Application of IEEE 1588 in Industrial Automation and Motion Control Systems

Anatoly Moldovansky
Rockwell Automation
October 10, 2005

Using time for control…

…not just network-based events!

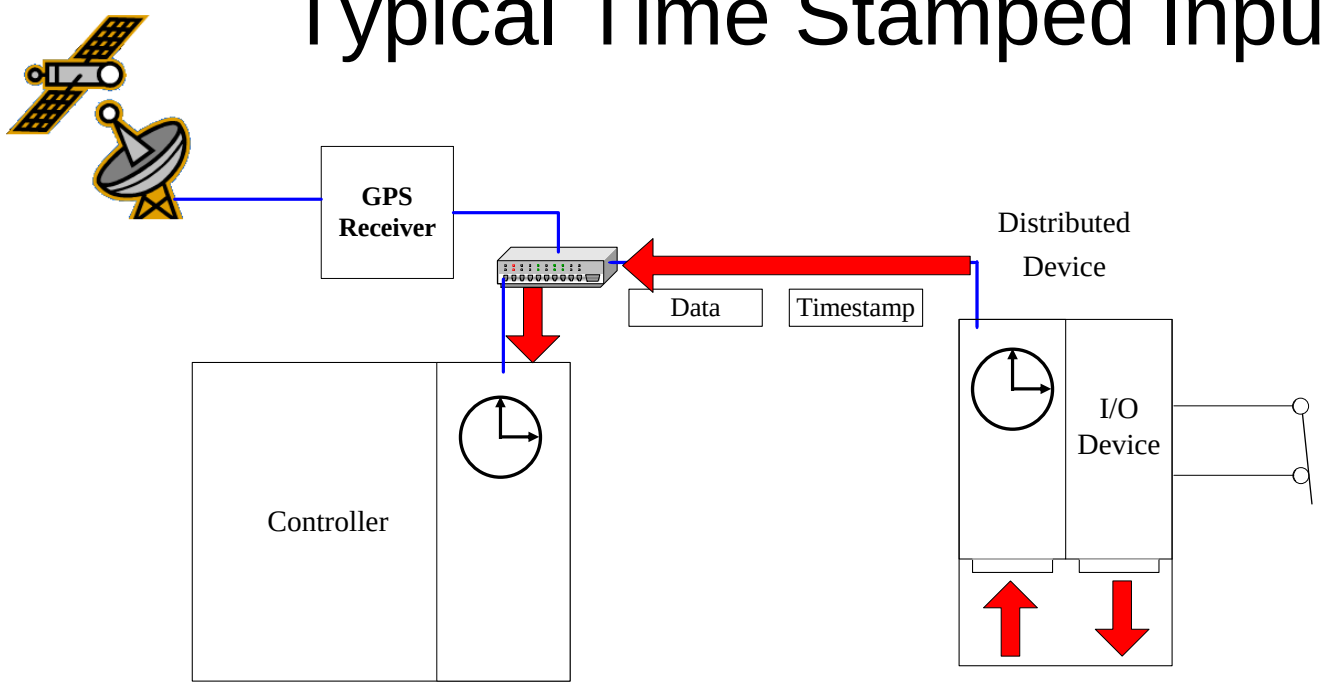
IEEE 1588 Provides Time Synchronization Services

- Synchronization Services
  - The industrial market is driving the need for synchronization to a common time-base with sub-microsecond accuracy, node-to-node.
- IEEE 1588
  - Nanosecond Clock Resolution
  - +/- 100 nanosecond, or better, clock synchronization between distributed devices

Applications for Time Synchronization

- **Sequence of Events Measurements**
- **Scheduled Outputs**
- **Synchronized Actuation**
- **Time-Stamped Data Logging**
- **Coordination with GPS Time**

