EtherNet/IP Design & Implementation Seminar
Solutions for Discrete, Motion, Safety, Process & Information Integration

Udaya Kumar, P.E.
Area Manager - Integrated Architecture
Rockwell Automation – St Louis

www.infoPLC.net
Agenda

- EtherNet/IP – Overview & Benefits
- EtherNet/IP – Key Terms, Topologies & Best Practices
- Embedded Switch Technology & Stratix Overview and Demo
- Multi-Disciplined Automation using EtherNet/IP – Overview
- EtherNet/IP Demo - Multi-Disciplined Automation
EtherNet/IP - Overview
EtherNet/IP - Overview
EtherNet/IP

Common Industrial Protocol (CIP) implemented on top of a Standard Ethernet stack (TCP/IP).

EtherNet/IP Encompasses all the different aspects of automation including these extensions:

Standard:
- IEEE 802.3 - standard Ethernet, Precision Time Protocol (IEEE-1588)
- IETF - Internet Engineering Task Force, standard Internet Protocol (IP)
- IEC - International Electrotechnical Commission – IEC 61158

is an open protocol managed by http://www.odva.org

EtherNet/IP - One network for all your automation needs
EtherNet/IP – World Wide Adoption

Source IMS Research

EtherNet/IP is the global leader for nodes sold
EtherNet/IP – Established (partial list)

300+ EtherNet/IP Vendors Registered
Benefits of EtherNet/IP

- Open protocol based on STANDARD Ethernet
- Seamless integration of automation system to business system
- IT Ready & Future Ready
- Multidiscipline control – discrete, motion, safety, drives & process
- Established – 300+ Vendors, over 4,500,000 nodes
- Topology to match your plant – Linear, Ring, Star & Mixed
- Scalable plant wide networks with 1,000s of nodes
Key Concepts & Network Topologies
Ethernet is a standard (IEEE) communications method developed for the building up of LAN’s or Local Area Networks.

**LAN:**

- Two or more computing devices linked together
- Network Interface in each device
- Cable or Radio to connect each device
- Infrastructure equipment (Switch, Router or Wireless AP) to send network traffic.
Layer 1 – Physical Layer
Infrastructure – Active Devices

- Hub – Multiport Repeater
- A hub is at the center of a star topology and utilizes twisted pair or fiber cable to connect to devices.
- A hub broadcasts everything it receives on any channel out all other channels …..

All nodes share 10 Mbps

One device sending at a time
**Switch**: a device that connects “nodes” to form a LAN (Local Area Network) Switches on the network recognize the MAC addresses of the attached nodes and record them into their own address table.

Multiple devices sending at the same time
MAC address

- The first 3 bytes represent the manufacturer the second 3 bytes represent the specific device from that manufacturer.
Layer 3 – Network Router

**Router:** Device which interconnects different physical segments or LAN’s via Routes.

Routers either learn dynamically or are told statically where different LAN’s reside and facilitate the transmission of data “Packets” among the networks. They connect LAN’s (Subnets) to form larger networks.

<table>
<thead>
<tr>
<th>Network</th>
<th>Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.17.10.0</td>
<td>1</td>
</tr>
<tr>
<td>10.10.10.0</td>
<td>2</td>
</tr>
</tbody>
</table>

Time-to-live (TTL)
- RA EtherNet/IP implementation for **multicast** – **TTL=1**
- RA EtherNet/IP implementation for **unicast** – **TTL=64**

Default Gateway
- 10.10.10.1
- 10.17.10.1

VLAN 17
Subnet 10.17.10.0/24

VLAN 10
Subnet 10.10.10.0/24

10.17.10.56

10.10.10.56
Layer 3 – Network Connecting Multiple LANS
Ethernet Terminology - Duplex

- Half Duplex
  - One station transmits, other listens.
  - If someone else transmits while you are transmitting, then a collision occurs
  - Any “Receive-while-Transmit” condition is considered a collision
  - Slower- can cause issues in the controls world

- Full Duplex (standardized in 802.3x)
  - Transmit and receive at the same time.
  - Transmit on the transmit pair, and receive on the receive pairs.
  - No collision detection, backoff, retry, etc.
  - Collision Free & Faster.

