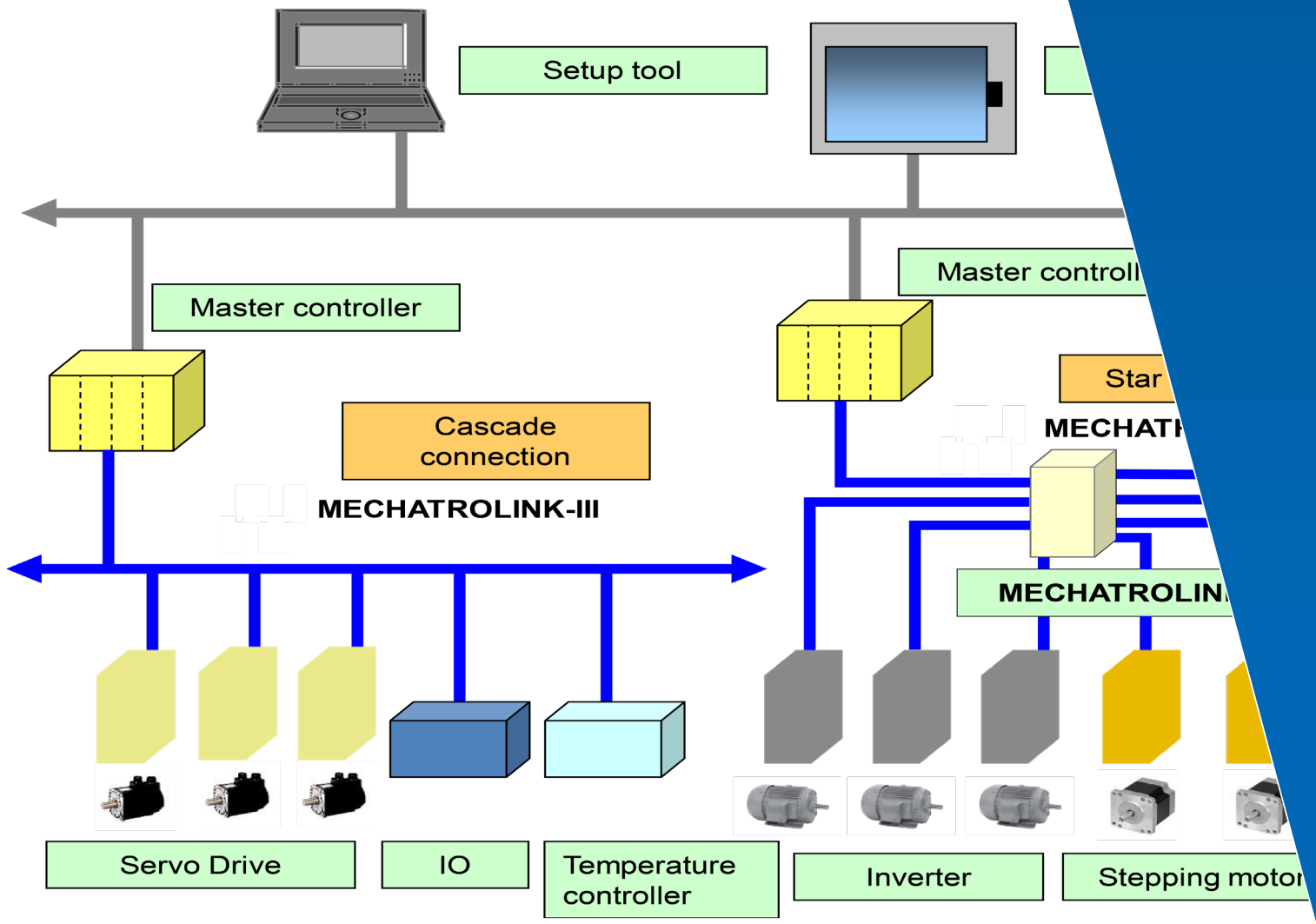
YASKAWA

Improving Reliability of Motion Control Networks

Network reliability plays a key role in optimizing system performance



Introduction

The most popular Motion Control networks today are Ethernet based. Ethernet has won the battle for the hardware layer in these types of networks. The ubiquity of Ethernet in computer networks has led to speed and cost advantages that are difficult to compete against.