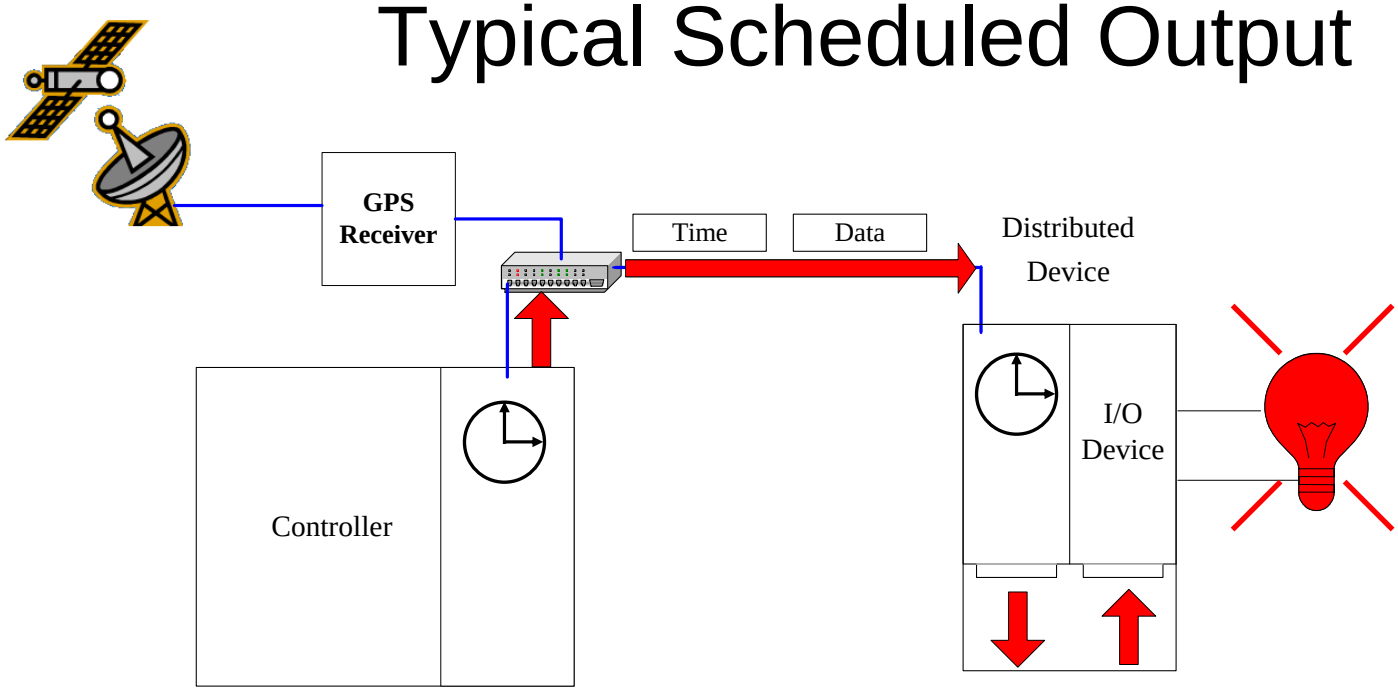
Typical Time Stamped Input



Applications for Time Synchronization

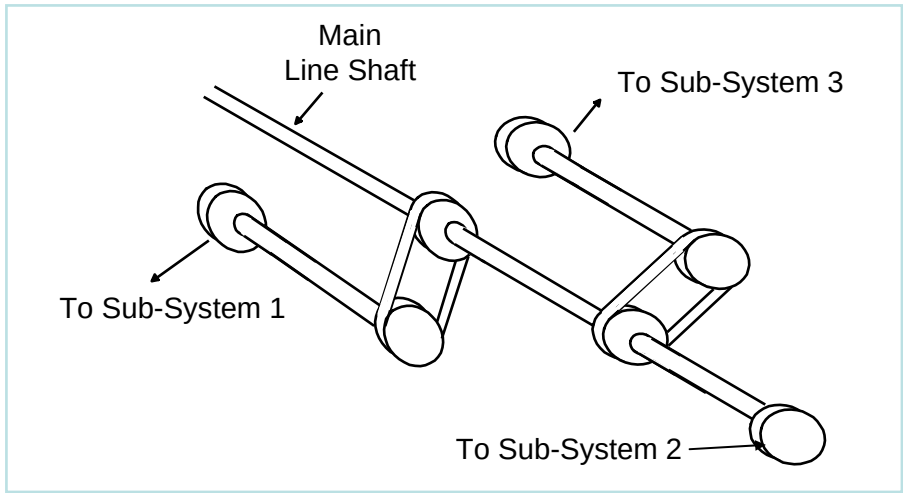
- **Sequence of Events Measurements**
- **Scheduled Outputs**
- **Synchronized Actuation**
- **Time-Stamped Data Logging**
- **Coordination with GPS Time**

Typical Scheduled Output



Distributed Motion Control

- Today's distributed motion control applications are founded in mechanical line shafting designs. A single mechanical line shaft drives multiple subsystems using belts, pulleys or gear boxes.