If one device is set to Full Duplex and other to Auto Negotiate, you may end up with Half Duplex resulting in slow traffic !!!
Ethernet Transmission Methods

One-to-one, individual transactions:
Example – Logix Message Instruction, Logix P/C Connection

One-to-many, single transaction:
Examples – IP Multicast, IP Surveillance, Webcast Streaming

One-to-all, single transaction:
Examples – ARP, RSLinx Classic RSWho Browse
Multicast Traffic - Overview

- Rockwell Automation uses Multicast traffic for class 1 messages on older firmware
- IGMP – Internet Group Management Protocol
- IGMP snooping is used to prevent multicast from flooding the network.
- Make sure IT is aware of multicast requirements

**Recommended to use Managed Switch with IGMP querier for multicast traffic management**
ODVA has specified QoS markings for CIP and PTP traffic. Using Rockwell Products like the Stratix 5700 recognize CoS and help you prioritize the traffic.
Network Segmentation

- **Why should you segment your networks?**
  - Improves performance
    - Provides efficient bandwidth utilization
  - Distributes traffic loading
  - Simplifies network security management
    - Creates domains of trust
  - Easier to maintain
    - Reduced administrative costs
  - Scalability
    - Framework for expandability
Virtual Local Area Networks (VLANs)

- Segmentation by VLANs
  - VLANs are logical subnets that are formed via software (configured in a managed switches)
  - Data is only forwarded to ports within the same VLAN
  - A layer 3 device is used to pass traffic between different VLANs
  - Provides flexibly in implementation—not constrained by hardware restrictions
  - Recommended method per Reference Architecture
Segmentation Models

By Function
- Robot Cell #1
- Robot Cell #2
- Robot Cell #3
- Robot Cell #4

By Layout
- Brewing
- Filling
- Packaging
- Shipping

By Traffic Type
- Enterprise
- HMI
- Control
- Video
VLAN Trunking for Layer 2 Switches

Switch WITHOUT Trunking
VLAN10 SW1 cannot talk to VLAN 10 SW2

Switch WITH Trunking
VLAN10 SW1 can talk to VLAN 10 SW2

The latest firmware for the Stratix 6000 does support VLAN Trunking

Stratix 8300 Layer 3 Switch
All VLANs can talk with each other

A Layer 3 Switch allows routing across VLANs and Subnets

Trunking – allows communications of like VLANs across multiple switches
Network Segmentation
Embedded Switch Technology & Stratix
Plantwide Network Architectures

**Star/Redundant Star**

- Controllers, Drives, and Distributed I/O
- Cisco Catalyst 3750 Stackwise Switch Stack
- Cell/Area Zone

**Ring**

- HMI
- Cisco Catalyst 2955
- Cell/Area Zone
- VFD Drive

**Linear**

- HMI
- Controllers, Drives, and Distributed I/O
- Cell/Area Zone
- 3750 Stackwise Switch Stack

**Device Level**

- Controller
- Servo Drive
- I/O
- VFD Drive

**Switch Level**

- EtherNet/IP
- I/O
- HMI
- Controller
- Servo Drive
- VFD Drive
- I/O
Embedded Switch Topology Overview

Technology that can help:

- Reduce port count requirements on base Ethernet switch
- Simplify configuration of the network
- Reduce cabling requirements
- Increase network resiliency
  - Device Level Ring – (DLR)
Linear Topology

Ideal applications include:
- Application covering more than 100 meters
- Migration from field bus network
Ring Topology (DLR)

Ideal applications include:

• Low cost resiliency requirement
• Migration from field bus networks
• CIP motion and CIP sync
DLR Enabled Products

- **ControlLogix EtherNet/IP module**
  - 1756-ENxTR

- **CompactLogix™ New PACs**
  - L1xER, L2xER, L3xER

- **Stratix™ ETAPs**
  - 1783-ETAP – 2 port copper
  - 1783-ETAP1F – 1 port copper 1 port fiber
  - 1783-ETAP2F – 2 port fiber
  - Enable single-port devices to join linear or ring topology

- **EtherNet/IP Devices**
  - Point I/O Adapter (1734-AENTR)
  - ArmorPoint I/O Adapter (1738-AENTR)
  - ArmorBlock I/O (1732E) – several versions
  - Kinetix 5500 & 6500 control modules – several versions
  - Flex I/O Adapter (1794-AENTR(XT))
  - SLC I/O Adapter (1747-AENTR)
  - ArmorStart
  - E1 & E3 Overloads
  - RFID products
How does DLR work?

