

Weigh2X

On-Board Weighing Systems

< White Paper >

High-Precision, Cost-Effective On-Board Weighing

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Intelligent On-Board Weighing Systems

Executive Summary

This white paper introduces the WEIGH2X TRUCK 3000 system, a cutting-edge on-board weighing (OBW) system that sets a new standard for precision, affordability, and reliability in the commercial vehicle industry. Designed to address the critical challenges of overloading, operational inefficiency, and safety compliance, the NEW-T3000 leverages axle-strain measurement technology and sophisticated algorithms to deliver unparalleled accuracy ($\pm 1-2\%$). At a fraction of the cost of traditional European solutions (e.g., VPG, VEI), our system provides a rapid return on investment (ROI) by eliminating scale fees, preventing overweight fines, optimizing load efficiency, and enabling data-driven fleet management. This document details the technical architecture, innovative core technology, and quantifiable benefits of adopting the WEIGH2X solution for modern fleets.

1. The Challenge: The High Cost of Weight Management Inefficiency

North American fleet operators face mounting pressure from stringent DOT regulations, rising operational costs, and intense competition. The traditional reliance on static scales creates significant bottlenecks:

- **Overweight Fines:** Costly violations and vehicle downtime.
- **Operational Inefficiency:** Long queue times at scales reduce daily trips and revenue potential.
- **Lack of Real-Time Data:** Inability to monitor loading processes leads to guesswork and suboptimal load distribution.
- **Vehicle Wear and Safety Risks:** Chronic overloading accelerates wear on tires, brakes, and suspensions, increasing maintenance costs and safety hazards.

While OBW systems are a proven solution, the market has been constrained by high-cost, low-accuracy options that fail to deliver a compelling ROI.

2. WEIGH2X On Board Weighing System

The NEW-T3000 is a comprehensive, end-to-end solution comprising hardware, software, and cloud services.

System Composition



Fig1 :System Architecture Diagram

High-Precision Strain Gauges(H200): The core sensing element, securely bonded to the truck axle.

Edge Computing Controller (GC50): A robust, IP68-rated module that performs real-time signal processing and data computation.

In-Cab Display(NEW-T3000): Provides instant weight feedback to the driver.

IoT Platform: A SaaS portal offering fleet-wide data analytics, historical reports, overload alerts, etc..

3. Technical Deep Dive: Engineering Superiority

3.1 Overcoming Fundamental Measurement Challenges

Challenge: Measuring Microscopic Deflection. Axle deflection under load is minimal (~1% of leaf spring deflection), demanding extreme sensor sensitivity.

Our Innovation: Proprietary sensors with high sensitivity (2V/ε) coupled with ultra-low-noise amplification circuitry (0.02% resolution) capture micro-scale changes.

Challenge: Ensuring Environmental Stability. Temperature fluctuations and vehicle vibration are primary sources of measurement error.

Our Innovation: Proprietary Intelligent Temperature Compensation and Vibration Compensation Algorithms neutralize thermal drift ($<0.05\%FS/^{\circ}C$) and mechanical noise, ensuring reliability from $-20^{\circ}C$ to $60^{\circ}C$.

Challenge: Guaranteeing Manufacturing Consistency.

Our Innovation: Pre-packaged sensor technology and a symmetric bridge design ensure consistent performance and durability across mass production.

4. Why Axle-Strain Measurement is the Superior Technical Path



Technology	Principle	Limitations / Challenges	Impact on Accuracy & Notes
Strain Gauge-Based (Axle)	Direct measurement of strain on the load-bearing axle.	Requires high-sensitivity sensors and precise installation.	Minimal. Compensated by advanced algorithms. Achieves stable accuracy of ±1-2% FS (Full Scale).
Leaf Spring Strain	Measures bending deformation of the leaf spring using strain gauges.	Material Creep and Hysteresis: Causes signal drift. Aging: Accuracy degrades with fatigue.	Significant. Inherent material limitations. Typical accuracy 3-5% FS .
Air Suspension System	Infers load by measuring pneumatic pressure within the air springs.	Indirect measurement: Affected by friction, temperature, and vehicle inclination.	Severe. Prone to systemic errors exceeding 10% FS on slopes or with temperature fluctuations.

