XTS_TRANSPORT_LAYER

Abstract

A Distributed Hardware Abstraction Layer for High-Speed XTS Transport Systems

Current industrial automation architectures struggle to manage the stochastic complexity of high-speed, synchronized movements required by modern linear transport systems (XTS).

The prevailing practice of tightly coupling application logic with hardware drivers results in rigid, procedural code that is prone to software latency and resistant to scaling. This framework offers a structured, fast and computationally lightweight approach to motion applications. In combination with the established PLC_MOTION_LAYER, motion tasks are no longer tightly coupled with the executing hardware layer.

With the evolution of TwinCAT motion —including MC3, XPlanar, NCI, and CAM—the necessity for a rigorous Hardware Abstraction Layer (HAL) has become critical to decouple process intent from physical execution.

This paper introduces a field-proven framework currently deployed in diverse high-volume production environments, including semiconductor backend processing, battery manufacturing, medical instrumentation, mechatronic assembly, and end-of-line packaging. The architecture facilitates "Lot Size 1" flexibility, orchestrating complex, highly synchronized tasks such as `Flying Saw` applications, kinematic transformations, and G-code execution with zero-latency logic.

By enforcing a strict separation of concerns and utilizing pointer-based linked list structures, the framework achieves a massive reduction in costly data operations. Performance benchmarks demonstrate logic execution times of **80μs for 40 Movers/20 Stations** and **300μs for 108 Movers/53 Stations**, easily maintained within a standard **2ms PLC cycle**. This lightweight construction allows for significant computational headroom while drastically reducing Time-to-Market, even when employing only the lowest layer of the framework.

While providing native access to the `Tc3_XTS_Utility` library for advanced track management and NCT features, the architecture ensures that the application layer remains agnostic to the underlying mechanics. This architecture offers a long term approach that uses interfaces to connect to the TcCOM driver of the XTS. By enforcing strict separation of concerns the long term maintainability remains side-effect free. Ultimately, the synergistic combination of the **PLC_MOTION_LAYER** (Kinetic) and **XTS_TRANSPORT_LAYER** (Logistic) establishes a robust foundation for highly distributed, hard real-time motion control systems.

The development of custom features and the specification of new production flow is supported by the built in simulation feature. The built in TwinCAT feature of using the motion kernels' (MOTION) setpoint generator for simulated motion. This feature enables automated unit testing and full observability of the development process. The logic layer is fully testable and portable. The time for

debugging during commissioning is reduced drastically and enables fine tuning as soon as mechanical and mechatronic installations are ready.

The framework is fully documented in intent and functionality and in combination with the TR3056 in Nuremberg the path to market and the time to market is supported from day 1.