- Supervisor blocks traffic on one port
- Sends beacon frames out of both ports to detect a break in the ring
Physical layer failure

- Link status messages are sent from the surrounding ring nodes to the ring supervisor to indicate the location of the break. Link status is in the form of MAC ID and IP Address information.
- After failure ring supervisor unblocks one port
- Network configuration is now a linear topology (faulted ring)
- Fault location is readily available
- If ring is restored, supervisor hears beacon on both ports, and transitions to normal ring mode
DLR Faceplate for FTVIEWSE

- Displays how many nodes are participating in the DLR
- Displays how many total rings faults have occurred
- Displays who is the DLR supervisor
- Also displays where the break is in the ring for ease of troubleshooting
Highlighted Features: Resiliency & Redundancy

When network availability is critical to the application

- Spanning Tree Protocol (STP/RSTP)
  - Mesh Topology
    - 1sec or more - recovery time
- Resilient Ethernet Protocol (REP)
  - Ring Topology
    - > 70 msec recovery time
- Device Level Ring
  - 3 msec recovery time for up to 50 devices

The right technology to meet your needs
NAT – Network Address Translation

Identical Machines are Less Expensive to Build, Install and Maintain

Plant Wide Network

Machine A

Machine B

Machine C

9300-ENA with NAT Application

PanelView™
192.168.1.2

Controller
192.168.1.1

Network Switch

Kinetix
192.151.186.1.3

Controller
192.168.1.1

Network Switch

Kinetix
192.168.1.1

Controller
192.168.1.1

Network Switch

Kinetix
192.151.186.1.3

9300-ENA with NAT Application

PanelView™
192.168.1.2

Controller
192.168.1.1

Network Switch

Kinetix
192.151.186.1.3

Controller
192.168.1.1

Network Switch

Kinetix
192.151.186.1.3

9300-ENA with NAT Application

PanelView™
192.168.1.2

Controller
192.168.1.1

Network Switch

Kinetix
192.151.186.1.3

Controller
192.168.1.1

Network Switch

Kinetix
192.151.186.1.3

Identical Machines are Less Expensive to Build, Install and Maintain

Plant Wide Network

9300-ENA with NAT Application

PanelView™
192.168.1.2

Controller
192.168.1.1

Network Switch

Kinetix
192.151.186.1.3

Controller
192.168.1.1

Network Switch

Kinetix
192.151.186.1.3

9300-ENA with NAT Application

PanelView™
192.168.1.2

Controller
192.168.1.1

Network Switch

Kinetix
192.151.186.1.3

Controller
192.168.1.1

Network Switch

Kinetix
192.151.186.1.3
9300-ENA can be configured to allow access to the controller on the plant-wide network, but blocks traffic and prevents access to other devices on the control network.
Stratix Switches & Stratix 5700 Overview
The Stratix Family

A unique line of industrial Ethernet switches – from plant floor to enterprise level applications

Stratix 2000 Unmanaged
- Port Configurations:
  - 4, 5, 7, & 8 port versions
  - Single fiber options

Stratix 6000 Fixed Managed
- Port Configurations:
  - 4 copper ports,
  - 8 copper ports plus 1 fiber

Stratix 5700 Managed
- Port Configurations:
  - Three port configurations (6, 10 and 20)
  - 2 to 4 fiber port options
  - Up to 2 gig ports

Stratix 2000 Unmanaged
- Port Configurations:
  - 4, 5, 7, & 8 port versions
  - Single fiber options

Stratix 6000 Layer 2

Stratix 2000 ETAPs

Stratix 5700 Layer 2

Stratix 8000/8300 Mod. Managed
- Port Configurations:
  - 6 to 26 ports
  - 6 & 10 ports base units with 2 port fiber option
  - 8 port copper & fiber expansion options
  - Up to 10 fiber ports
  - 2 gig ports
  - Layer 3 VLAN and subnet routing (8300)

Applications with small, isolated networks

Monitor and control distributed devices

Plant floor and enterprise integration
**Compact & Scalable**

- Premiere Integration to the Integrated Architecture
  - CIP interface
    - Studio 5000 AOP
    - ControlLogix tags
    - FactoryTalk View faceplates
- Built with Cisco technology (IOS)
  - Common feature set with Stratix 8x00
  - Common IT development tools
    - (CLI, CNA, DM, CiscoWorks)
- Simple to Deploy & Maintain
  - Easy integration
    - Default configurations
    - Common Smartports
    - DHCP per port IP addressing
  - Easy maintenance
    - Secure Digital card for configuration backup
    - Diagnostics & network management tools

