MODSIM World 2026 Abstract Submission

Title: Racing Intelligence: How Adopting Elite Racing Data Analysis Philosophies Compresses Time-to-Decision

Track: Mission Readiness

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Abstract

The transition from simulated training to operational readiness often suffers from discrepancies between virtual model behavior and real-world physics which degrade user trust. This paper presents case studies of a methodology developed for elite racing used to compress time-to-decision and maximize performance output. The framework utilizes high-velocity federated architectures to synchronize disparate sensor streams and achieve extreme parity between live, virtual, and constructive (LVC) environments. This process represents a high-integrity methodology defense agencies can adopt to resolve common pain points cited by high-ranking officials across all military branches and addressed in numerous SBIR initiatives. By adopting these racing-derived methodologies, we have already successfully demonstrated the ability to overcome these critical data analysis bottlenecks.

The study details algorithms used to process tens of billions of data points at sustained rates exceeding hundreds of thousands of measurements per second. In the first case study, we examine a federated model used for the Nürburgring 24h race to balance performance of vehicles from elite OEMs to within a 0.3% lap time window, regardless of highly divergent design philosophies. This implementation requires synchronization of disparate telemetry, GPS, and timing data streams into a unified source of truth providing near real-time performance intelligence.

In the second case study, we examine the highly iterative analysis and correlation cycle required to anchor real-world telemetry with models derived from test facilities such as wind tunnels, kinematics rigs, and ride control rigs. We describe how these high-fidelity models are refined using virtual lap simulation and driver-in-the-loop (DIL) platforms, saving time and money by allowing virtual optimization of complex setup parameters and test plans before physical deployment.

High-precision correlation is critical for accurate decision making and ensuring development does not proceed down the wrong path. Using sensor-based performance metrics we demonstrate methods to resolve model discrepancies. As an example, we will analyze how a simple speed delta between simulated and physical data can be used to identify potential errors in aerodynamic, powertrain, or suspension sub-system models. This diagnostic rigor eliminates manual analysis, significantly reducing time to correlation, and ensuring model

refinements are based on mathematical certainty.

To validate human-in-the-loop integration, we present a side-by-side video comparing real-world performance with DIL training. The video demonstrates the spatial and millisecond-level synchronization made possible by the correlation process and how it is used to validate a digital twin model. This level of correlation reduces negative training and ensures driver feedback is relevant to real-world experience.

By adopting the federated architectures and validation methodologies derived from racing, the MS&T community can quickly, efficiently, and inexpensively resolve gaps in intelligent state monitoring. These racing methodologies offer a direct path for defense organizations to synchronize large-scale telemetry with digital twins, ensuring training platforms evolve with the technical rigor and architectural agility required for absolute mission readiness.

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