The CIP Motion Peer Connection for Real-Time Machine to Machine Control

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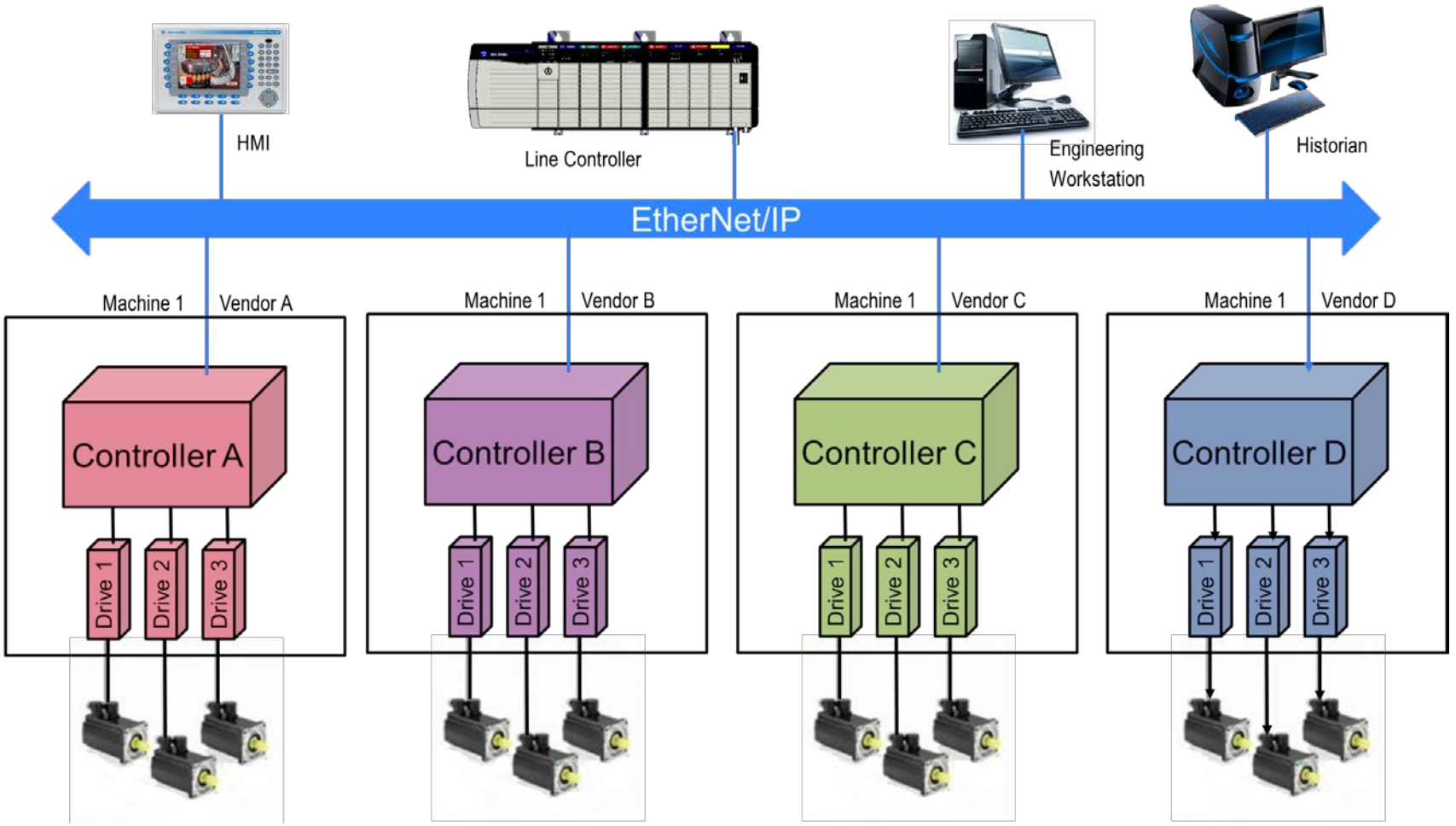
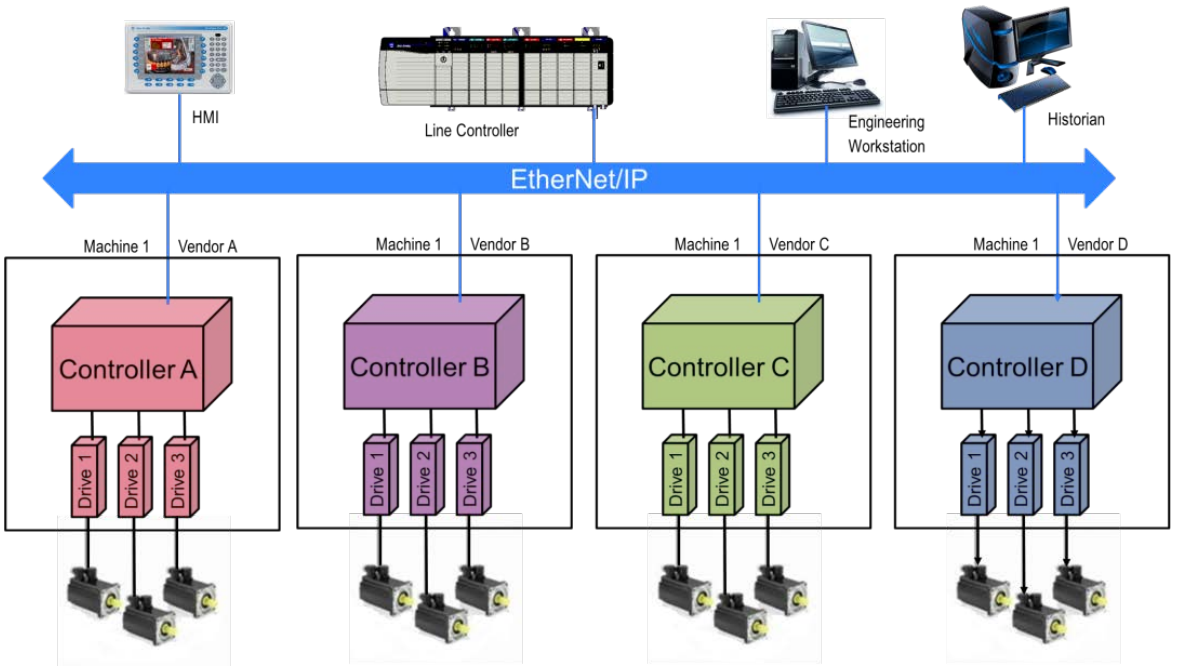
Technical Track

Today's Motion Market Lacks a Real-Time Machine to Machine Standard



Today's Motion Market Lacks a Real-Time Machine to Machine Standard

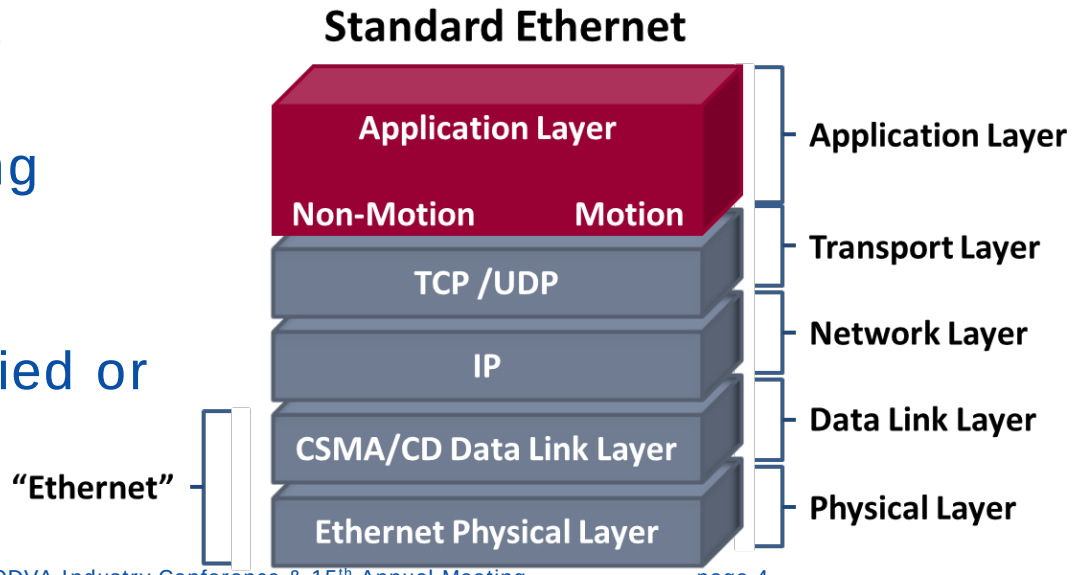
- There is no existing Machine to Machine Technology for real-time coordination
- Existing physical layer is available for line control and can carry this information between controllers.
- Vendor drive technology is unaffected.



