EtherNet/IP – Example of IP-based Industrial Network
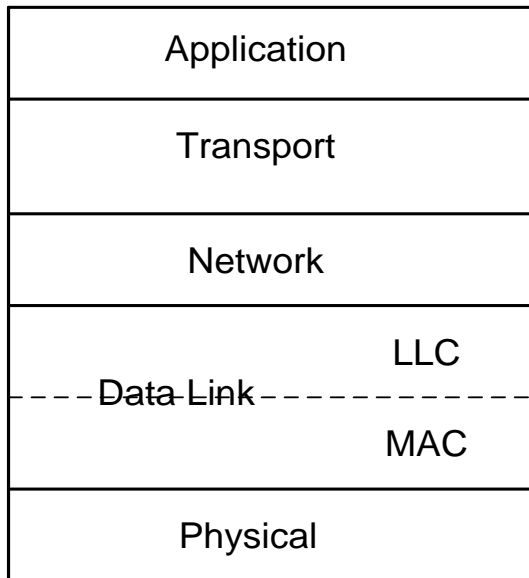
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Who is Rockwell Automation?

- Rockwell Automation is a leading supplier of industrial control products and solutions.

- Product examples include: programmable controllers, industrial software, motion control devices (electrical drives and motors), I/O modules to interface to various sensors and actuators, industrial computers and operator interface devices, and industrial networks.

- These products are used to build control systems utilized in various types of manufacturing including discrete part manufacturing (diapers, shaving blades), batch (beer, soup), and continuous process (metals, petrochemical).
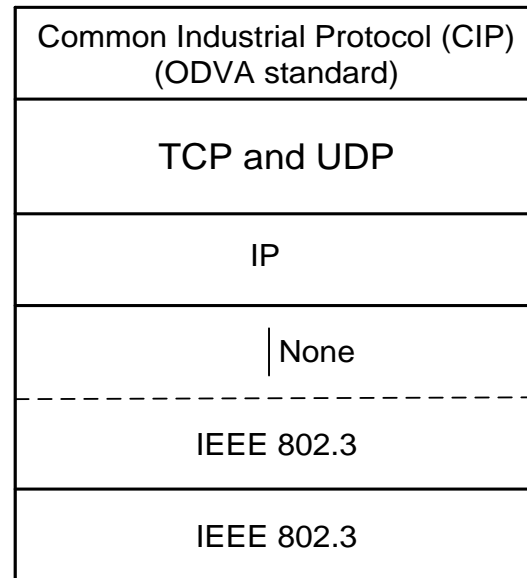
EtherNet/IP

- EtherNet/IP is an industrial local area network used as a control system backbone. EtherNet/IP specification is maintained by Open Device Vendor Association or ODVA. Simplified ENIP Architecture is shown below.

OSI Reference Model Layers	EtherNet/IP Layers
Application	Common Industrial Protocol (CIP) (ODVA standard)
Transport	TCP and UDP
Network	IP
Data Link — LLC / MAC	None / IEEE 802.3
Physical	IEEE 802.3

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EtherNet/IP (cont.)

- EtherNet/IP is 10/100Mbps half/full duplex network supporting copper and fiber media.

- EtherNet/IP application protocol, CIP, is a is connection oriented protocol, operating under assumption of unreliable layers below it.

- UDP is used for real-time communication (controller-to-I/O modules, controller-to-drives, controller-to-controller).

- TCP is used for non-real time communication.

- Ethernet/IP supports IEEE1588-based time synchronization using end-to-end delay measurement mechanism.

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Traffic Types

- Cyclic with short (few hundred microseconds) update periods
  - Examples:
    - Motion control (Controller-to-Drive and Drive-to-Controller)
    - Controller-to-Controller

- Cyclic characterized by relatively long update periods (typically 1-100 ms)
  - Examples:
    - Controller-to-Output Modules
    - Input Modules-to-Controller
    - 1588 traffic

- Event Driven (driven by change of state on an input or application triggered)

- Non-Real Time

IP- Supported Services

- Addressing (unicast/multicast)

- DSCP codes used for traffic prioritization

- Time To Live (TTL = 1 is used for traffic with local importance)

- Other Layer 3 protocols (e.g., IGMP) are also supported

Traffic Prioritization

Traffic Type	CIP Priority	DSCP	802.1D Priority (if used)	CIP Traffic Usage (recommended)
PTP Event (IEEE 1588)	n/a	59 ('111011')	7	n/a
PTP General (IEEE 1588)	n/a	47 ('101111')	5	n/a
Real-Time	Urgent	55 ('110111')	6	CIP Motion
	Scheduled	47 ('101111')	5	Safety I/O I/O
	High	43 ('101011')	5	I/O
	Low	31 ('011111')	3	not recommended
Non Real-Time	All	27 ('011011')	3	CIP messaging