**Best of Rockwell & Cisco in a compact size**
Hardware Features

- 3 base platforms offering 20 configurations
  - 6, 10 & 20 port base units
    - 6 copper & 4 copper + 2 SFP slots
    - 8 copper + 2 combo*
    - 16 copper + 2 combo* + 2 SFP slots
  - 2 Gig port option

- SFP slots support multi & single mode fiber

- Advanced feature set to address:
  - EtherNet/IP applications
  - Security
  - Resiliency & Redundancy

- Two software packages - Lite & Full versions

- Conformal coating option for harsh environments
Optional Software Feature Set

- Based of of Cisco IOS® Software
  - World’s leading network infrastructure software

- Common feature set and configuration tools with Stratix 8x00 family

- Software option:
  - **Lite** - Ideal for machine level networks with limited integration into a plant-wide infrastructure
  - **Full** – Ideal when machines that need to integrate with a converged plant-wide infrastructure
    - Includes IT-friendly features and functions

Hardware and software options helping to reduce your costs yet give you the performance & functionality you need
Premier Integration into the Integrated Architecture

**Device Profiles, Configuration Wizards, Operator Faceplates**

- Advanced status and diagnostic information
  - Logix Predefined Tags
  - Product identification
  - I/O connection
  - Port Status
  - Alarms
  - Broken wire detection
  - Save and restore
  - Link Status
  - Unauthorized device
  - Threshold exceeded
  - Bandwidth Utilization
  - Alarm relays
  - Port Control
Add On Profile (AOP)
Add Stratix switches into the project just like you would I/O, Drives, Communication modules
Simple configuration and diagnostic tags available in the profile
Advanced diagnostics, including broken wire detection

You don’t need to be an IT professional to configure or manage the switch
Smartports

- Are a set of recommended configurations that can be set on a specific switch port
- Pre-defined settings for common devices like Logix controllers, I/O, ETAPs, Desktop devices
  - Optimizes traffic through the network
  - Minimizes latency
- Create, modify, import, export and develop custom Smartport macros
  - Select the device to the assigned port, the configuration parameters are assigned to the port
  - Create your own Smartport to customize and develop your own standards

Simplifies deployment and commissioning of equipment
Cisco Command Line Interface - CLI

- CLI is the Cisco primary user interface for configuring, monitoring and maintaining Cisco devices.
- It is the primary tool used by IT professionals today.
- Used for advanced configurations:
  - Global macros and Smartports are simply user friendly CLI scripts.
- Available on Stratix 8000/8300 & 5700.

IT professionals know and understand the language, helps with product acceptance when IT is involved.
Configuration Copy and Backup Options

- Secure Digital (SD) support
  - Contains switch configuration and IOS
  - Simple device replacement
- Quickly duplicate and manage configurations
  - Standard configurations copied to:
    - Multiple SD cards
    - Multiple switches
  - Store and copy on a PC
    - Configuration file can be edited on PC as .txt file
    - Edit and copy to SD card for fast deployments
- Store configuration as part of Studio 5000 project

Simplify duplication & storing switch configurations
Easy Switch Replacement Simplifies On-site Maintenance

Get your machines back up and running FAST!

- SD card stores entire configuration
  - Operating system (IOS)
  - Configuration parameters
- Install SD card from failed switch into replacement switch
- Power on and the switch is back to its required configuration

NO PC, NO set-up, NO configuration required!
Industrial Connectivity
1585 Media and Fiber SFP

- M12 Connectivity
- 600V rated STP cable
- Small Form-Factor Pluggable
- RJ45 Connectivity

http://www.ab.com/networks/media/ethernet/
Best Practices & Troubleshooting
Best Practices

From “Top 10 Recommendations for EtherNet/IP Deployment”…

- Understand networked device requirements/application – priority, Ind vs Non-Ind
- Design for future plant expansion – use reference architectures
- Segmentation
  - Create zones/layers utilizing L2 & L3 switch hierarchies
  - Locate devices based on function, availability & performance
- Use managed switches
  - Loop detection, multicast traffic management, security, diagnostics
  - Supports PTP, QoS, IGMP, REP protocols to reduce network latency & jitter
- Install robust physical layer (media) – 1 GB uplinks, redundant paths, environment
- Apply appropriate security – physical, device, application, network

DLR – Application Guide

- How to construct/configure DLR network
- How to monitor DLR status
  - RSLogix5000, RSLinx, Device webpages, faceplates, programmatically (MSG’s)
- How to troubleshoot DLR networks
- Common Network Topologies

Remote Access

“Internal” or External?

