ODVA INDUSTRY CONFERENCE 20TH ANNUAL MEETING

An Approach to CIP Motion on TSN Networks

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Abstract

We will present an evaluation on the aspects of the TSN adoption method and the performance of TSN adoption for a CIP system.

Based on the evaluation results, we demonstrate the feasibility of integrating EtherNet/IP systems into networks deploying TSN.

We also propose both enhancements and requirements for the TSN incorporation into CIP technologies and EtherNet/IP specifications.

We believe that these conclusions can help inform ODVA contributions to IEC/IEEE 60802 Industrial Automation Profile for TSN working group.

This presentation highlights test cases and conclusions
Detailed justification is in the published paper

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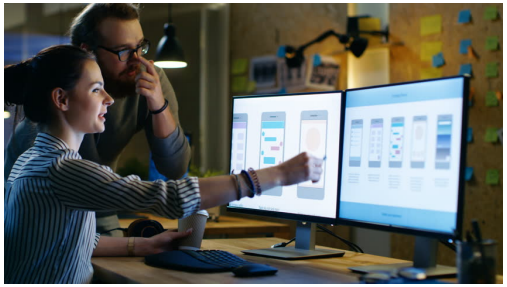
Conclusions

Viability

CIP Motion can be adapted to support TSN networks without structural changes to either timing model or communication patterns



Benefit

There are foreseeable applications where motion control will not be reliable without use of a TSN Network

Legacy

In well engineered networks performance of CIP Motion without TSN matches or exceeds that with TSN

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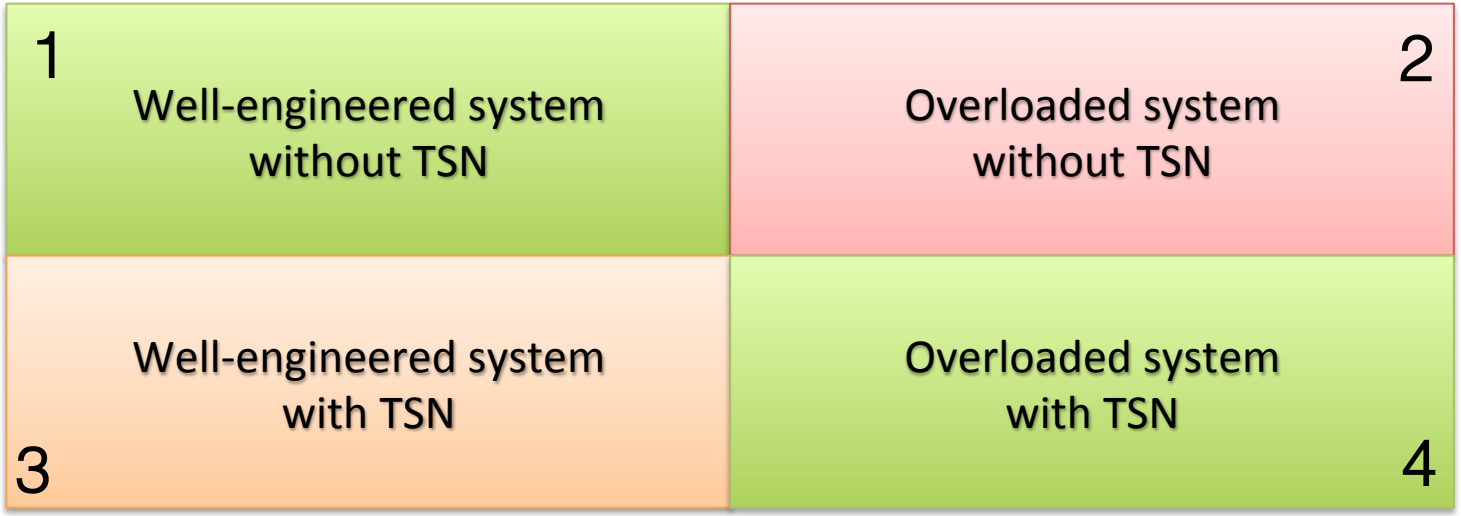
Test Cases