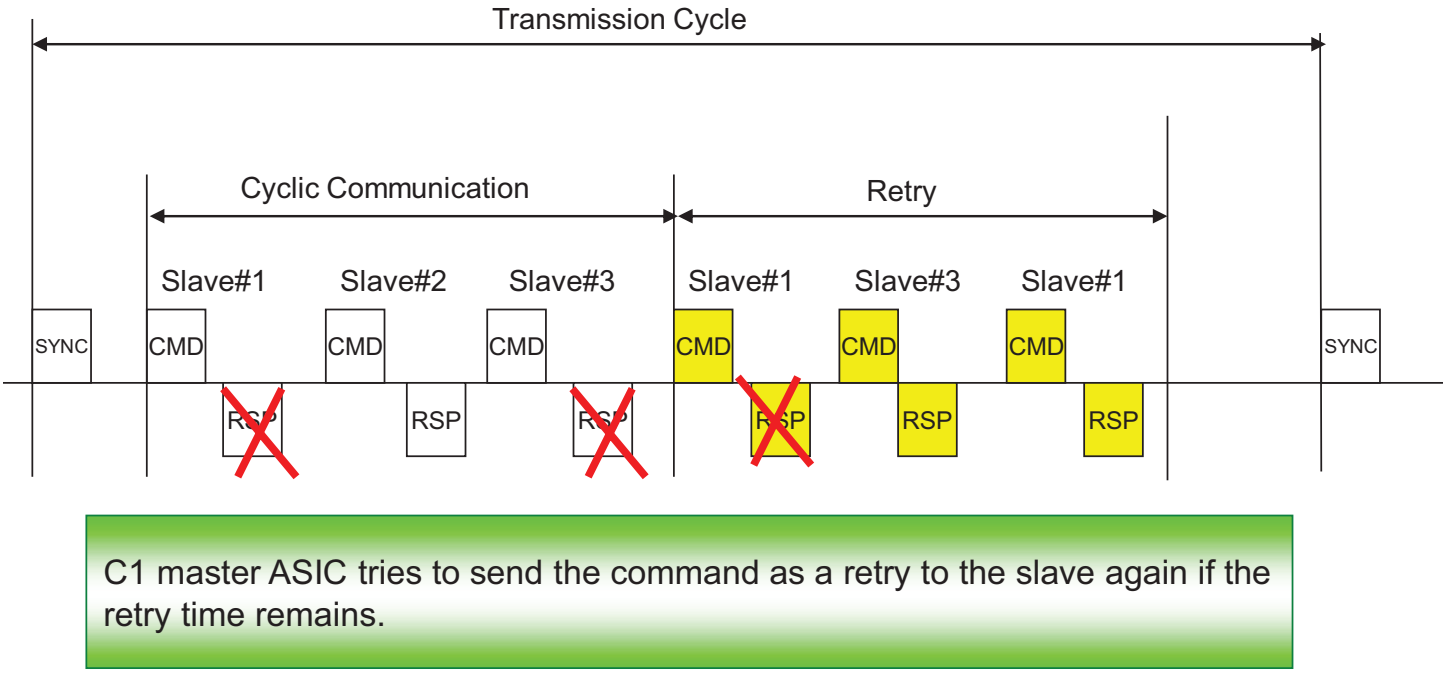
But the hardware layer is just the first decision when designing a reliable network. Other choices include the right protocol and the network topology

Selecting a Protocol

While speed is important, it should not be the only criteria that you use to select an Ethernet-based protocol for your Motion Control network. Reliability of the network can be the difference in producing a damaged part or a production part. Certain protocols have features built in to ensure that electrical noise does not ruin your part.

As an example, the Mechatrolink III protocol has a retry feature built into the ASIC chip of the products that will resend a packet during the same communication cycle if the original packet failed to reach its destination.