- From Business Network to Plant Network
- From External Site to Plant Floor

Remote Site
- Plant Engineer
- Machine Builder
- System Integrator

Enterprise Systems

Industrial Plantwide Systems

WAN

DMZ

192.168.1.x

10.10.10.x
Remote Access – recommended path

1. Remote engineer or partner establishes VPN to corporate network; access is restricted to IP address of plant DMZ firewall

2. Portal on plant firewall enables access to industrial application data and files
   - Intrusion protection system (IPS) on plant firewall detects and protects against attacks from remote host

3. Firewall proxies a client session to remote access server

4. Access to applications on remote access server is restricted to specified plant floor resources through industrial application security
Remote Access – Internal 9300-ENA

- Linux-based Ethernet network appliance
- Translates up to 128 Ethernet devices
- Simple web configuration
- Supports 1:1 NAT and Range NAT
- Limits remote access to specific IP addresses

1:1 NAT

Range NAT
Remote Access – Rockwell Virtual Engineer

Virtual Support Engineer Software Agent
- RA 200R industrial PC installed on machine
- Remote Access for Customer, OEM, or Rockwell

Scalable Solution
- **Remote Access**
  - Connection to Service Center
  - Ability to remotely connect to your assets
  - Remotely program machines

- **Remote Access and Alarming**
  - Receive alarms on critical tags (up to 100)
  - Analytics on all assets

- **Application Support** – Custom Quote
  - Alarms delivered to Rockwell Automation Application Engineers
  - Designated engineers assigned to your account
  - Guaranteed response times
Ethernet Capacity Tool
Ethernet Capacity Tool

- Flex I/O Rack: 15
- No. of Update Rate (msec): 20
- PowerFlex 525 Drive: Node Group 2
- Scanner Processor: CompactLogix L3ER
- Ethernet/IP: 32 slots at 128 Mbps
- I/O Packets per second: 9550 at 6760 usable
- EtherNet/IP Capacity Tool
- EtherNet/IP Node 5: Node Group 5
Ethernet Capacity Tool
Ethernet References

- Ethernet/IP Design Considerations
  - [Link](http://literature.rockwellautomation.com/idc/groups/literature/documents/rm/enet-rm002_en-p.pdf)

- Media Planning and Installation Manual
  - [Link](http://www.odva.org/portals/0/library/publications_numbered/pub00148r0_ethernetip_media_planning_and_installation_manual.pdf)

- Segmentation Methods within the Cell/Area
  - [Link](http://literature.rockwellautomation.com/idc/groups/literature/documents/at/enet-at004_en-e.pdf)

- Troubleshooting Ethernet/IP Networks
  - [Link](http://literature.rockwellautomation.com/idc/groups/literature/documents/at/enet-at003_en-p.pdf)
Stratix, DLR & NAT Demo
EtherNet/IP For Automation
EtherNet/IP & CIP - Overview

Common Industrial Protocol (CIP) implemented on top of a Standard Ethernet stack (TCP/IP).

- Time synchronization on EtherNet/IP
- CIP Motion: Controller to Controller & Drive to Drive motion synchronization
- CIP Safety: Scalable, routable, network-independent safety protocol

EtherNet/IP - One network for all your automation needs
CIP Sync - Overview

- CIP Extension
  - Defines time synchronization services and object
  - Allows distributed control components to share a common notion of time for CIP Networks

- Implements IEEE-1588 precision clock synchronization protocol
  - Referred to as precision time protocol (PTP)
  - Provides +/- 100 ns synchronization (hardware-assisted clock)
  - Provides +/- 100 µs synchronization (software clock)

- Time Synchronized Applications such as:
  - Input time stamping for
    - Alarms and Events,
    - Sequence of Events (SOE)
    - First fault detection
  - Time scheduled outputs
  - Coordinated Motion
EtherNet/IP For Discrete Automation
Logix for Discrete Automation
EtherNet/IP for Discrete Automation