All test cases use an IEEE 802.1AS clock

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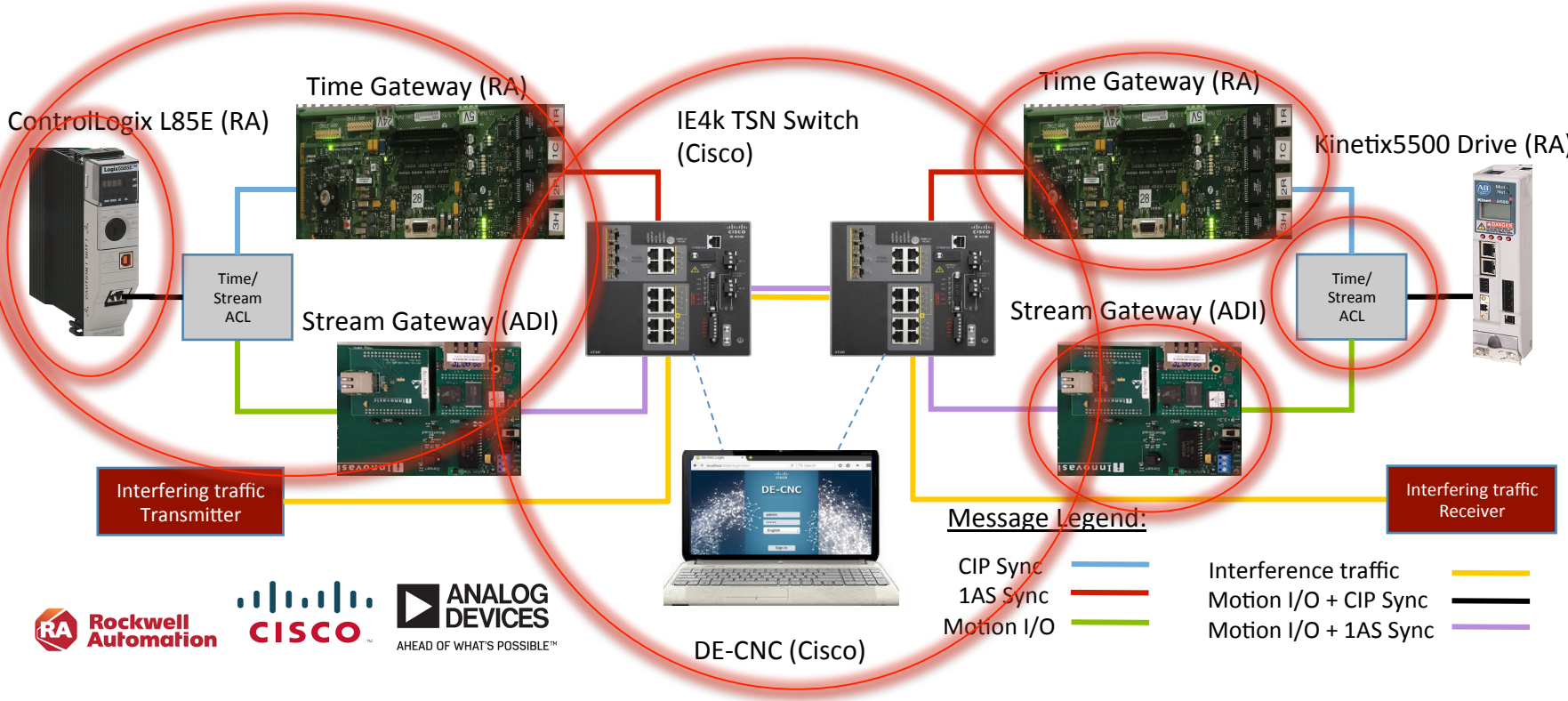
Testbed Topology at 100Mbps and Application



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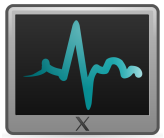
Test Case 1 Evaluation

No interfering traffic, no 802.1Qbv schedule

Controller

Mean delay

208us
140us prod hw



Packet Jitter

38us

Drive

This test case demonstrates that migration from IEEE 1588v2 default profile to IEEE 802.1AS clock synchronization is viable and can be implemented in a heterogeneous system with both techniques used for different devices.

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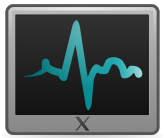
Test Case 2 Evaluation

Interfering traffic, no 802.1Qbv schedule

Controller

Mean delay

375us
208us (Case 1)



Packet Jitter

105us
38us (Case 1)

Drive

The performance degradation (both delay and jitter) validates previous analysis and shows that it is questionable to establish a converged network for both critical applications and interference traffic with quality of service tags set to the same values.

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Test Case 3 Evaluation

No interfering traffic, 802.1Qbv schedule active

~360us + 130us due to prototype limitations

Controller

Mean delay

758us
208us (Case 1)

Packet Jitter

14us
38us (Case 1)

Drive

The performance degradation compared to Test Case 1 demonstrates that where there is no interfering traffic (with the same QoS tag values) adding TSN functionality to the network architecture delivers no significant performance benefit to any individual axis and by increasing the mean delay may result in a reduction in the number of axes supported in a given system

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Test Case 4 Evaluation

Interfering traffic, 802.1Qbv schedule active

Controller

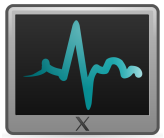
Mean delay

758us

375us (Case 2)

758us (Case 3)

208us (Case 1)



Packet Jitter

28us

105us (Case2)

14us (Case 3)

38us (Case 1)

Drive

With no performance degradation for CIP Motion traffic compared to Test Case 3 we have demonstrated that where there is interfering traffic (with the same QoS tag values) adding TSN functionality to the network architecture can ensure consistent CIP Motion operation in applications where there would have been either performance degradation or system failure using traditional Ethernet techniques

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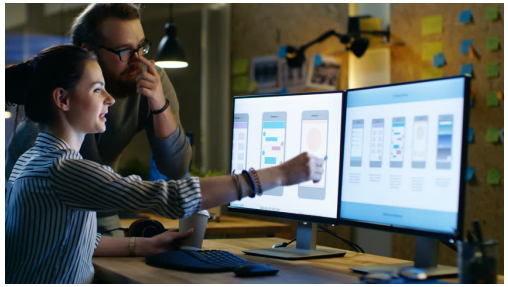
Conclusions

Viability

The IEEE 1588 default profile clock used by CIP Motion must be integrated ***with the IEEE 802.1AS(2020) clock used in TSN***



Benefit

The isochronous application used in CIP Motion today must be adapted to synchronise with an isochronous IEEE 802.1Qbv schedule

Legacy

We must avoid either/or implementations; TSN must be used to expand application coverage of CIP Motion and not narrow it

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