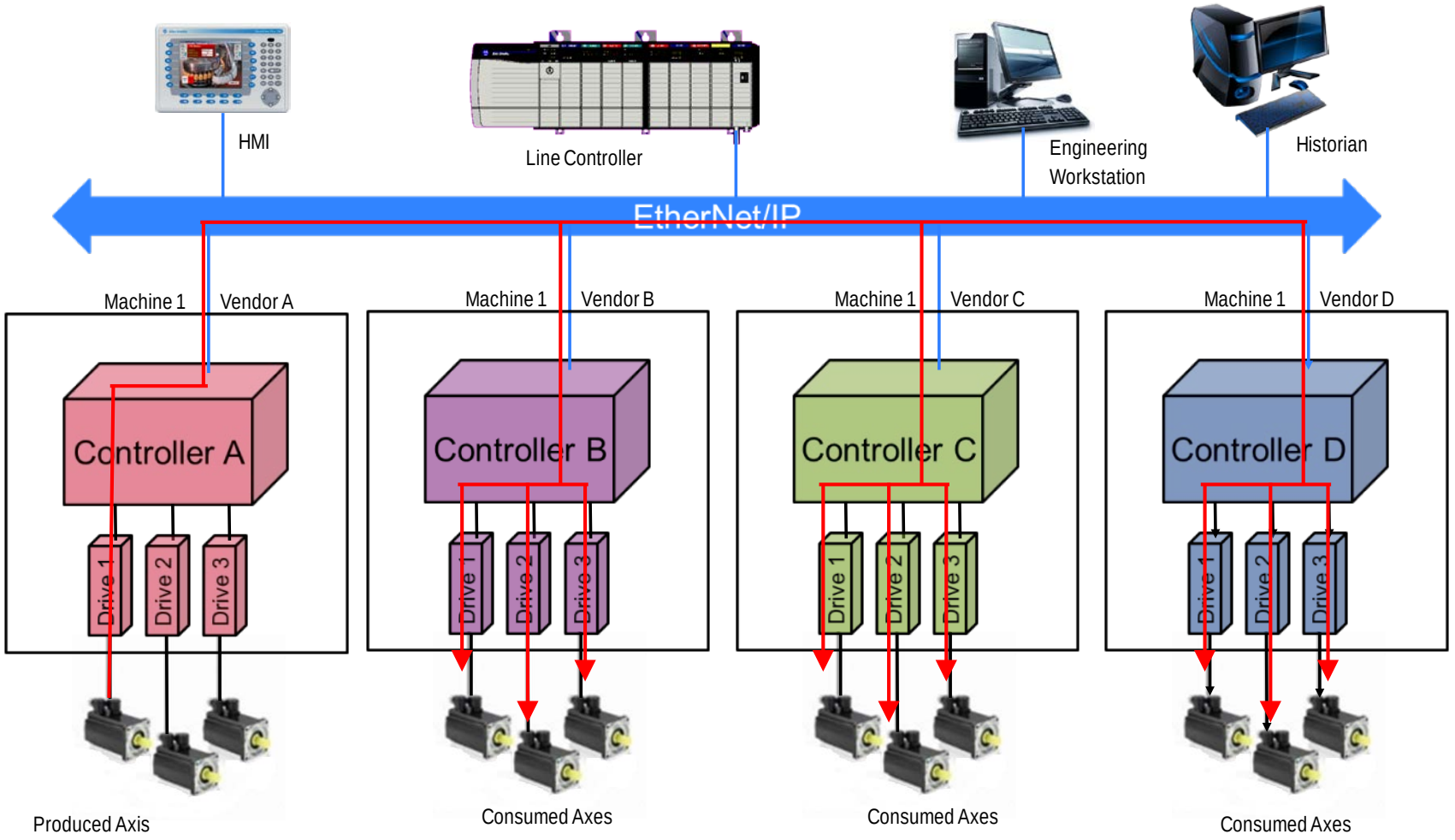
CIP Motion Peer Connection

Built on Standard Ethernet Stack

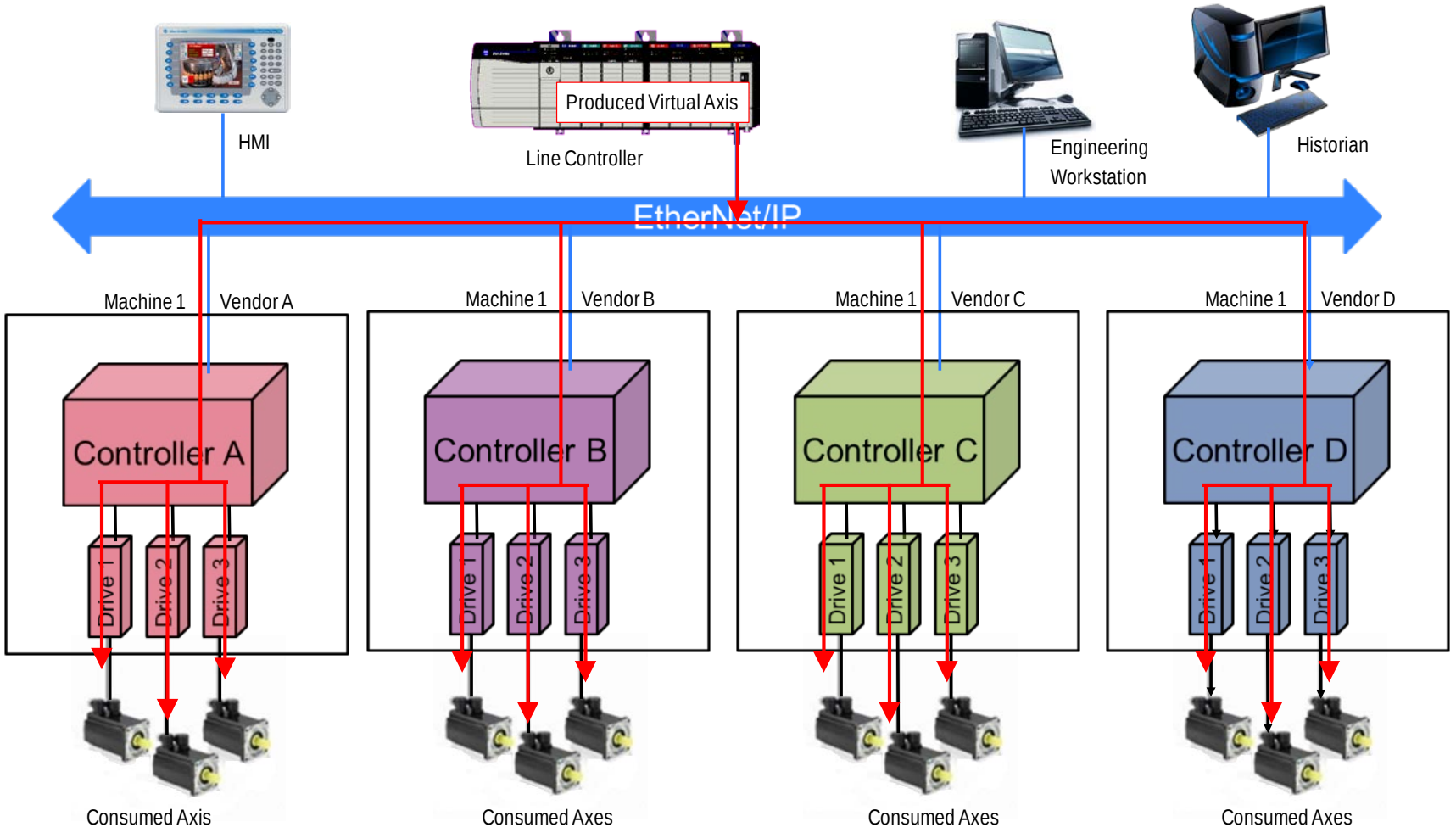
- Allows for layering of real-time information on existing line control network
  - CIP Sync technology provides the reference for real-time interpolation or extrapolation of position across a multi-vendor configuration
- Uses existing Ethernet stacks typically used in today's HMI, Engineering Workstations, and Historian Products
- Allows for non-intrusive distribution of real-time motion information for gearing and line-shafting applications.
- Vendor core drive technology is not modified or changed.