Conclusion: The NEW-T3000's Axle-Strain method provides a direct, fundamental measurement free from the systemic errors that plague alternative technologies.

Performance Benchmarking Table

Parameter	NEW-T3000	Typical Leaf Spring Strain-Based OBW	Air Suspension / Gyro-Based OBW
Accuracy (Full Scale)	±1% - 2%	±3% - 5%	±5% - 10%
Response Time	<1 ms	Slow, with hysteresis (drift)	Slow (requires stabilization)
Installation Complexity	Low (Adhesive Mount)	Medium (Mechanical Clamping)	High (Plumbing & Calibration)

Parameter	NEW-T3000	Typical Leaf Spring Strain-Based OBW	Air Suspension / Gyro-Based OBW
Lifespan	Life of the Axle	Limited by spring fatigue	Limited by mechanical wear of components
Cost (Hardware + Integration)	~\$2,000+	\$5,000+	\$5,000+



5. Quantifiable Benefits and ROI

- 1. Eliminate Overweight Fines:** Prevent thousands of dollars in fines and downtime by ensuring compliance in real-time.
- 2. Maximize Load Efficiency:** Optimize every trip to approach legal limits safely, increasing revenue per journey.
- 3. Reduce Operational Costs:** Cut scale fees and reduce vehicle wear and tear, lowering total cost of ownership.
- 4. Enhance Safety & Security:** Prevent overloading hazards and monitor high-value cargo.
- 5. Data-Driven Management:** Leverage cloud analytics to benchmark driver performance, plan routes, and optimize fleet operations.

6. Case Study: Proven Results in the Field

Case Study 1: Bulk Terminal Operator Achieves 20% Efficiency Gain

Background:

A bulk handling operator at a major port sought to boost the efficiency of its existing fleet through digital transformation. Its trucks averaged approximately 10 daily trips between the dock and the yard, but the reliance on static scales provided no real-time guidance for loading operations.

Solution:

The fleet was integrated with the NEW-T3000 onboard weighing system, which enabled high-precision, real-time weighing during the loading process.

Result:

Real-time data allowed for precise optimization of loading operations, entirely eliminating delays previously caused by over- or under-loading estimations. This intervention increased average daily trips from 10 to 12 per truck, corresponding to a 20% increase in daily hauled tonnage and a significant boost in operational productivity.

Case Study 2: Electric Truck Fleet Establishes Data-Driven Energy Benchmark

Challenge:

An operator of an identical-model electric truck fleet observed significant monthly variations in energy consumption. However, differing workloads and a lack of precise load data made it impossible to establish a reliable energy efficiency benchmark or identify underperforming vehicles.

Solution:

Integration of the NEW-T3000 system provided accurate data on the cumulative weight hauled by each vehicle per month.

Result:

The fleet manager gained the ability to perform precise, load-normalized comparisons of energy consumption across the fleet. By calculating the median energy use and identifying maximum deviations, a credible performance benchmark

was established. This data-driven approach enables targeted performance reviews and maintenance for outliers, driving down the fleet's overall energy consumption.

Case Study 3: Empowering Port Autonomous Trucks with Enhanced Algorithm Stability and Intelligent Control through Real-Time Load Analytics

Challenge: A leading L4 autonomous trucking company specializing in port operations faced a critical gap in their perception system. Their existing approach relied on indirect mass estimation through powertrain torque output and acceleration response modeling—a method that yielded errors exceeding $\pm 15\%$, suffered from significant response lag, and failed to provide axle-specific load distribution data. This uncertainty in real-time vehicle mass severely limited their ability to optimize braking and steering algorithms across varying load conditions, creating safety margins that compromised operational efficiency. Without accurate, instantaneous weight data, their autonomous systems couldn't differentiate between an empty and fully-loaded vehicle quickly enough to adjust control parameters—a fundamental requirement for safe autonomous operation in dynamic port environments.

Solution: We deployed our GH200 strain sensors with GC50 signal processors directly on the vehicle axles, transforming weight measurement from estimation to direct sensing. The system achieves $\pm 2\%$ accuracy in static conditions and maintains within $\pm 5\%$ accuracy during vehicle operation through advanced Kalman filtering algorithms. Unlike indirect methods, our solution provides instant, axle-specific load data via CAN bus integration into the autonomous vehicle's perception layer. This real-time mass and center-of-gravity information enables dynamic adjustment of control parameters with no lag—a 3x improvement in accuracy and elimination of the response delay that plagued their previous approach.