Linear

Mixed

Ring
EtherNet/IP for Discrete Automation

L3 CompactLogix with multiple device level rings
EtherNet/IP for Discrete Automation

- **Premier Integration of IO devices to the control system**
  - IO and devices are defined and configured in the IO tree using AOP
  - Predefined tags for the devices are created for data exchange
  - Controller has enhanced status/information about the device
  - Allows user to leverage Rockwell and third party face plates for easy integration
  - Diagnostic information to aid in maintenance & troubleshooting IO devices

- **Typical IO devices for discrete automation**
  - Distributed IO - ControlLogix, Point IO, Flex IO, Armor Point IO, Armor Block IO, SLC IO
  - Drives - PowerFlex 755, 753, 700, 70, 525, 40, 40P, 4 & ArmorStart
  - Stratix Switches – Stratix 8000, 8300, 5700, 6000
  - Other Devices – Encoder, MCC, E1 Plus, MultiSight Vision, PowerMonitor & RFID
CIP Sync – SOE Example

Clocks on the Network are synchronized to +/- 100 Nanosecond Resolution

System Time Source Grad Master Clock

Boundary Clock

Boundary Clock

Transparent Clock

Please refer to publication ia-at003__en-p.pdf for CIP Sync application guidelines
EtherNet/IP For Motion Control
CIP Motion - Overview

- Traditional approach to motion control
  - Network Scheduling (time-slot)

- CIP Motion approach
  - Pre-determined Execution Plan for position path, based on a common understanding of time between the motion controller and drives …… where to be and at what time

- CIP Motion based servo drives includes:
  - Kinetix 350
  - Kinetix 5500
  - Kinetix 6500
EtherNet/IP based Motion Control

Kinetix 6500

Kinetix 5500

Kinetix 350

Kinetix 300
## EtherNet/IP Servo Drives - Capabilities

<table>
<thead>
<tr>
<th>Model</th>
<th>Power Range</th>
<th>110V</th>
<th>230V</th>
<th>480V</th>
<th>Embedded Switch Technology</th>
<th>CIP Motion</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinetix 300</td>
<td>0.4…3.0 kW</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Safe Torque-off Control, ISO-13849-1 Certified, PLd, category 3</td>
</tr>
<tr>
<td></td>
<td>continuous output power</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinetix 350</td>
<td>0.4…3.0 kW</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Safe Torque-off Control, ISO-13849-1 Certified, PLd, category 3</td>
</tr>
<tr>
<td></td>
<td>continuous output power</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinetix 5500</td>
<td>0.2…14.6 kW</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Safe torque-off control, ISO-13849-1 certified, PLd, category 3</td>
</tr>
<tr>
<td></td>
<td>continuous output power</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinetix 6500</td>
<td>1.8…22 kW</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>TÜV certified, SIL CL3, PLe, category 4 safety performance</td>
</tr>
<tr>
<td></td>
<td>continuous output power (inverter)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These drives support various rotary & linear actuators.
Servo Rotary Motors/Actuator Options

- **TLY** Compact Servo Motors
- **MPL** Low Inertial Servo Motors
- **MPF** Food Grade Servo Motors
- **MPM** Medium Inertial Servo Motors
- **MPS** Stainless Steel Servo Motors
- **VPL** VP Low Inertia Servo Motors
- **RDD** Direct Drive Servo Motors
<table>
<thead>
<tr>
<th>Feature</th>
<th>Logix Motion on CIP Motion</th>
<th>Logix Motion on SERCOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axes supported per controller (position mode)</td>
<td>Up to 100 axes on ControlLogix Up to 16 axes on CompactLogix</td>
<td>Up to 32 axes on ControlLogix Up to 8 Axis on CompactLogix</td>
</tr>
<tr>
<td>Motion Interface needs</td>
<td>No needs for dedicated card CIP motion uses Eth/IP (ENxT up to 8 or 128 axes)</td>
<td>Need a SERCOS network card (3,8, 16 axes)</td>
</tr>
<tr>
<td>Motion network topology &amp; flexibility</td>
<td>Star, linear, ring or hybrid topology, with any combination of EtherNet devices.</td>
<td>Limited to a Ring Topology only (maximum of 16 drives/ring)</td>
</tr>
<tr>
<td>High performance drive control</td>
<td>Simplified tuning with robust out-of-box results. Load Observer functionality</td>
<td>Basic tuning functionality. No Load Observer</td>
</tr>
<tr>
<td>Extensive Motion diagnostics</td>
<td>Time stamped Fault &amp; Alarm logs. Drive diagnostic Tools(web page)</td>
<td>No time stamped logs Drive diagnostic on K6200 only (via EtherNet/IP)</td>
</tr>
<tr>
<td>Easy 3rd party motor integration</td>
<td>Rotary/Linear permanent magnet AC motor on PF755 only</td>
<td>No easy integration of PM motor AC motor only with Kinetix 7000</td>
</tr>
<tr>
<td>Single Coarse Update Rate throughput</td>
<td>20 R/W tags, MRP, Registration</td>
<td>2 read tags only, Multiple CUR for registration and MRP</td>
</tr>
</tbody>
</table>
Discrete & Motion with CompactLogix L1
Each document also shows the complete BOM. We also have these popular drawings for L3 & L2 controllers.
Popular Configuration Drawings