This feature has proven its reliability in applications like Machine Tools and Semiconductor manufacturing where a minor flaw in the part can cause significant financial losses.



C1 master ASIC tries to send the command as a retry to the slave again if the retry time remains.

The retry feature of the MECHATROLINK-III network protocol

Selecting a Network Topology

Another often overlooked contributor to a network's reliability is its topology. Network topology refers to how the network is connected or structured. It can refer to the physical layout and to the logical layout. The logical structure is how the controller sees the network which may or may not be the same as the physical layout. However, in Motion Control networks they are usually the same.

The easiest and by far the most common topology is the Cascading Bus. In this network you have a cable that plugs into your controller and into the first drive. That drive has two identical connectors and you use the second connector to cable from the first drive to the second. This continues until all of the nodes of the network have been connected. The nodes don't have to be the same and usually consist of a variety of servos, inverters and remote I/O blocks.

The popularity of this topology comes from its simplicity and cost. However, it does have some disadvantages. The dependency on the serial nature of this topology means that if there is one cut in the cable then all communications are lost to every node beyond that point. So, if network reliability is paramount to your application, then you should consider other topologies.

One topology that can greatly improve your networks reliability is a Star topology. This topology is more expensive because it requires additional hardware. However, it has many benefits that justify the additional cost.

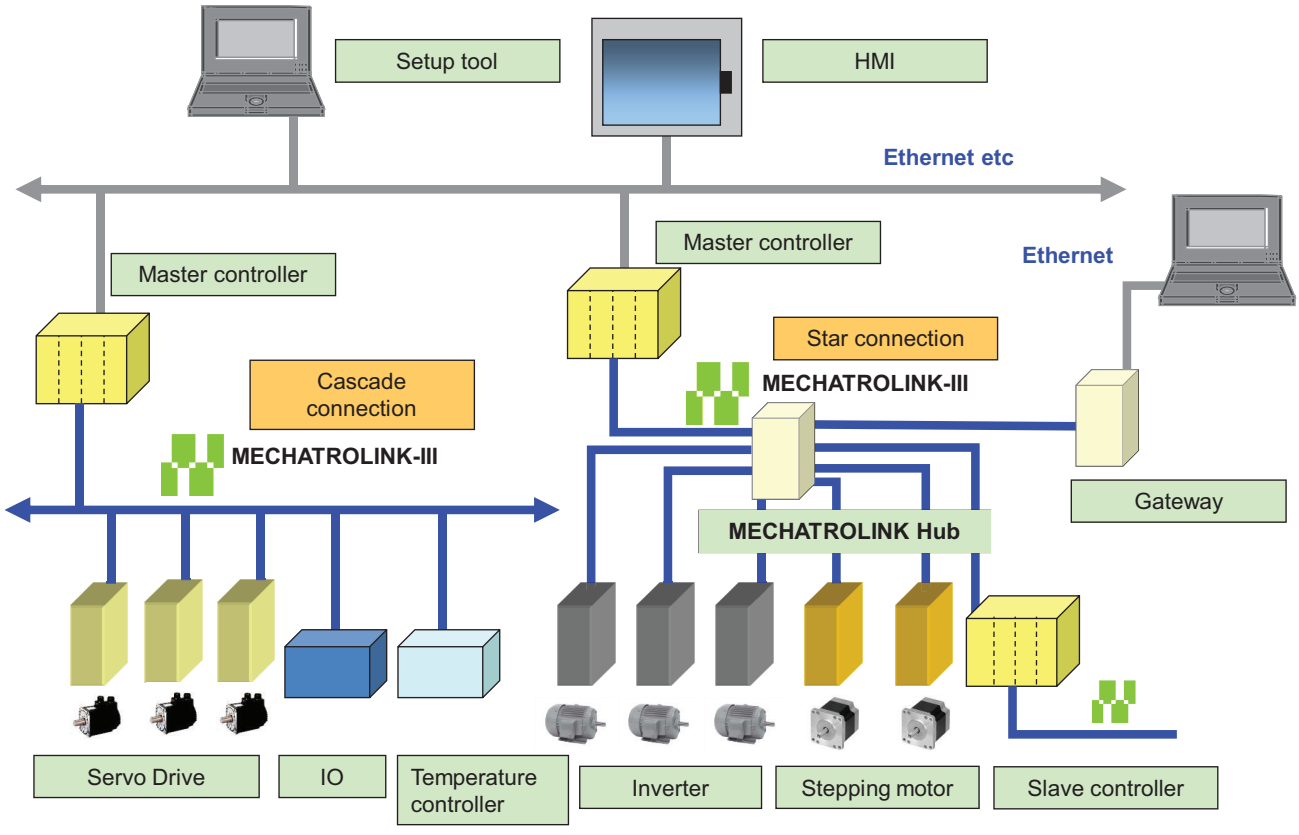
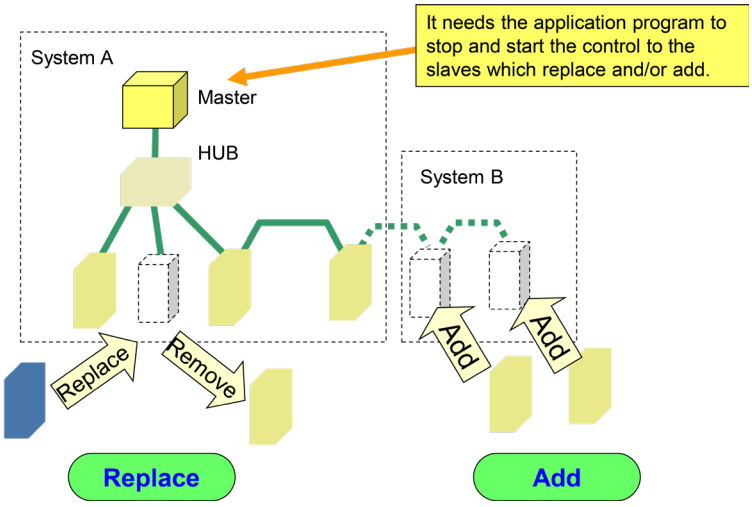