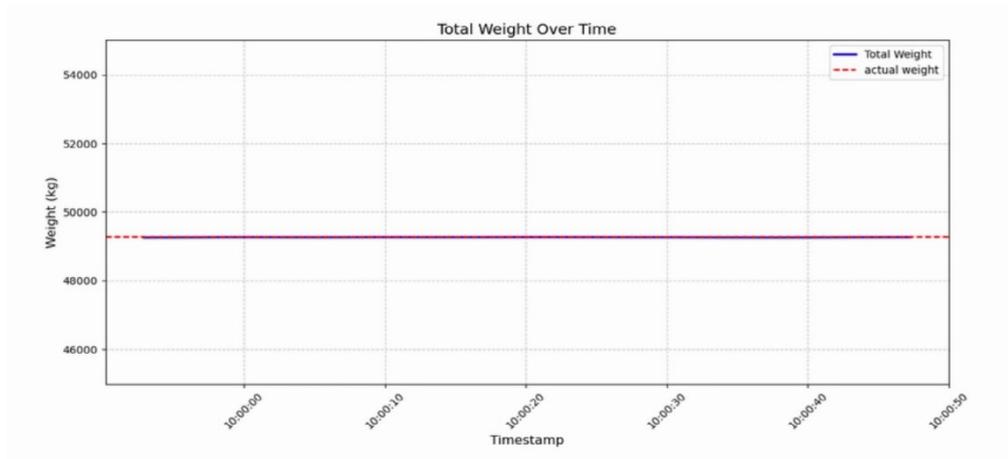
Result: The precision weight data transformed the autonomous system's performance. With accurate mass information replacing unreliable estimates, the vehicle achieved 35% reduction in braking distance variance and 28% improvement in steering response consistency across load conditions (0-40 tons). The elimination of the $\pm 15\%$ weight uncertainty allowed the engineering team to tighten control tolerances, improving both safety and efficiency. The system now maintains stable performance whether running empty or fully laden, accelerating the client's path to commercial deployment. This implementation has become the reference architecture for autonomous port vehicle weight sensing, with the client reporting it as a "game-changing enhancement" to their perception stack.

7. The Foundation for Adaptive Driving: Mass as a Critical State Variable

■ Field Measurement chats and Filtering

The field measurement primary data source is a six-axle tractor-trailers.

Over the course of the 50-minute test, the sensor output maintained strong linear correlation and exceptional stability.

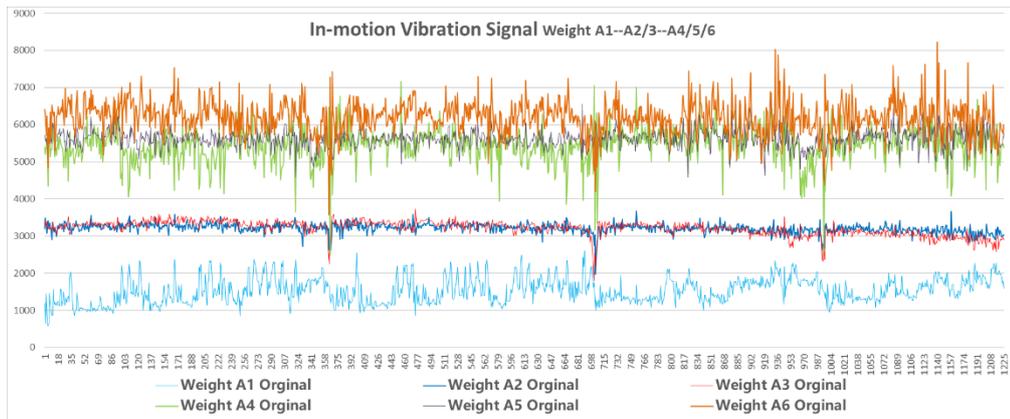


Real-time vehicle control requires high-frequency data, the accurate knowledge of a vehicle's static total mass is the foundational parameter upon which all dynamic calculations are built. Our Weigh2x system provides this critical baseline with industry-leading $\pm 2\%$ FS Composite Error, $\pm 1\%$ FS Linearity Error and $\pm 1\%$ Repeatability Error accuracy.