- Includes – Quick Product Specs, Basic Architecture, BOM
- Available for L1, L2, L3 & CIP Motion
- Literature Library - IASIMP-QR019, QR020, QR025, QR026, QR028
EtherNet/IP For Safety Control
CIP Safety - Overview

- CIP Extension
- High-integrity Safety Services and Messages for CIP
  - Data redundancy - data sent twice (actual & inverted)
  - Safety CRC redundancy – actual & inverted
  - End-to-end Safety CRCs - individual CRCs for data (actual & inverted) and overall message
  - Every packet is time stamped
- IEC 61508 – SIL3 and EN 954-1 - Cat 4
- Two behaviors must be implemented:
  - Real-time transfer of safety data
    - Safety Validator Object
      - Client (Device producing safety data)
      - Server (Device consuming safety data)
    - Safety Messages
  - Configuration of safety devices
    - Safety Supervisor Object
      - Originator (Device originating connection)
      - Target (Target of connection origination)
    - SafetyOpen, SafetyOpen Response
Full 1oo2 Architecture

- GuardLogix safety system provides complete dual channel operation
  - CIP Safety I/O devices have full dual channel behavior
  - GuardLogix 1oo2 design provides full independent dual channel behavior
  - No single point of failure
  - Superior diagnostic coverage due to two independent processor designs in critical components

- Two controllers are used to obtain high integrity
  - Primary contains and executes both standard control and safety logic
    - Safety isolated from standard
  - Partner contains and executes only safety logic

Data redundancy
Safety CRC redundancy
End-to-end Safety CRCs – individual CRCs for data and for overall message
Every packet is time stamped
Safety Integrated Logix Controllers

- Enhanced ControlLogix /CompactLogix Processor with Integrated Safety Partner creates a SIL 3 capable controller

- RSLogix5000
  - Safety Task automatically created with tools that restrict user to Safety functions
  - Single controller view

- Safety Control - Safety Task
  - Restricted set of features and functions
  - Safety Certified Standard Instructions
  - Safety Certified Application Instructions
  - Security (Safety Task Signature, Locking)
  - Safety I/O automatically mapped into safety memory

GuardLogix Controllers
1756-L71S, L72S, L73S
GuardLogix Safety Partner
1756-L7SP
Safety I/O on EtherNet/IP

- **CompactBlock Guard I/O on EtherNet/IP**
  - 1791ES-IB8XOBV4 - 8 Safety IN, 4 Bipolar Safety OUT
  - 1791ES-IB16 - 16 Safety IN

- **POINT IO Safety on EtherNet/IP**
  - 1734-IB8S - 8 Point Safety Sink Input
  - 1734-OB8S - 8 Point Safety Source Output
  - 1734-IE4S – 4 Point Safety Analog Input Module

- Combine your safety and standard I/O into one distributed I/O platform

Safety modules can communicate over STANDARD EtherNet network
GuardLogix as a Multidiscipline Controller

Safety & Standard IO can use the same Point IO adapter
Safety IO can leverage standard Ethernet network
Kinetix – Safety Features

- Integrated Safe Torque Off – Kinetix 300/350/5500
  - Performance Level d (PLd) and safety category 3 (CAT 3) per ISO 13849-1

- Enhanced Safe Off or Advanced Safety with Kinetix 6500
  - **Safe Torque Off** - Drive output is safely disabled to eliminate motor torque without removing power from the entire machine – Meets SIL CL3, Cat. 4, PL e safety performance
  - **Advanced Safety** - Monitor the speed of your application. If in excess of the safe speed you have defined, initiate Safe Stop – Meets SIL CL3, Cat. 4, PL e safety performance. Other advanced safety functions include Safe Direction, Safe Max Acceleration, Zero speed Monitoring.

