m (512 ft)</b>
<b>250K</b>	<b>250m (820 ft)</b>	<b>6m (20 ft)</b>	<b>78m (256 ft)</b>
<b>500K</b>	<b>100m (328 ft)</b>	<b>6m (20 ft)</b>	<b>39m (128 ft)</b>

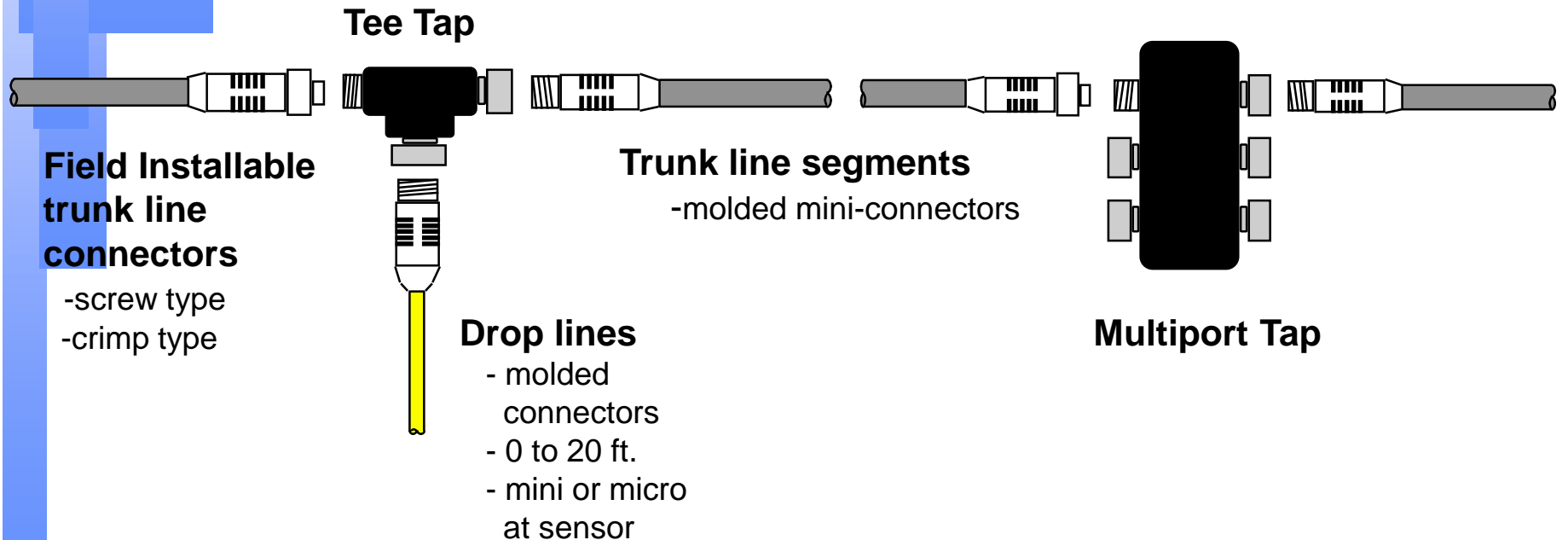
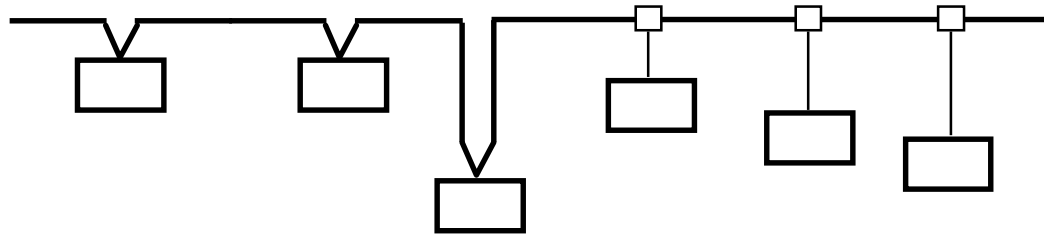
NOTE: Thin cable may be used as trunk. Maximum distance is 100 meters, regardless of data rate.