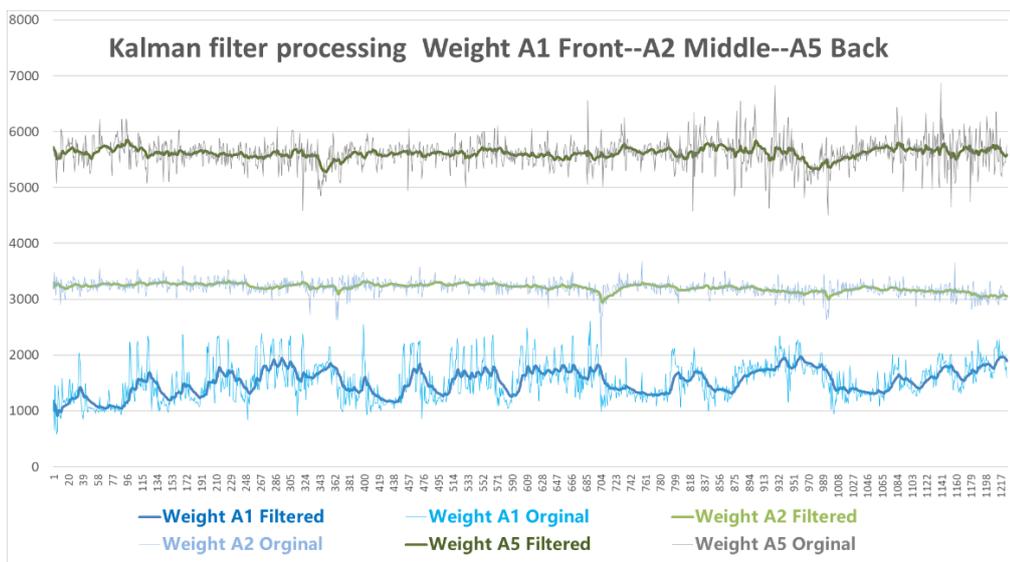
Total mass directly determines a vehicle's inertial properties. By providing this data via vehicle CAN bus, our system enables Advanced Driver-Assistance Systems (ADAS) to proactively adjust stability control (ESC), anti-lock braking (ABS), and traction control (TCS) thresholds before a maneuver is initiated, significantly enhancing safety for heavy-duty vehicles.

■ In-motion Vibration Signal

The in-motion vibration signal contains signatures of both road excitation and vehicle body resonance.



Now the **0.5Hz data** provides exceptional accuracy for static and quasi-static load monitoring. While **insufficient for vibration analysis**, as a critical input for calculating vehicle stability metrics.



Our current system provides a highly accurate baseline vehicle weight at a 0.5Hz rate. The essential next phase of development involves adding high-frequency motion sensors (IMUs). By fusing our trusted weight data with these rapid motion measurements, we will create a real-time picture of dynamic forces—such as load transfer in a turn or during braking—providing the critical data required for autonomous vehicle control.

8. About US: A Trusted Technology Partner

sustainability, flood resilience, and connected communities.

Our founding leadership team brings together world-class expertise from academia, industry, and public service. It includes Dr. Jeff Yang, former Senior Physical Scientist and Acting Associate Division Director at the U.S. EPA, with extensive experience in environmental research and technology consulting; Dr. Heng Wei, Professor of Intelligent Transportation Systems and ASCE Fellow from the University of Cincinnati, a recognized academic leader with longstanding contributions to intelligent infrastructure systems; and a former Industry Client Executive from Siebel/Oracle. They are supported by an experienced R&D team with top graduates from Tsinghua University in precision instrumentation, creating a unique fusion of theoretical knowledge, commercial expertise, and practical application.

Building upon patented innovations in mathematical modeling, industrial AI, edge computing, and IoT systems, we are developing integrated solutions that span research, consulting, engineering, and implementation. Our work supports heavy-duty industries including construction machinery, mining operations, transportation systems, and waste management, while advancing urban resilience through intelligent infrastructure and environmental technologies, with specialized capabilities in flood prediction and mitigation systems.

The Institute is establishing partnerships with government agencies, industry leaders, and academic institutions worldwide to transform urban landscapes into safer, more sustainable, and resilient environments for future generations.

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