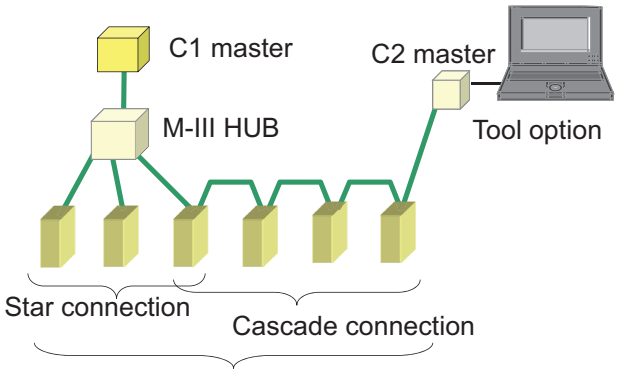
Diagram shows both cascade and star topologies



Addition of one or hubs can potentially increase network cycle time

In this configuration each node is connected to a hub or switch that is connected to the controller. This structure increases the reliability since a failure in a single servo amp, inverter or I/O block will not disrupt the entire network. In some cases, you can "hot swap" an axis without affecting the rest of the network.

Depending upon the number of nodes in your network adding one or more hubs or switches can potentially increase the cycle time of the network.



Hybrid Star and Cascading Bus Topology

Another added benefit of this topology is modularity. Since the hubs or switches allow nodes to be added or removed without disrupting the entire network, an engineer can design a very modular machine. In the case of Yaskawa's Mechatrolink III network, hubs can be used to create a star topology or even a hybrid star and cascading bus topology.

Each hub for Mechatrolink III can support up to 8 nodes. The nodes can even be cascaded to another level. However, there can only be two hubs between any node on the network and the controller. The Mechatrolink III network can support up to 62 nodes. These features allow an engineer to create a network that is optimized for cost, speed and reliability.

Yaskawa America, Inc.
Drives & Motion Division
yaskawa.com

Document WP.MTN.12
05/01/2018

YASKAWA