Switch latency in industrial applications

Industrial applications, such as machine control, are typically built in “long line” configurations. For these installations, to minimize wiring cost and complexity, typical installations use a “daisy chain,” where each node has (2) external switched ports and an internal port that goes to the end-node. There can be many hops along the line (64 hops or greater), and, as switch latency along these hops accumulates, the time available for control loop updates is reduced, possibly to an unusable level.

A common application is motion control, where fast control loop update times are required. Update rates vary depending upon the application and are on the order of 2 ms down to 100 µs for the control loop are common. To support this requirement, low latency for messages through the network is a high priority. Even Gigabit data rates are not sufficient to solve this problem. For instance, in a line topology of 64 hops, accumulated latency would exceed a 100 µs control loop even at Gigabit speeds. It is also worth noting that a control loop is typically divided into three parts: the time to transmit inputs, the time to calculate outputs and the time to transmit outputs, so the actual budget for transmission is on the order of 33 µs. There is a need to get the lowest latency possible so that the most cost effective link speed can be utilized.

There are additional challenges to the use of high data rates in industrial applications. The environment for these networks frequently is severe, with high EMC, severe temperatures and extreme vibration. Additionally, there is the potential for the reuse of existing cabling (brown-field wiring) providing an additional system-level challenge. Currently these applications are looking at a 100Mb/s rate for an optimal balance of installed cost versus electronics complexity for maximum reliability.

There is interest (see the list of supporters below) in utilizing the Industry Connections New Ethernet Applications (NEA) activity to discuss the best approach to address this problem in a manner that insures standardized and interoperable behavior. It has come to our attention that existing and long-standing practices, addressing this problem within such long-line industrial Ethernet networks may violate certain aspects of the IEEE802.1 and IEEE802.3 standards. We hopeful that the NEA activity will provide a forum to drive a successful resolution of this issue.

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