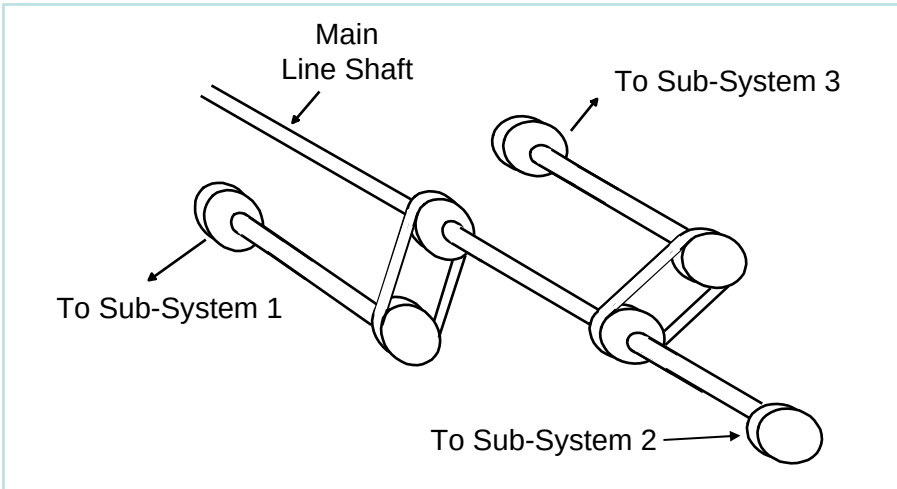
- Typically, these applications are characterized as phase locked - or "lineshaft" applications. Like a large music box, all mechanical elements are timed and phased through mechanical means.

Distributed Motion Control

- Mechanical Lineshafts are inflexible
  - Single product design
  - Long product change-over
  - Run-time adjustments for re-phasing were non-existent or required expensive differential gear-boxes.
  - Wear and tear of mechanical components
- Much power was expended on moving machinery and not product.