# Power and Signal

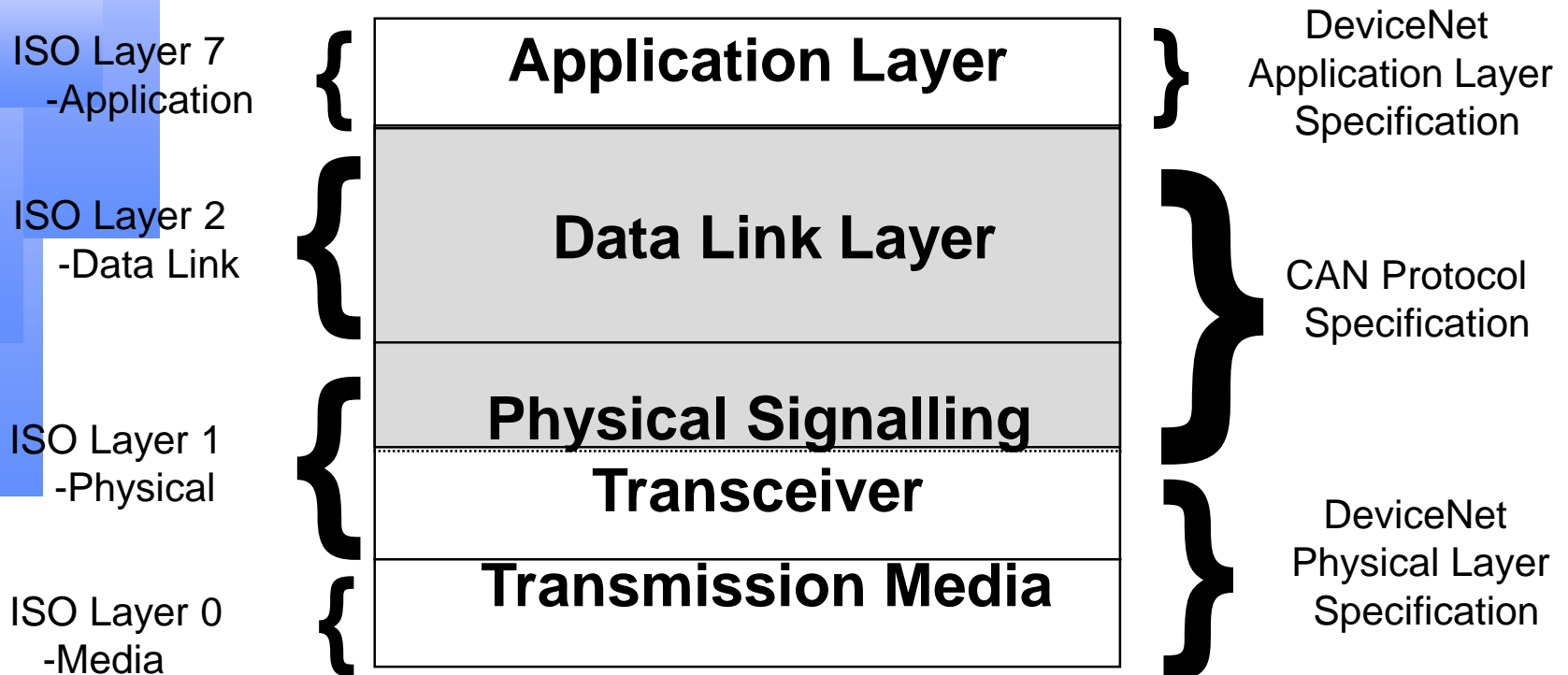


- Two twisted pair
  - Signal pair: low loss, high velocity with foil shield
  - Power pair: up to 8A capacity with foil shield
    - NOTE: Class II NEC Code limits current to 4A on any segment
  - Overall braid with drain wire
- Sensors can be powered direct from bus
- Opto-isolation for self powered devices
  - e.g. drive, PLC, weigh scale, etc.
- Multiple power supplies can be used
  - used for additional power or as back-up