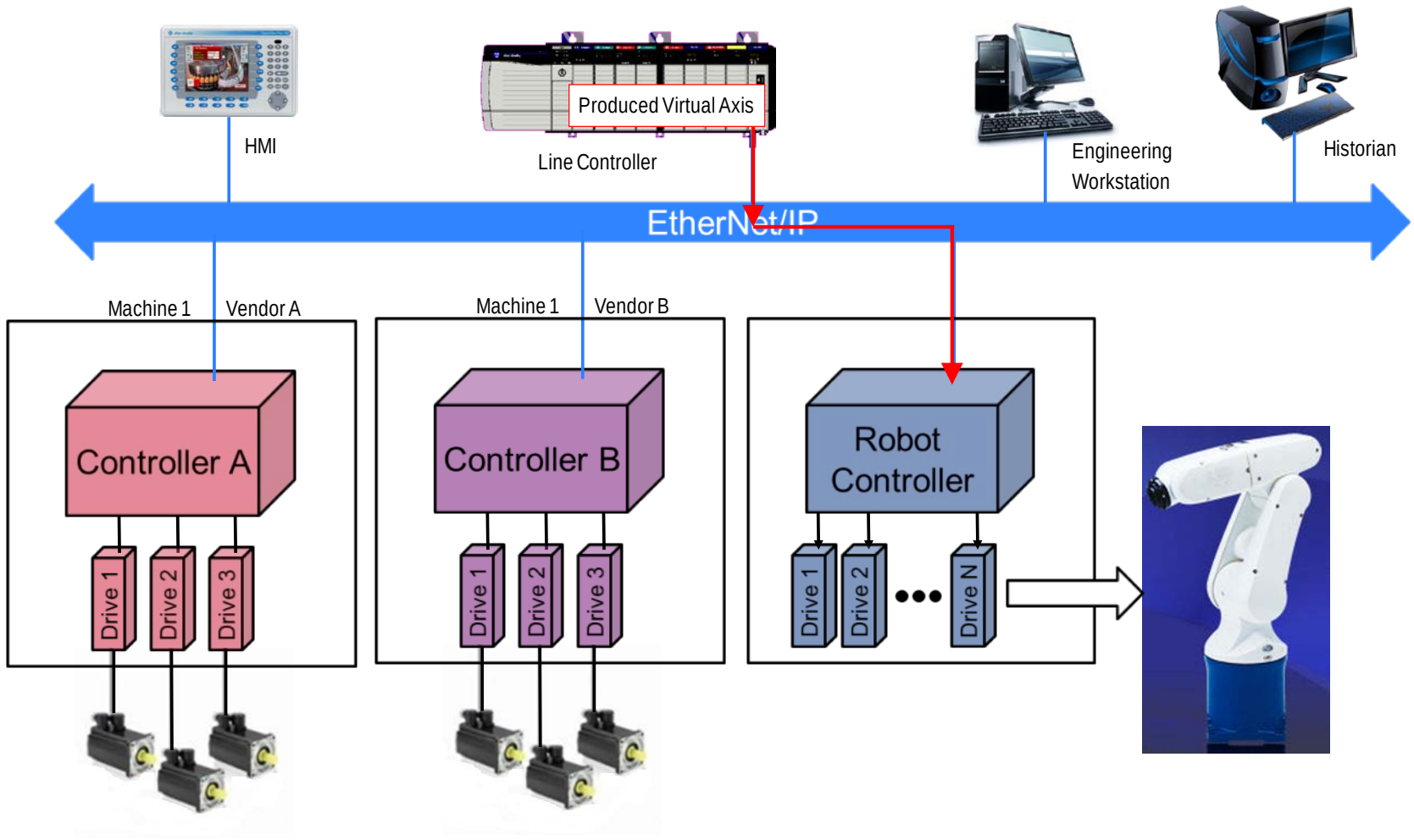
Use Case 1: Produced Axes from Vendor A to Vendors B, C, & D



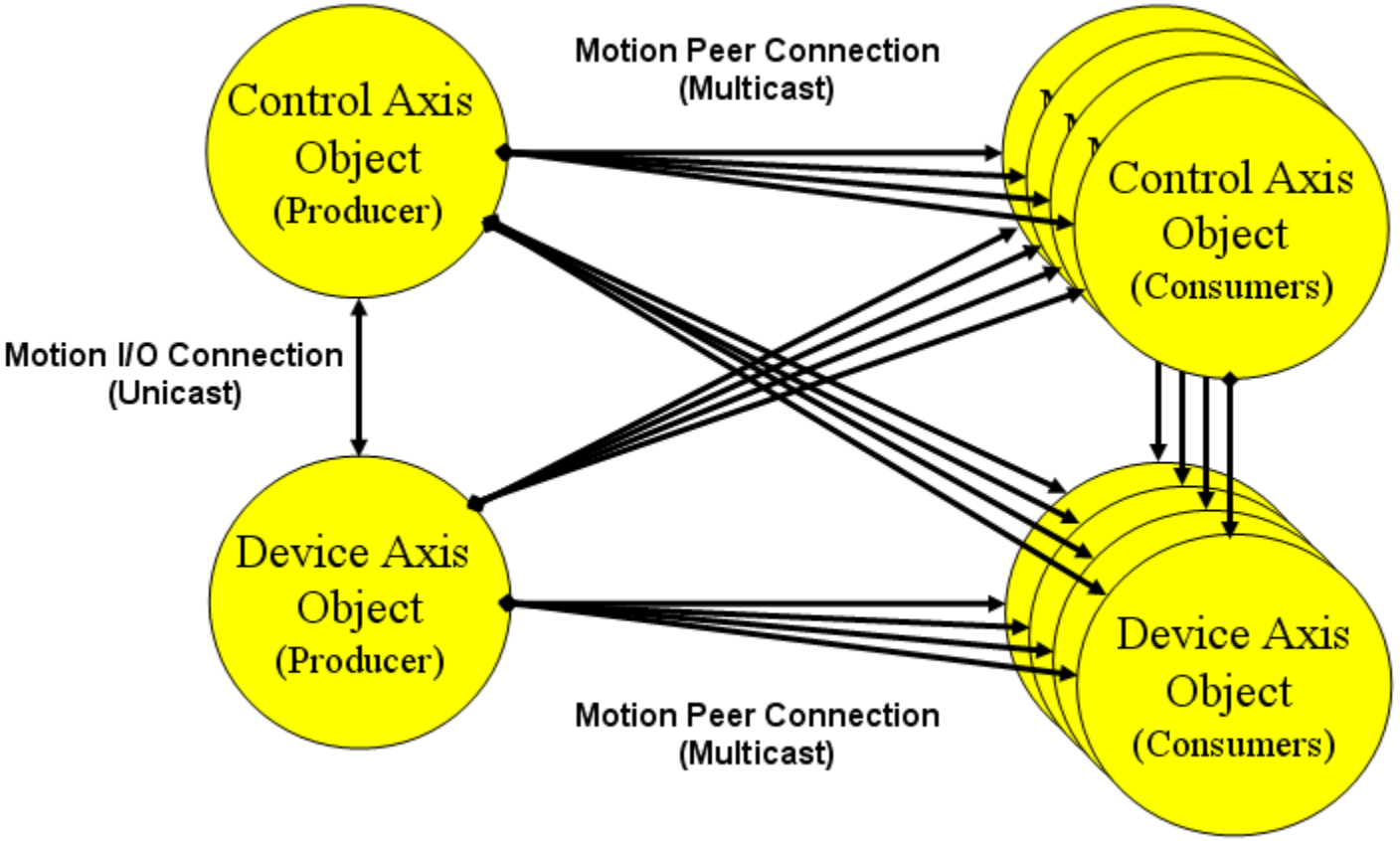
Use Case 2: Produced Virtual Axis from Line Controller