Performance

- Performance goals are met using networks dedicated to different classes of service (motion control, I/O control, HMI)

- Other options aimed to improve performance:
    - VLANs
    - IGMP Snooping
    - QoS

Multiple Networks Example
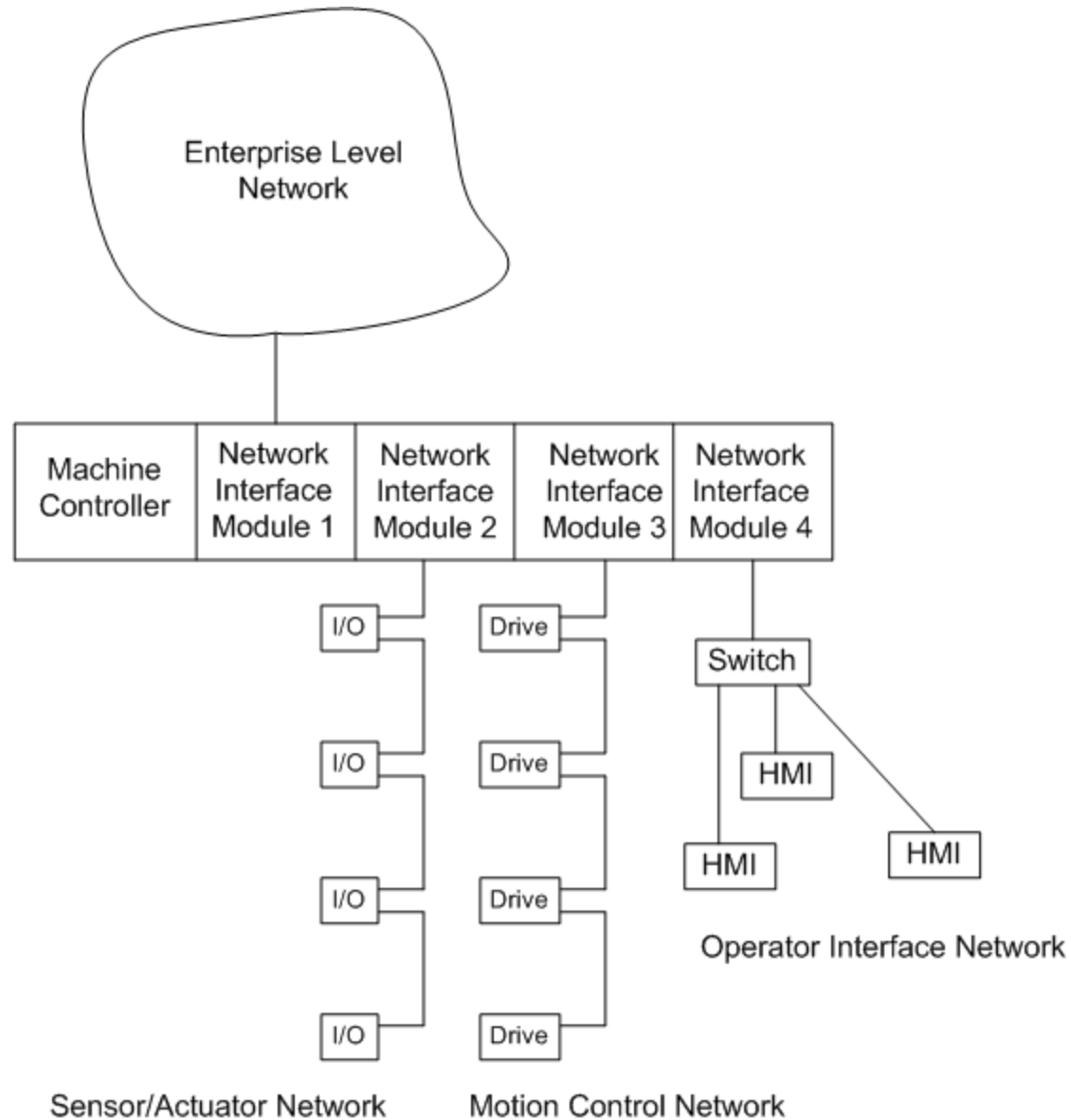
Performance Parameters

- Performance parameters of a typical EtherNet/IP motion control network:

    - Maximum number of nodes: 50

    - Message Transmission Period: 500μs

    - Average message data size: 125 bytes

Connectivity

- Link to plant network is a requirement these days

- Due to support of TCP/IP this connection is seamless

Redundancy

- Redundancy is achieved today through network duplication
  - Another ODVA network, ControlNet, is currently used

- Seamless redundancy is under consideration

Thank you for your attention