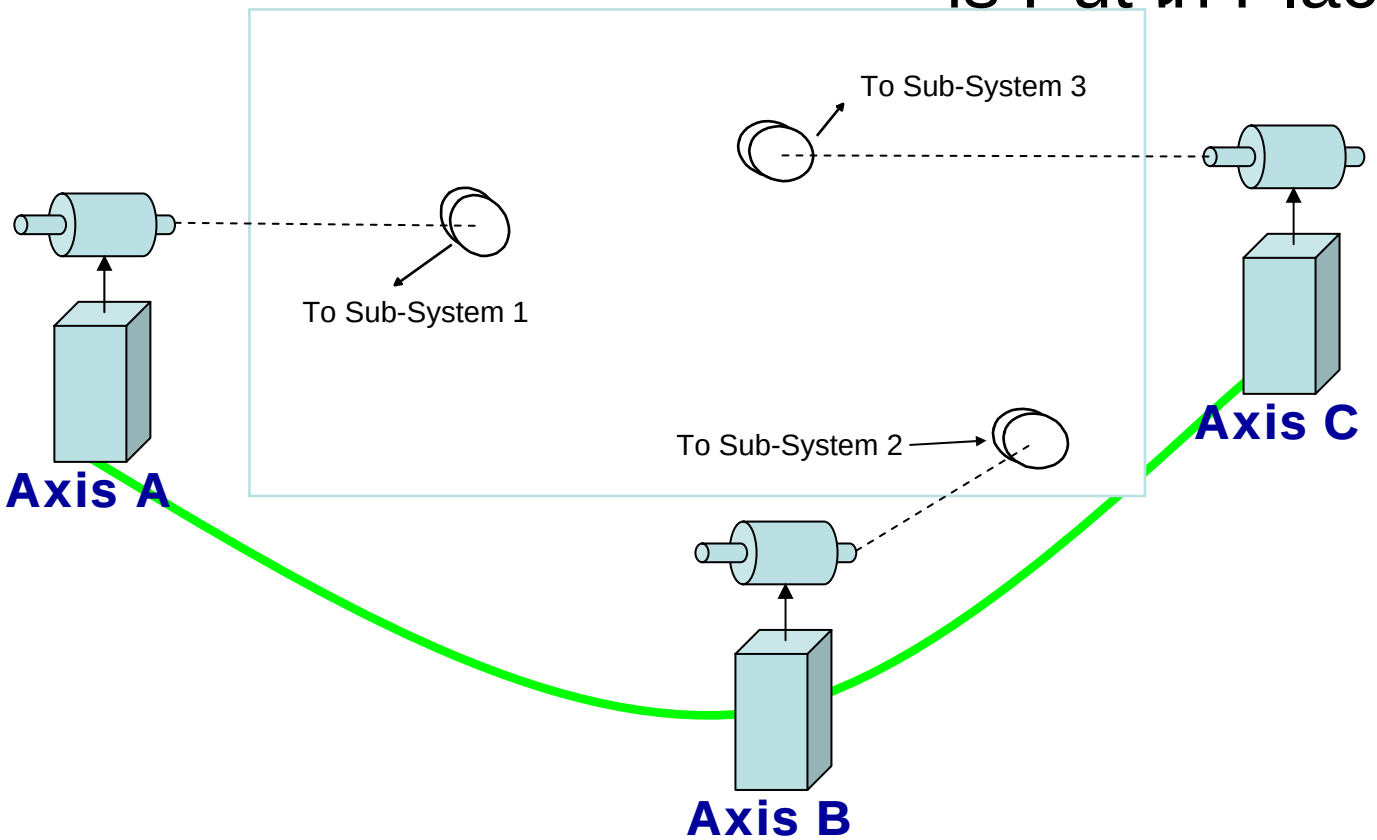
Distributed Motion Control

- Mechanical designs have given way to electronic design control schemes



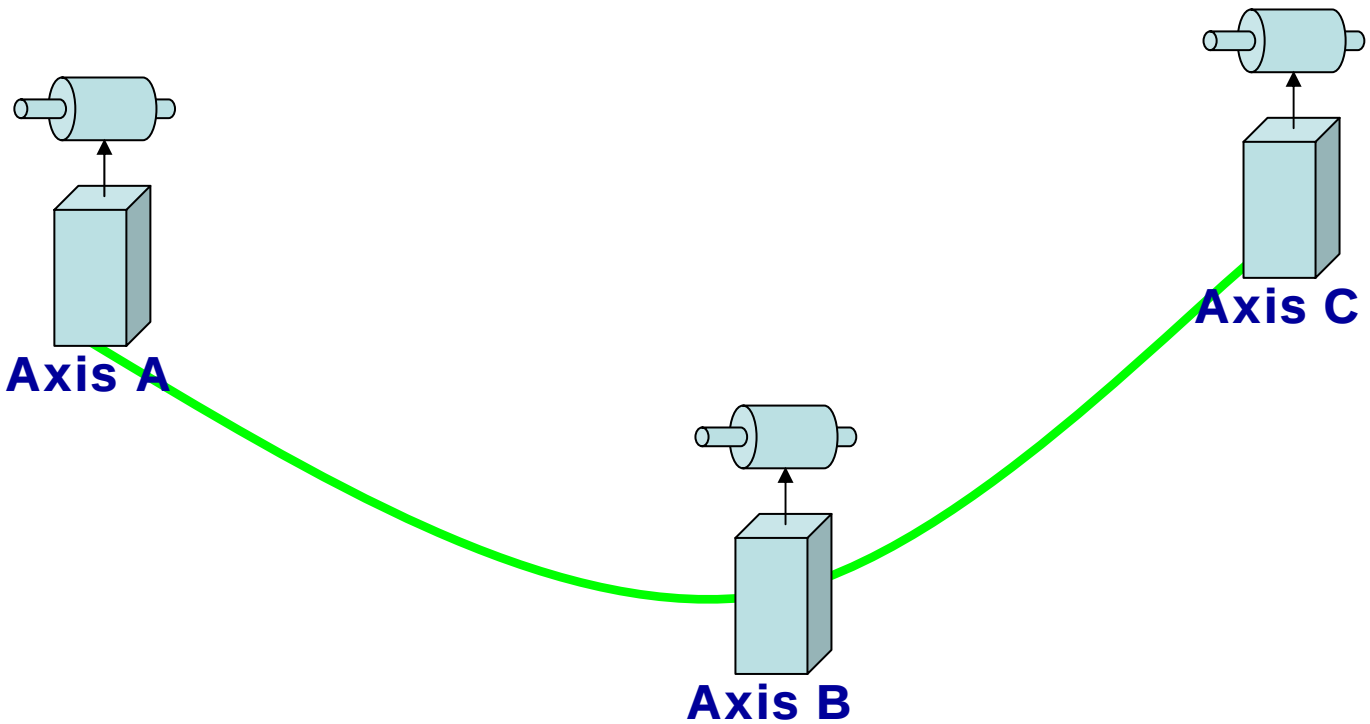
Distributed Motion Control

A Communications Network is Put in Place…