Use Case 3: Produced Virtual Axis To Robot Controller



The CIP Motion Peer Connection Object Model



Proposed CIP Motion Peer Connection

← 32-bit Word →

Peer Connection Format
Connection Header
Instance Header
Instance Data Block

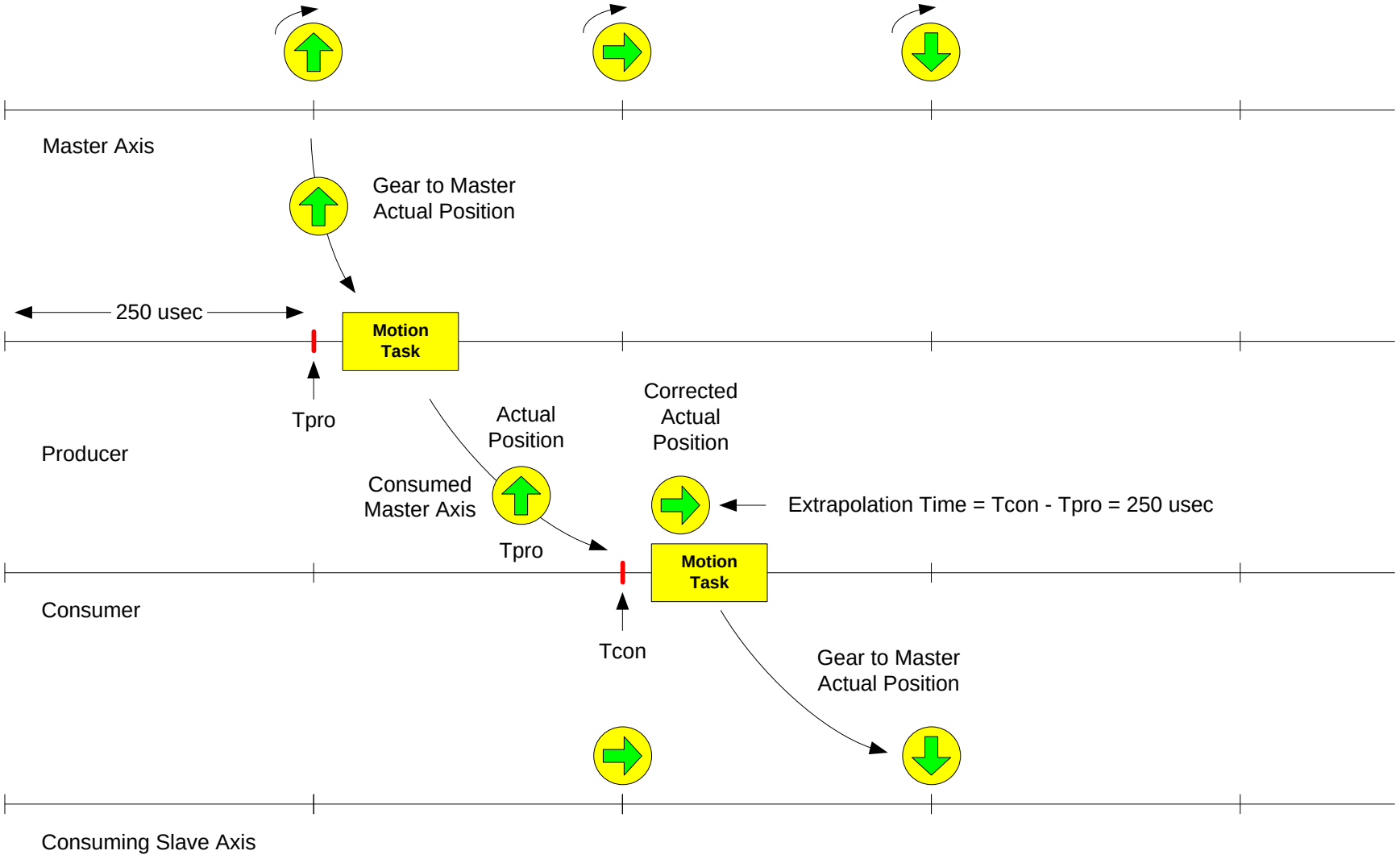
Connection Header			
Connection Format	Format Revision	Update ID	Node Status
-	Node Fault/Alarm	-	Time Data Set
Producer Time Stamp			
Producer Time Offset			

Instance Data Block		
Instance Number	Cyclic Blk Size	Attr Blk Size
Cyclic Data Block		
Attribute Data Block		

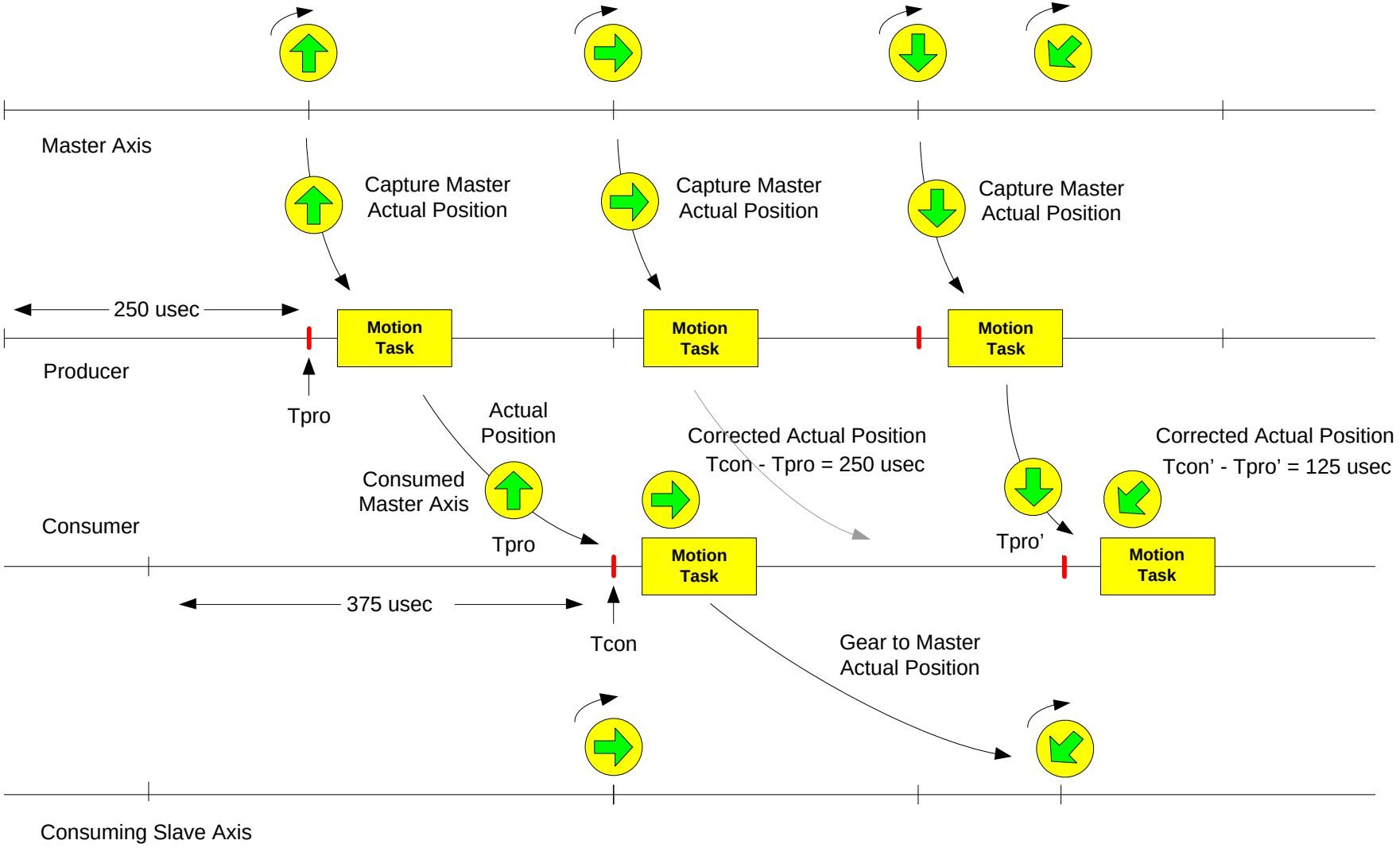
Cyclic Data Block			
Control Mode	Feedback Mode	Axis State	Axis Config
Command Data Set	Actual Data Set	Status Data Set	Cyclic Data Control
Unwind			
Command Data 1			
Command Data 2			
...			
Actual Data 1			
Actual Data 2			
...			
Status Data 1			
Status Data 2			
...			