---

Rockwell Automation offers PowerFlex Drives with PLd safety
EtherNet/IP For Process Control
EtherNet/IP for Process Automation

- **Engineering Work Station**: RSArchitect, RSLogix 5000, FactoryTalk View Studio
- **Operator Work Stations**: FactoryTalk View SE
- **Asset Management**: FactoryTalk Asset Centre

---

- **Process Controller**
  - 1756 Hart IO
  - Flex HART
  - Discrete Analog
  - HART

- **Drives**
  - EN2H1
  - FF H1
  - EN2PA
  - Profi PA

- **EtherNet/IP Motor Control Centers**
EtherNet/IP based Process Instruments

Industry First – EtherNet/IP Instruments from Endress+Hauser

- **The Promag 53** sensors can measure most liquids with a minimum conductivity of 5 µS/cm. A minimum conductivity of 20 µS/cm is required for measuring demineralized water. Together with the Ethernet technology, this opens up new possibilities in the areas of process monitoring, quality assurance and plant safety.

- **The Promass 83** and the new compact **Promass 100** sensors allow multiple process variables to be measured at the same time: Mass flow, density, temperature and even viscosity. Together with the Ethernet technology, these devices open up completely new possibilities in the areas of process monitoring, quality assurance, and plant safety.

These instruments can be setup & configured in RSLogix via AOP
EthereNet/IP for Profibus PA Instrument Integration

- Configuration & Diagnostics in AOP
- Add devices while online
- Auto device discovery and configuration
- • Supports 24 devices on a single segment
  - 8 Input & 8 Output PVs per field
- Redundancy Options
  - Redundant linking devices
  - Redundant PA media
  - EtherNet/IP Device Level Ring
  - Redundant Controllers

1788-EN2PAR EtherNet/IP to Profibus PA Gateway

Product Profile
1788-pp005_en-p.pdf
EthereNet/IP for Foundation Fieldbus Instrument Integration

- Configuration & Diagnostics in AOP
- Add devices while online
- Auto device discovery and configuration
- Supports 16 devices on a single segment
  - 8 Input & 8 Output PVs per field device
- Redundancy Options
  - Redundant linking devices
  - Redundant FF media
  - EtherNet/IP Device Level Ring
  - Redundant Controllers

1788-EN2FFR EtherNet/IP to Foundation Fieldbus Gateway

Product Profile
1788-pp004_en-p.pdf
EthereNet/IP for Foundation Fieldbus Instrument Integration

1788-EN2FFR EtherNet/IP to Foundation Fieldbus Gateway
ControlLogix Redundancy

- Leverage Ethernet/IP for I/O
- Use EtherNet Linear & Ring Protocol.
- Support for 1715 Redundant IO platform
- ControlLogix Redundancy system switches IP address of the EtherNet adapters on switchover.

Refer to publication 1756-um535_en-p.pdf for more information on how to design a ControlLogix Enhanced Redundancy System
EtherNet/IP for Process Automation
OEM Skid
EtherNet/IP – Multi-Disciplined Demo
EtherNet/IP Demo Setup
EtherNet/IP Demo Setup
EtherNet/IP – Multi-Disciplined Demo

- AOP & Device Configuration – PowerFlex Drive & Encoder
- EtherNet/IP Diagnostics – Webpage
- Motion Demo – Kinetix 300 & Kinetix 6500
- Safety Demo – Safe Off & Advanced Safety
- Process instrument integration – HART & Profibus PA
- Information Integration – 9300 ENA & ViewPoint Demo
Why EtherNet/IP for Automation?

- EtherNet/IP is **STANDARD** Ethernet
- Deploy **STANDARD** network for plant wide automation and information integration.
- Ease of integration & reduce engineering cost
- Remotely design, monitor, troubleshoot the entire system
- Provide rich diagnostic information about devices
- Single network for multi-disciplined automation!
- Automation to business system integration

EtherNet/IP provides ability to simplify architecture while lowering cost.
Thank You