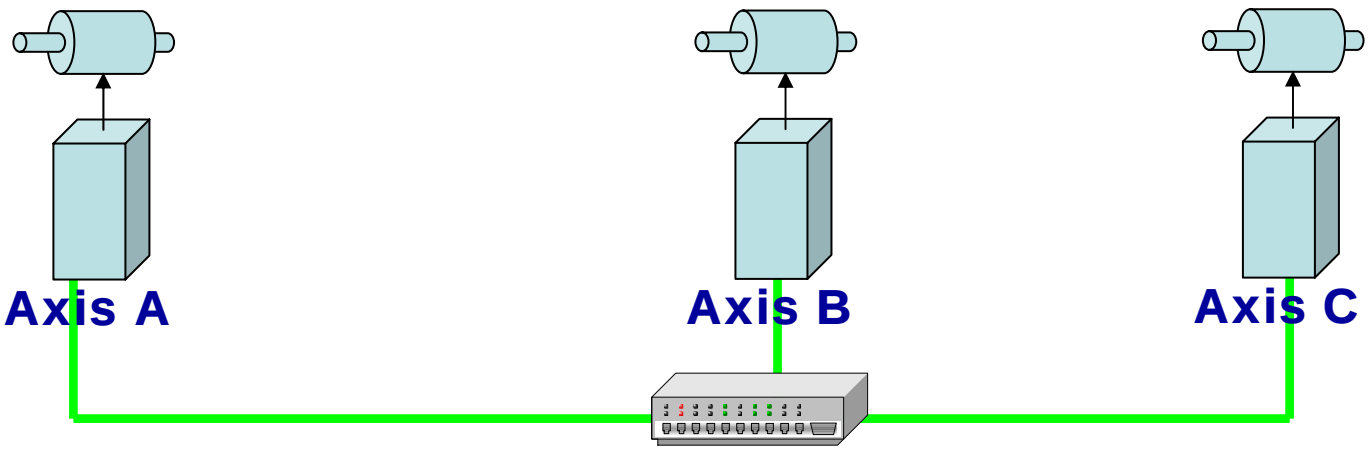
Distributed Motion Control

And the Result is an Electronic LineShaft!



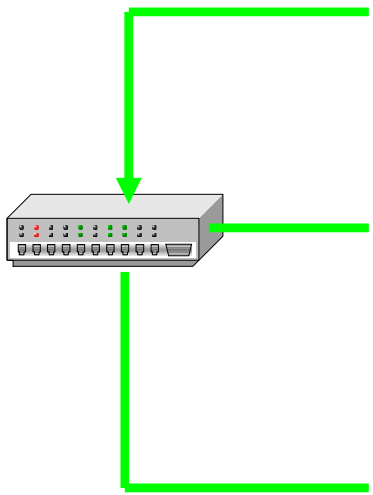
Distributed Motion Control

- And the Result is an Electronic Lineshaft!



Why is Time Synchronization Required?