Attribute Data Block		
Cyclic Attr 1 ID	Attr 1 Dimension	Attr 1 Element Size
Attr 1 Start Index (array only)	Attr 1 Elements (array only)	
...	...	
Cyclic Attr 1 Data		
...		

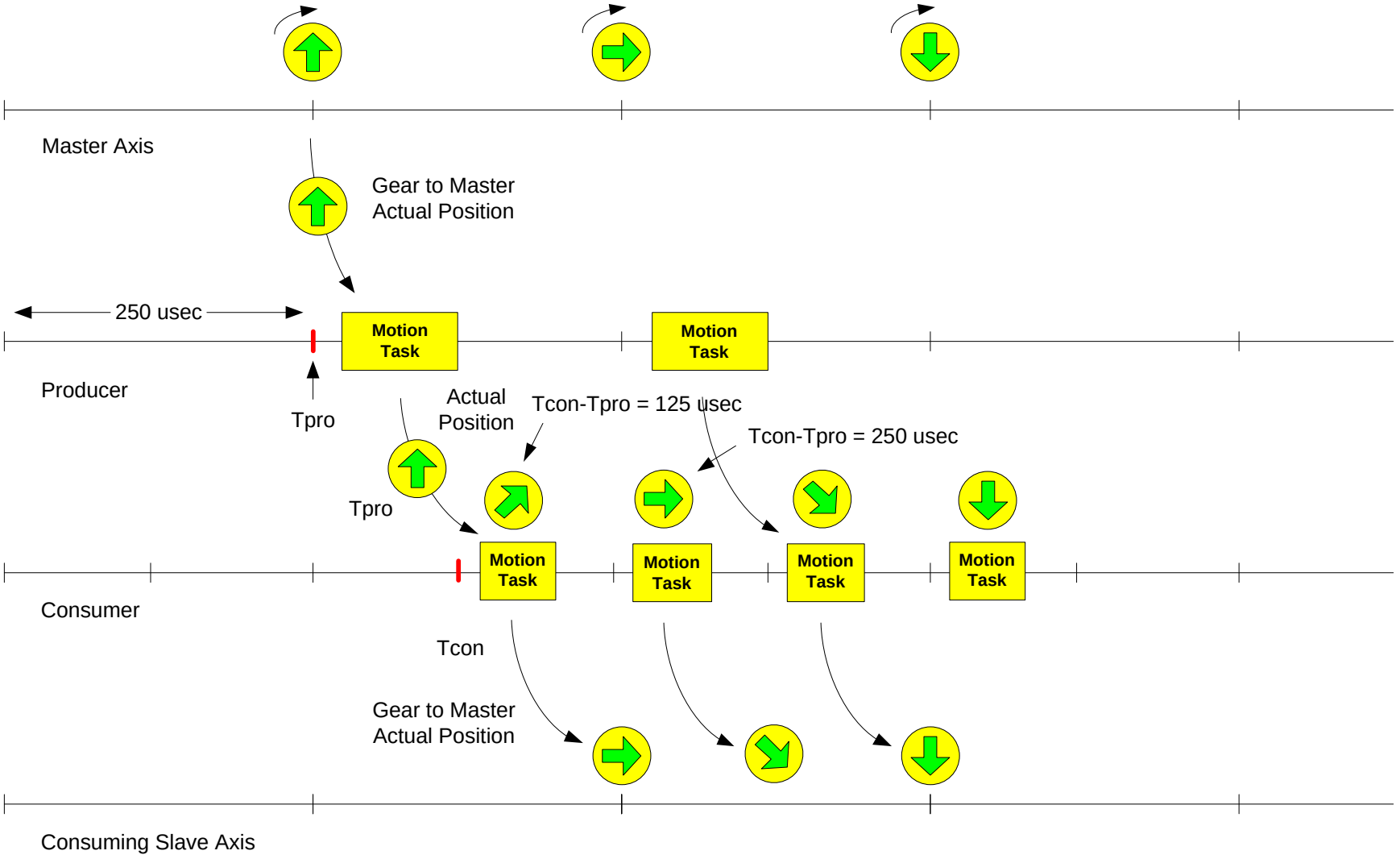
Command Position and Time Stamp Allow for Proper Interpolation / Extrapolation



Time Stamp Correction with Fast Producer and Slow Consumers



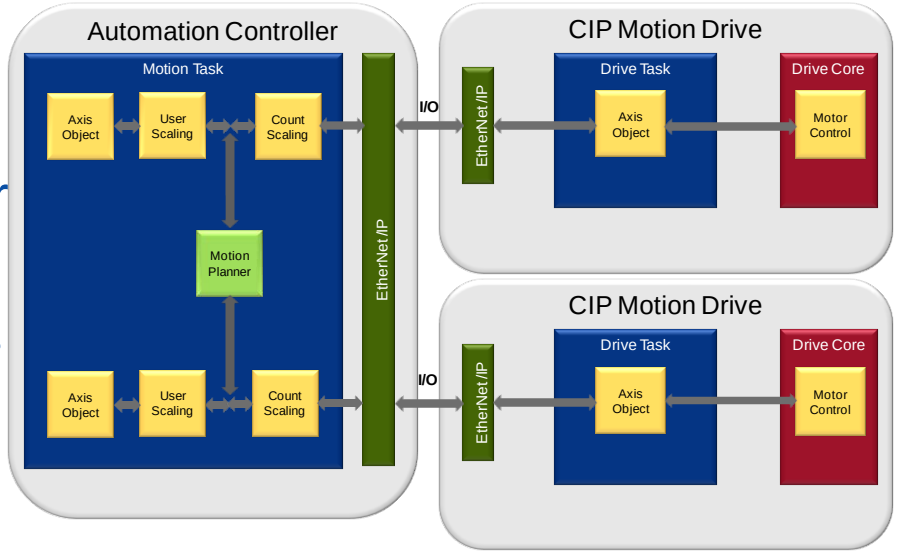
Time Stamp Correction with Slow Producer and Fast Consumers



The CIP Motion Peer Connection for a Distributed Motion Architecture

The Traditional Centralized Motion Planner Model Allows for Easy Coordination of a Multi-Axis System

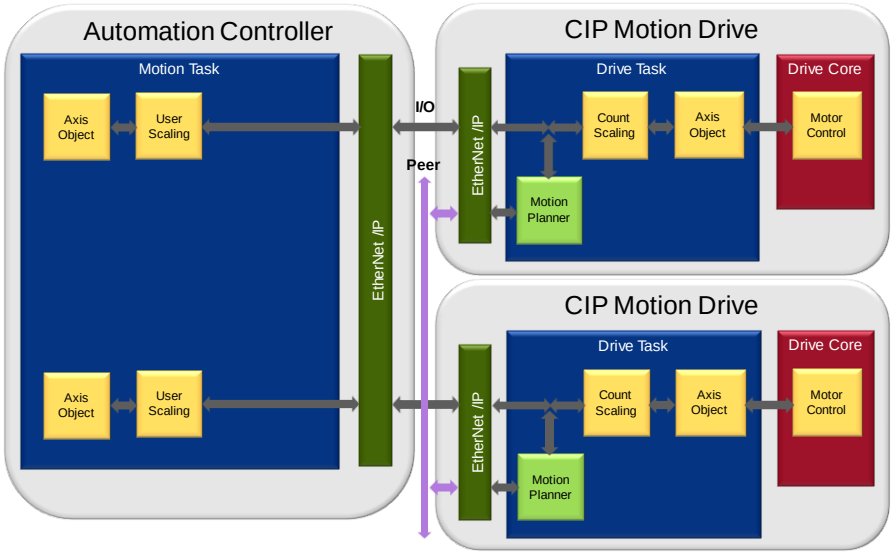
- All coordination is managed from a single controller
- Single programming environment for programming and execution of motion control
- However, system performance is dependent on the power of a single controller
- Communications between the controller and the axes can be highly loaded



The CIP Motion Peer Connection for a Distributed Motion Architecture

The advent of the CIP Motion Peer Connection Enables the Migration of the Motion Planner to the Drives