# Typical Sealed-Style Taps



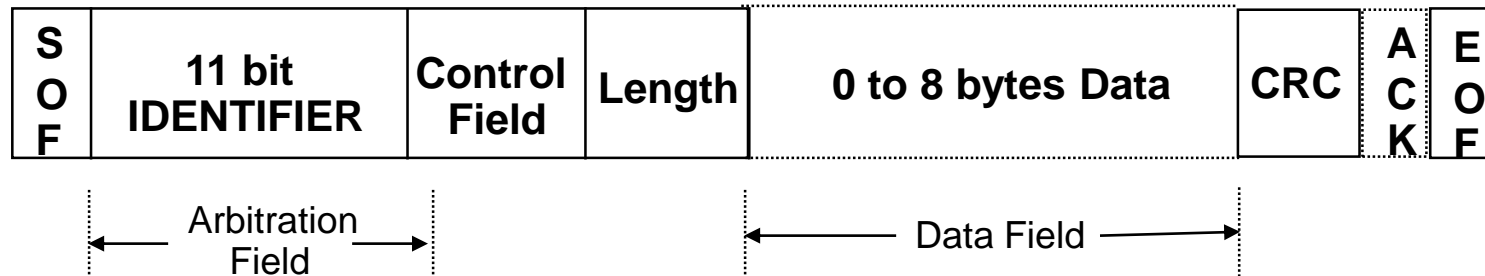
# CAN in the Stack



# Data Link Layer Characteristics

- **CSMA/NBA** - Carrier Sense Multiple Access with Non-destructive Bitwise Arbitration
- Any node can access bus when quiet
- Data portion of packet can be 0 to 8 bytes long
- Non-destructive bit-wise arbitration allows 100% utilization and message priority based on 11-bit packet identifier
- CAN provides automatic error detection, signaling, and retries

## CAN Data Frame Overview

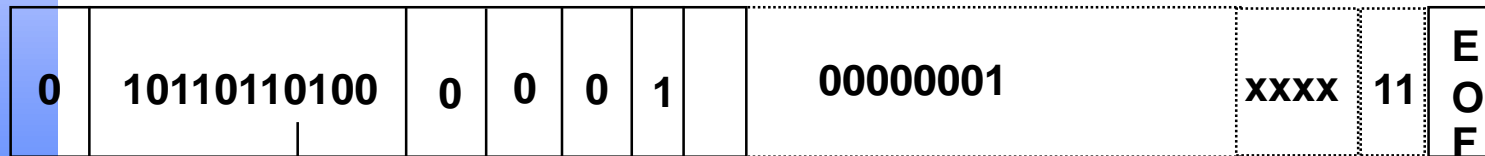


SOF - Start of Frame  
LEN - Data Length Code  
CRC - Cyclic Redundancy Code (CRC 16)

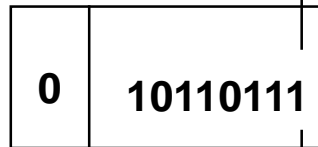
ACK - Acknowledgment

# CAN Arbitration Example

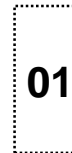
Node 1 Transmits:



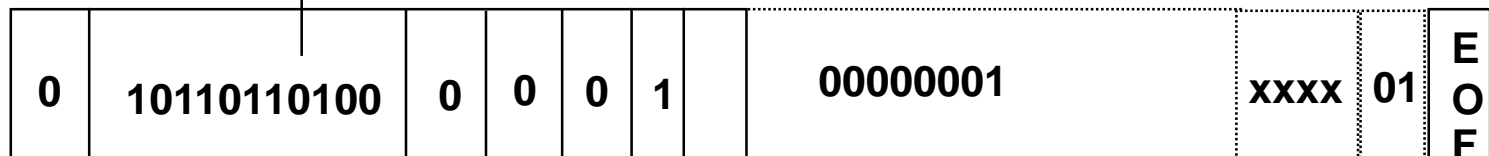
Node 2 Transmits:



Node 2 losing arbitration  
and stops transmitting!  
Node 2 still ACKs message.



As seen on the wire:



Arbitration  
Field



# CAN Error Detection

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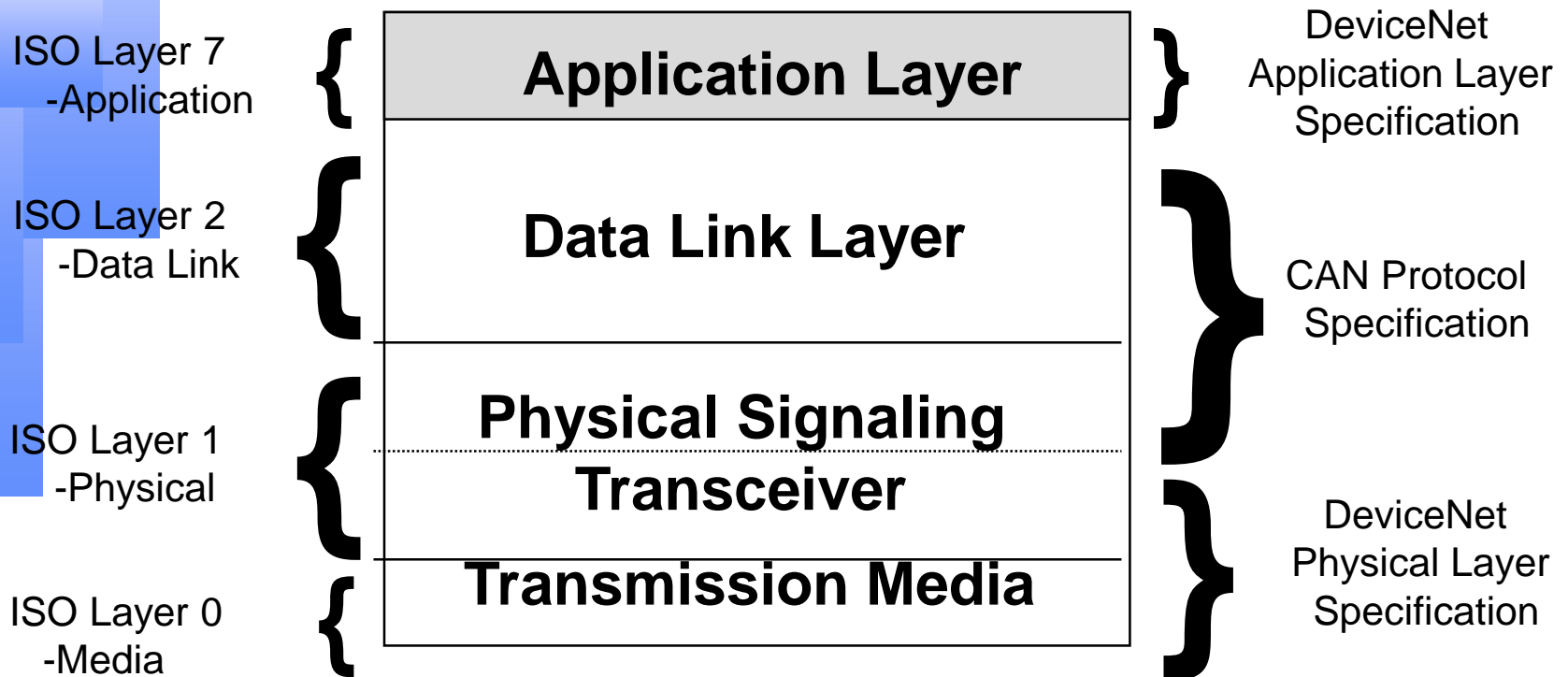
- **Bit Errors**
  - Transmitting node checks bit on bus versus what it sent
- **Stuff Error**
  - After 5 consecutive bits of same value, transmitter must insert opposite value bit
- **Acknowledgment Error**
  - All nodes respond in the ACK slot if they receive the message properly
- **CRC Error**
  - 16 bit transmitted value recalculated by receiving node
- **Form Error**
  - check for delimiter and other packet formats violations

# DeviceNet Supports Multiple Network Models and Data Movements

- Network Models
  - Master/Slave
  - Peer-to-Peer
  - Multi-master
- Data Movements
  - Change of State data
  - Cyclic Data Production
  - Strobed
  - Polled data

**Producer/Consumer Paradigm allows for multiple model support vs. limited Source/Destination**

# Application Layer



# Functions of Application Layer

- **CAN Identifier Assignment**
  - establishes priority in arbitration process
  - used by receiving nodes to screen for “their” messages
- **Two Messaging Types**
  - I/O Messages for Time Critical control data
  - Explicit Messages for typical Client/Server functions
  - Fragmentation supported for data greater than 8 bytes
- **Duplicate Node Address Detection**
  - each node must pass before going on line
- **Device Application Data Consistency**
  - Identity data: Type, Vendor, Cat. #, Serial #, ...
  - Comm Link data: Node Address, Baud Rate, ...
  - Device Config data: e.g., drive - Accel/Decel, Freq Control, ...

# Device Configuration Support

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- **Provide for User Friendly configuration**
  - Computer based, notebook, palmtop, etc.
- **Electronic Data Sheet (EDS)**
  - standardized ASCII file format
  - provides description of device attributes
    - name, ranges, eng. units, data type, etc.
  - public attributes from device profiles
  - vendor specific attributes
  - device vendor does once
    - all software vendors use as input
- **Parameter Object**
  - same content as EDS, but on board the device itself
  - no mismatches between tool and device/version

# Device Interchangeability

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- Standardized “Data Sets” (profiles) for various device types
- Allows user to substitute “logically” equivalent devices among vendors
  - only provides for same device types, data structures and meaning
  - NOT complete functional interchangeability
- User still has to determine “application” equivalency
  - accuracy, life, mechanical strength and mounting, environmental ratings, response time, capacity, etc.
  - this is the same as when replacing a device connected to an I/O point
  - substitution with another vendor’s product not likely if user has utilized any vendor specific parameters
- System can “key” devices to prevent illegal substitutions
  - For example, system can be configured to not accept a “reflective” photoeye for a “diffuse” photoeye