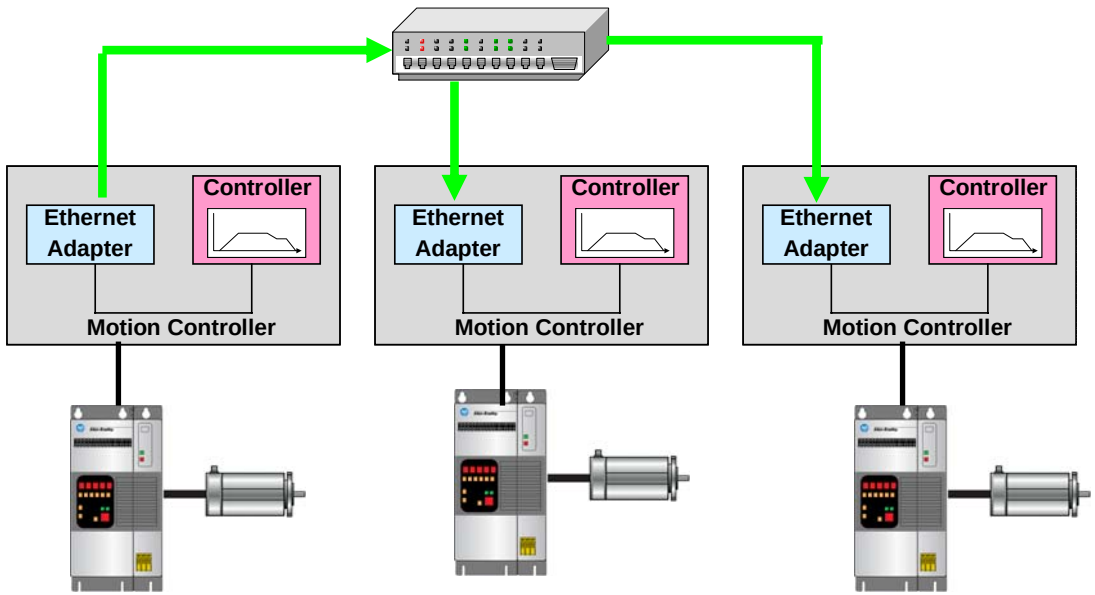
- Each Motion Controller Controls *Position over Time*



CIP Motion™

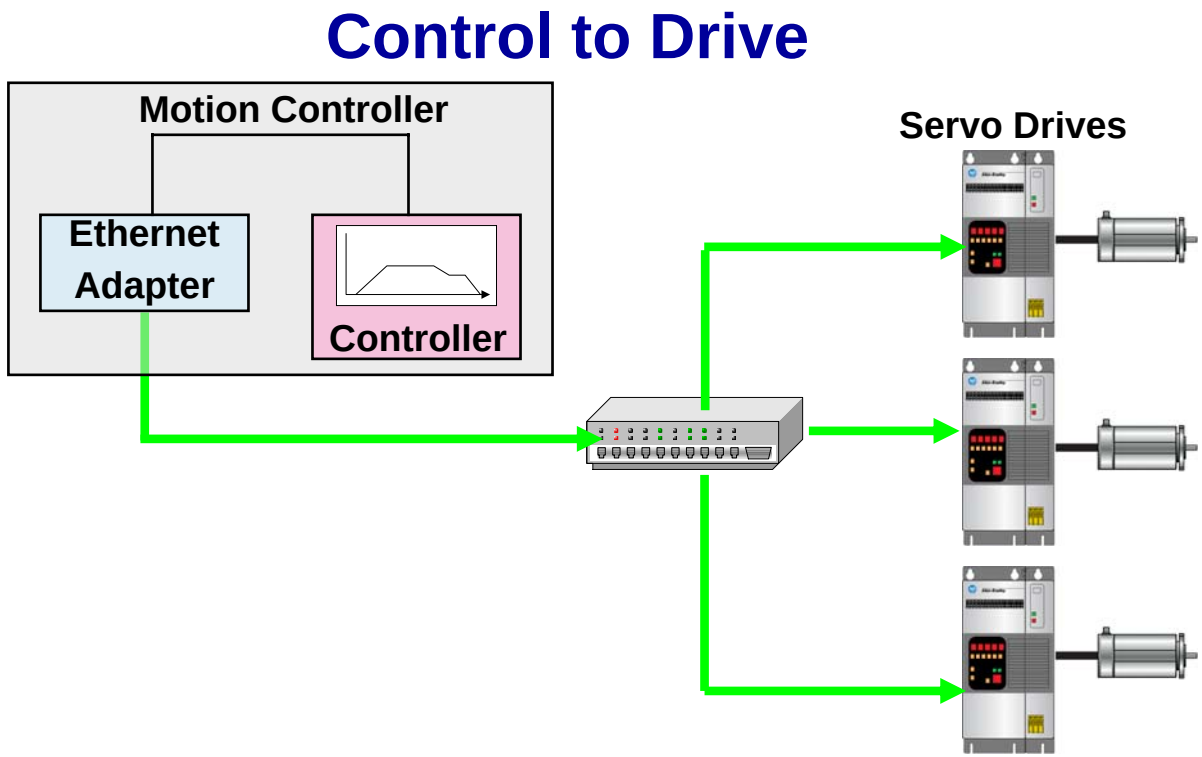
- There are Two Types of Connections that are Typically Used for Distributed Motion Control