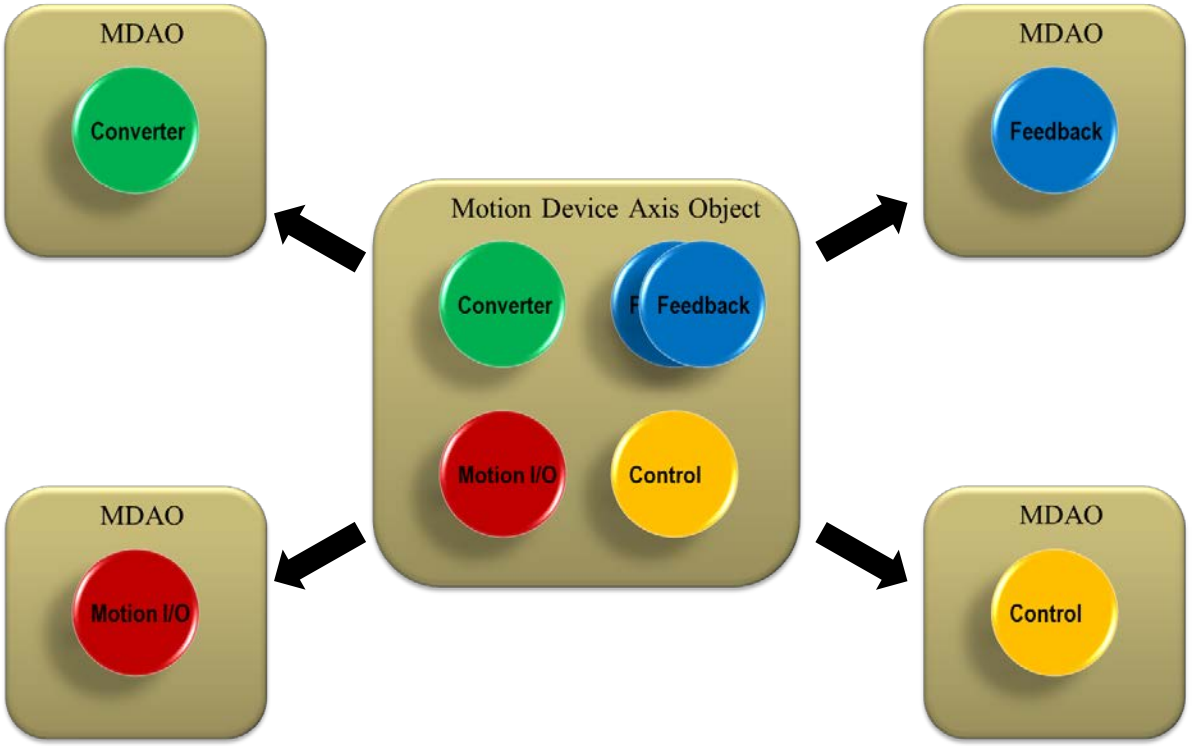
- Distributes performance throughout the system
- Real-time communications between the controller and the drives is dramatically reduced
- System performance capacity easily increases by an order of magnitude
- Real-time communications is shared across the Peer Connection from drive to drive



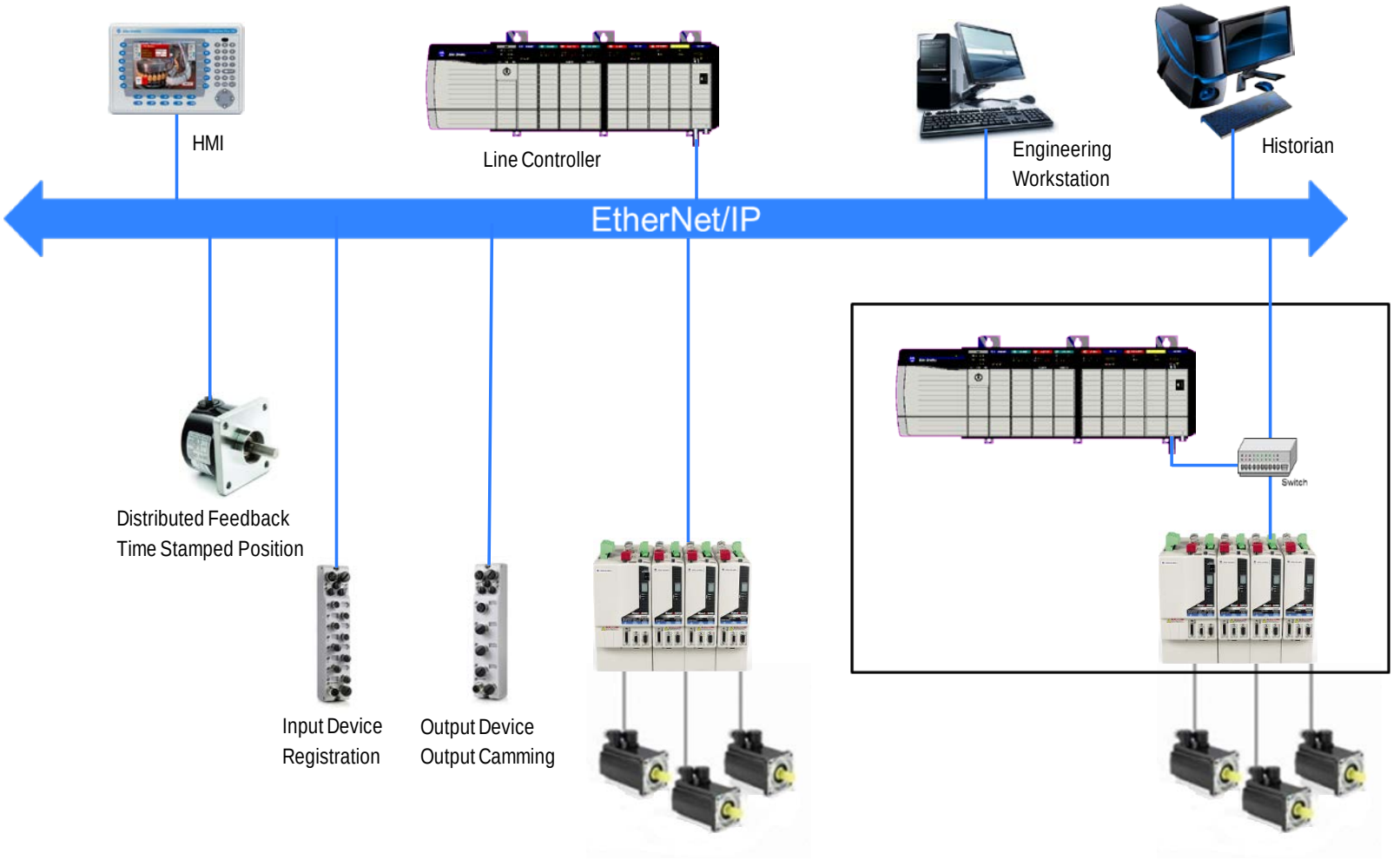
Distributed Motion Functionality

Current Trends in Lean Drive Design Push for the Offloading of Motion Functions to Distributed Devices

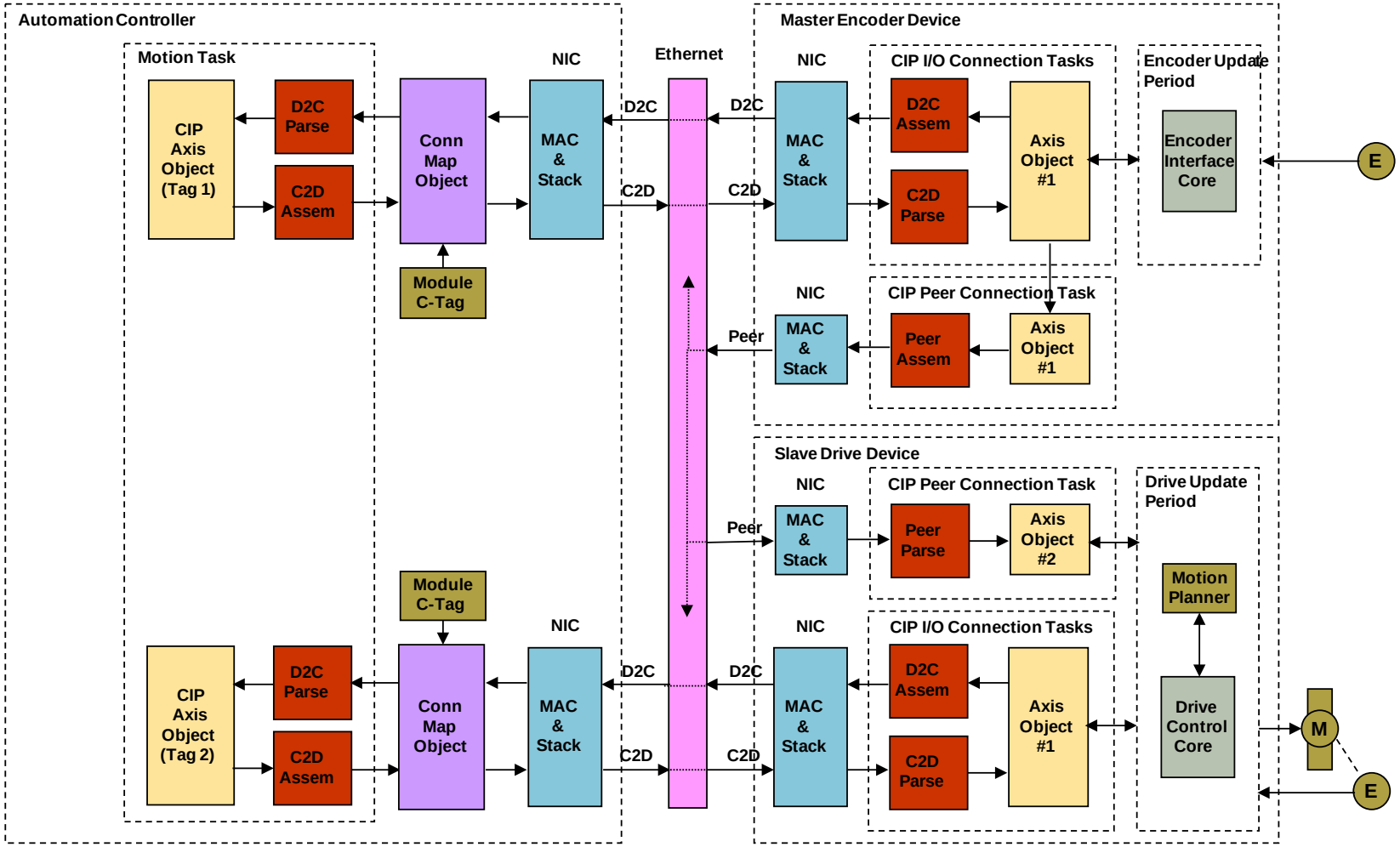
- Feedback
- Motion I/O
- Control
- Converter