Peer to Peer

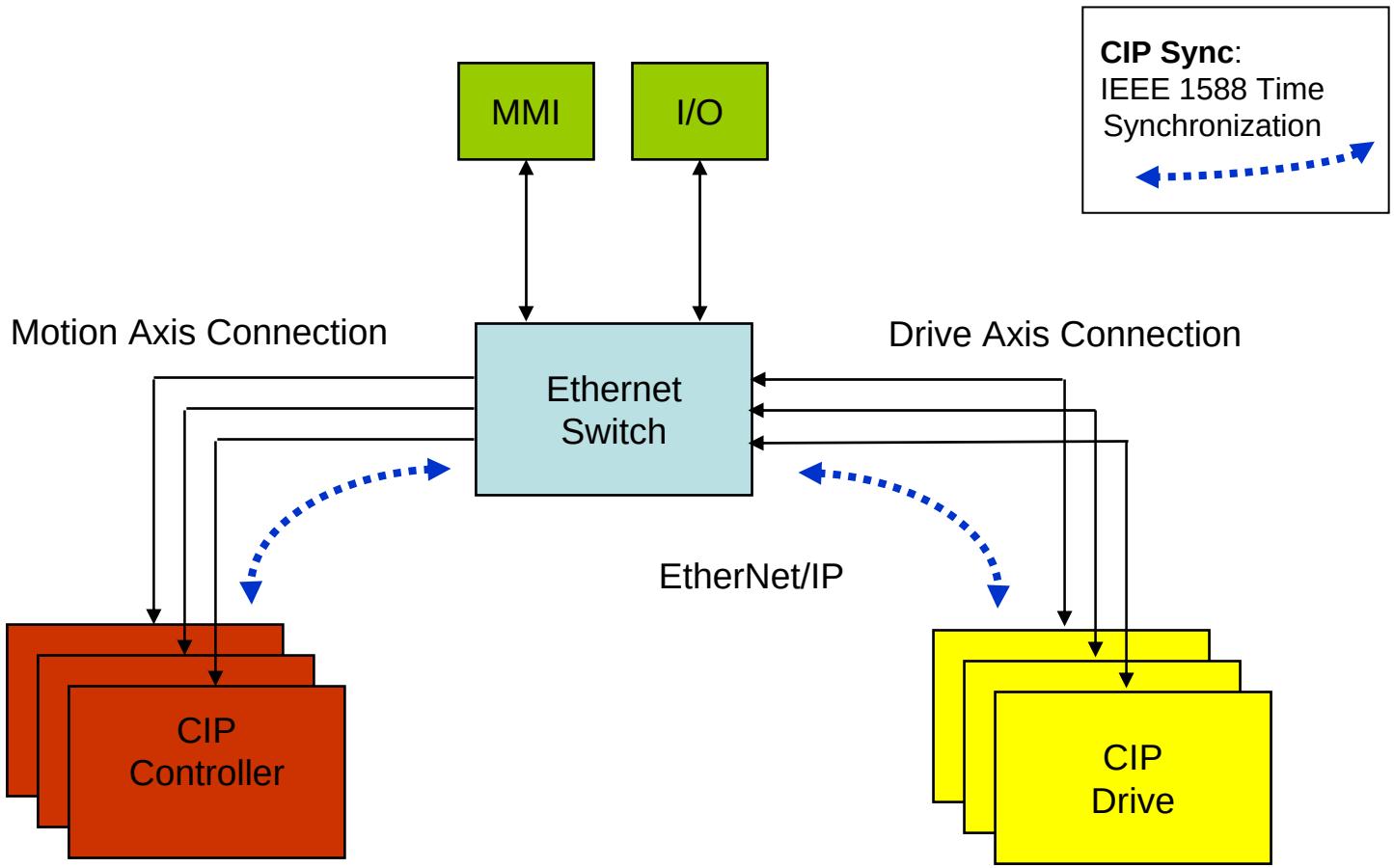


CIP Motion™

- There are Two Types of Connections that are Typically Used for Distributed Motion Control



CIP Motion Architecture



Demo

CIP Motion™ Demo