Distributed Motion Functionality



Feedback Device

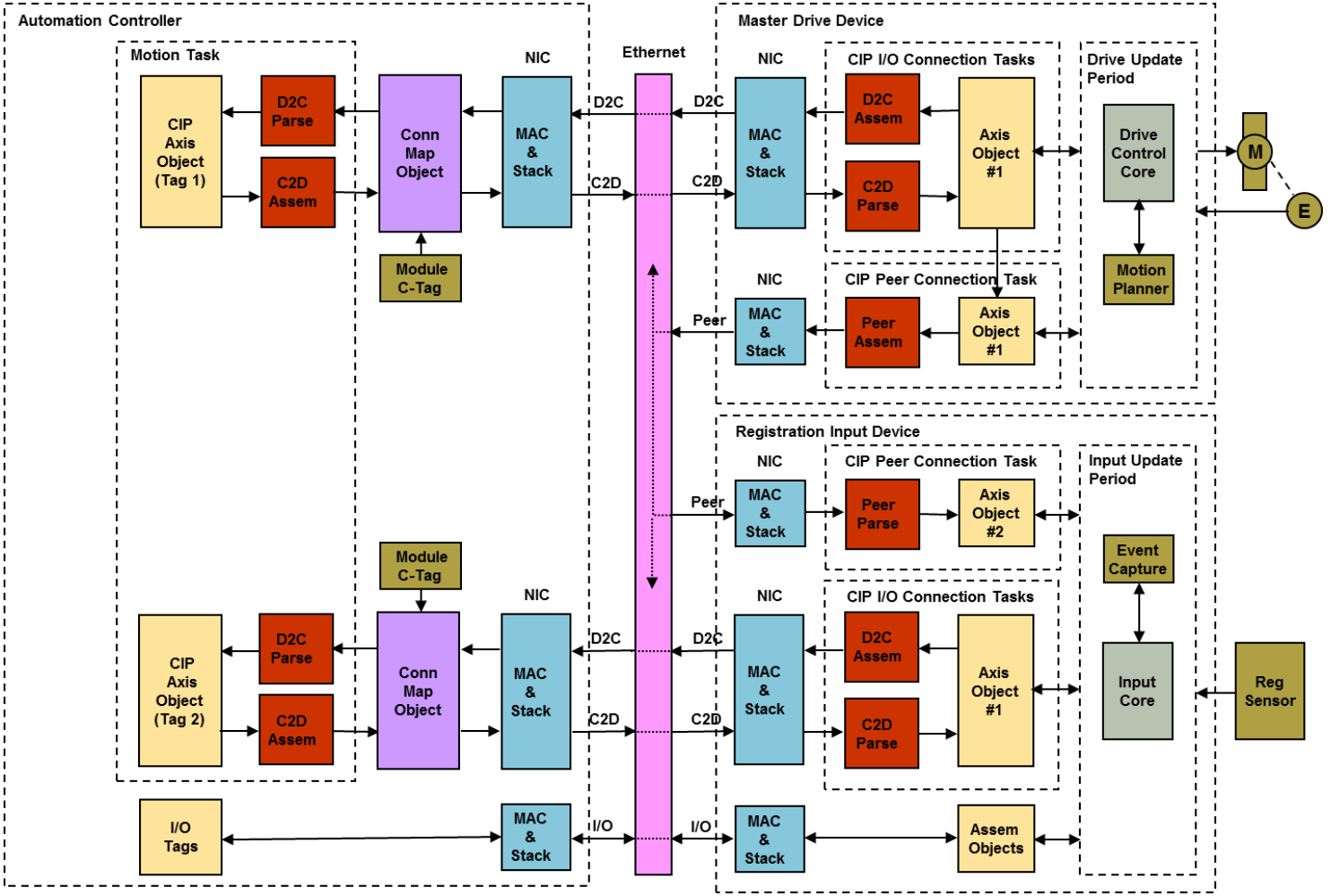


Feedback Device

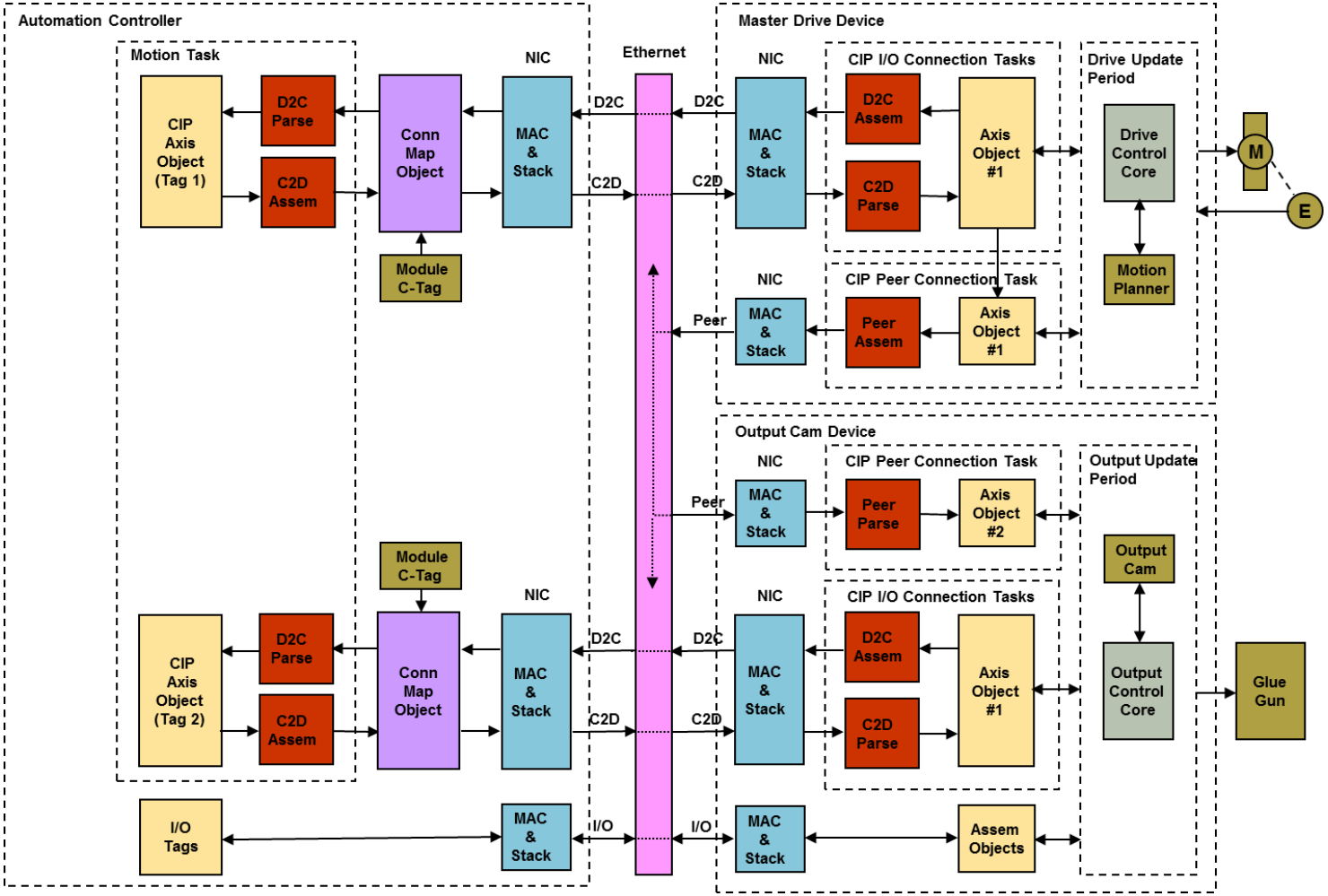
Instance Attribute			Implementation by Device Control Code					
Attr. ID	Acc. Rule	Attribute Name	E	F	P	V	T	Conditional Implementation
1351	Set	Induction Motor Rotor Leakage Reactance	-	R	R	R	R	Induction Motor only
1352	Set	Induction Motor Rated Slip Speed	-	O	O	O	O	Induction Motor only
1400 + o	Get	Feedback n Catalog Number	O	-	O	O	O	E
1401 + o	Get	Feedback n Serial Number	O	-	O	O	O	E
1402 + o	Get	Feedback n Position	R	-	R	R	R	E
1403 + o	Get	Feedback n Velocity	R	-	R	R	R	E
1404 + o	Get	Feedback n Acceleration	R	-	R	R	R	E
42	Set*	Feedback Mode	R	R	R	R	R	

(E = CIP Motion Encoder Device)

Motion Registration Input



Motion Position Output

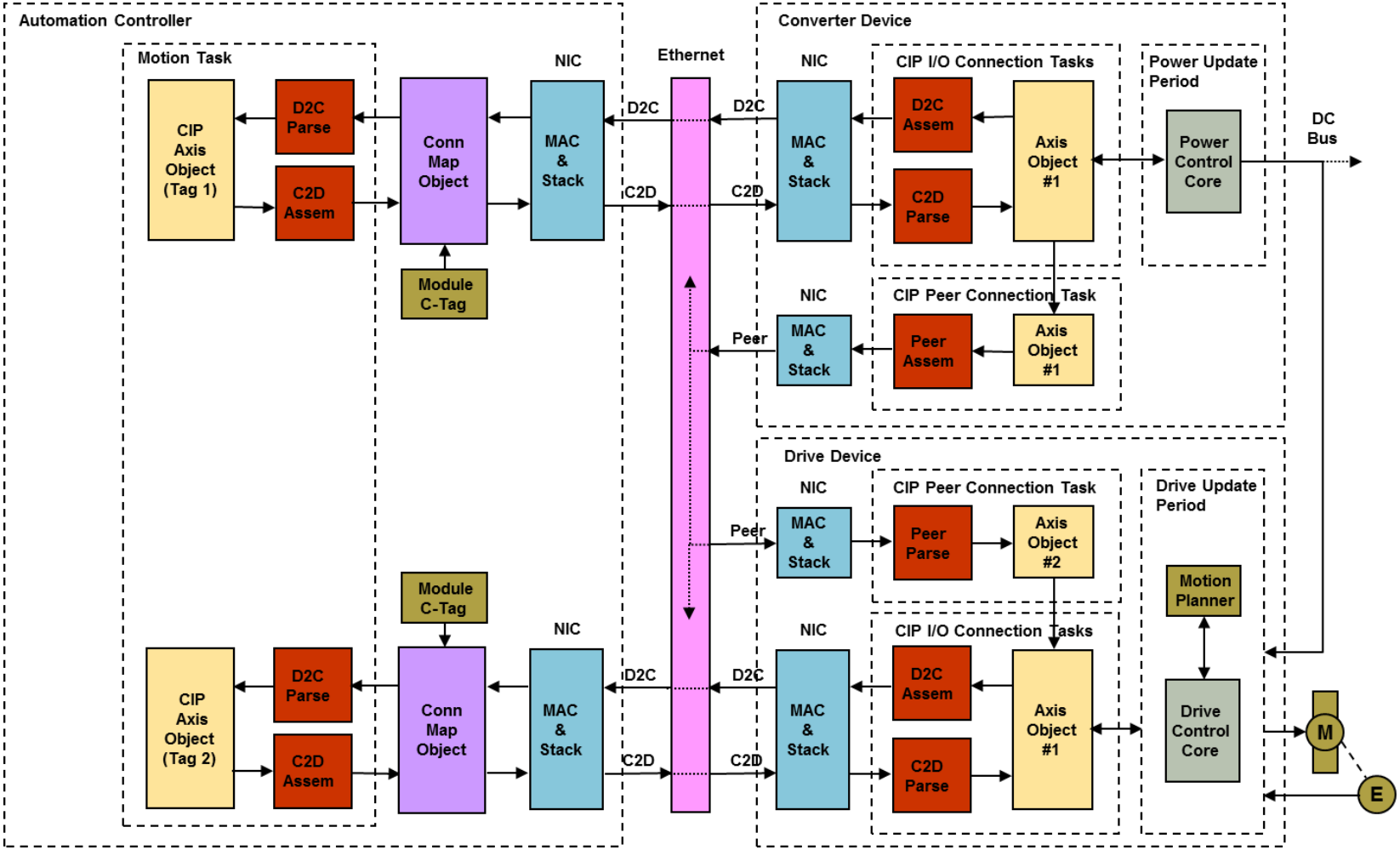


Motion I/O

Instance Attribute			Implementation by Device Control Code						
Attr. ID	Acc. Rule	Attribute Name	IO	E	F	P	V	T	Conditional Implementation
1434 + o	Set	Feedback n Velocity Filter Bandwidth	-	O	-	O	O	O	
1435 + o	Set	Feedback n Accel Filter Bandwidth	-	O	-	O	O	O	
60	Set*	Event Checking Control	R	R	-	R	O	O	
61	Get	Event Checking Status	R	R	-	R	O	O	
62	Get	Registration 1 Positive Edge Position	O	O	-	R	O	O	
63	Get	Registration 1 Negative Edge Position	O	O	-	R	O	O	
64	Get	Registration 2 Positive Edge Position	O	O	-	O	O	O	
65	Get	Registration 2 Negative Edge Position	O	O	-	O	O	O	
66	Get	Registration 1 Positive Edge Time	O	O	-	R	O	O	
67	Get	Registration 1 Negative Edge Time	O	O	-	R	O	O	
68	Get	Registration 2 Positive Edge Time	O	O	-	O	O	O	
69	Get	Registration 2 Negative Edge Time	O	O	-	O	O	O	

(IO = CIP Motion I/O attributes)

Converter Module



Converter Module

Instance Attribute			Implementation by Device Control Code						
Attr. ID	Acc. Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
614	Set	Mechanical Brake Control	-	-	O	O	O	O	
615	Set	Mechanical Brake Release Delay	-	-	O	O	O	O	
616	Set	Mechanical Brake Engage Delay	-	-	O	O	O	O	
620	Get	DC Bus Voltage	R	-	R	R	R	R	
621	Get	DC Bus Voltage - Nominal	R	-	R	R	R	R	
622	Set	Bus Configuration	O	-	O	O	O	O	
623	Set	Bus Voltage Select	-	-	R	R	R	R	
624	Set	Bus Regulator Action	R	-	R	R	R	R	
625	Set	Regenerative Power Limit	R	-	O	O	O	O	

(B = CIP Motion Converter device)