HUMATICS DIGITAL TRAIN POSITIONING SYSTEM

PRECISION IN ALL OPERATING ENVIRONMENTS

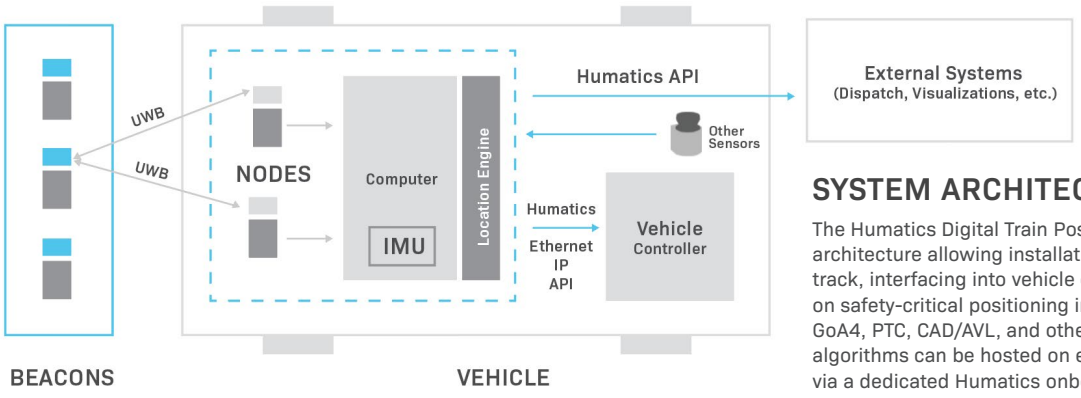
The Humatics Digital Train Positioning System is a drop-in replacement for traditional railway odometry sensors such as tachometers, single-axis accelerometers, and transponders (balises). Humatics technology is directly applicable for transit modes including mass transit, commuter or regional trains and trams, work trains, and freight rail. Humatics' core system consists of a sensor fusion localization software and hardware odometry solution using Ultra Wideband (UWB) sensors, inertial measurement unit sensors (IMU's), and Global Navigation Satellite Systems (GNSS) where available. The system is expandable to ingest next generation sensors as needed. The system provides high-availability and ultra-precise position, speed, and acceleration to vital and non-vital onboard systems for signaling, train control, yard and depot management, platform screen door control, grade crossing detection, passenger information displays, and other positional based applications of interest.

The Humatics Digital Train Positioning System uses the right sensor to solve the right problem at the right cost point. In open-air environments, position is calculated by GNSS and IMU sensors with no wayside infrastructure. In urban areas with degraded GNSS and urban canyons, wayside UWB beacons are installed at key locations to ensure precise positional coverage. In GNSS-denied environments such as tunnels and where high-precision is required, UWB beacons serve as a bubble of positional coverage only where necessary to achieve centimeter-level positioning.

BENEFITS

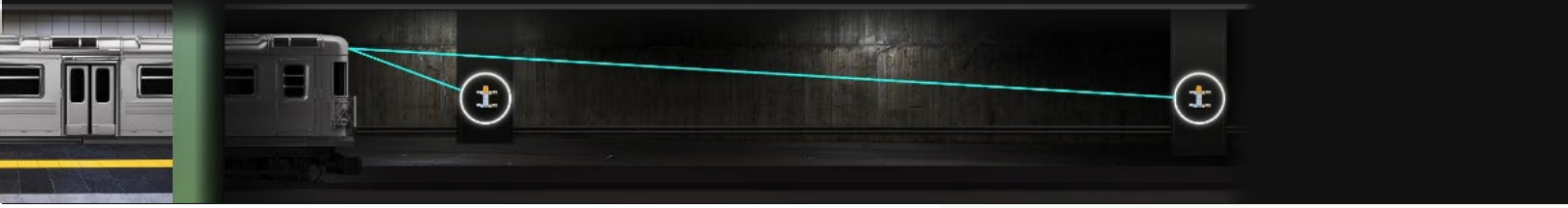
1. Precision positioning in open air, urban canyons, and tunnels with low to no infrastructure required
2. Position and speed are immune to wheel slip/slide
3. Rapid installation and servicing of both onboard and wayside equipment
4. Reduced total cost of ownership by eliminating undercarriage and in-track equipment
5. Full yard automation with a fraction of equipment compared to traditional yard automation
6. Future-proofing for advanced virtual coupling, automated train rescue, and platform screen door integration

Humatics develops system architectures to integrate train control systems, meet functional requirements, and meet Reliability, Availability, Maintainability, and Safety (RAMS) targets. In the process of doing so, we balance the tradeoffs between positioning precision and cost of deployment, while incorporating diverse sensors into the architecture to eliminate common mode failures. Humatics is excited to support transit agencies and improve headways, efficiency, and operations for customers worldwide.



SYSTEM ARCHITECTURE

The Humatics Digital Train Positioning System has a simple architecture allowing installation within any vehicle and on any track, interfacing into vehicle controllers and systems that depend on safety-critical positioning information: CBTC, ERTMS/ETCS, GoA3, GoA4, PTC, CAD/AVL, and others. Humatics proprietary positioning algorithms can be hosted on existing computing hardware or added via a dedicated Humatics onboard processor.



APPLICATIONS

SIGNALING & TRAIN CONTROL

Replace legacy odometry systems such as wheel sensors and track-mounted transponders. Interfaces with Communication-Based Train Control (CBTC), European Train Control System (ETCS/ERTMS), Positive Train Control (PTC), and transit CAD/AVL systems. Train-to-train and train-to-wayside ranging communications enable advanced autonomous applications such as virtual coupling and digital platooning.

PLATFORM SCREEN DOOR AND BERTHING CONFIRMATION

Enable precision stopping and proper berthing confirmation with full integration to modern platform safety systems. Integrate with platform screen door controllers providing accurate and timely train-at-stop and door control and status information to SIL-4 door controllers.

GRADE CROSSINGS

Continuous positioning and speed powers smart grade crossing solutions, drastically improving crossing activations and minimizing cross-traffic impediments. A data interface that is adaptable to any crossing controllers ensures compatibility.

YARD AND DEPOT AUTOMATION AND MANAGEMENT

Automation and efficient yard management are enabled by real-time positioning in yards and maintenance facilities with minimal infrastructure required.

REAL-WORLD PERFORMANCE

Humatics has recently operated in multiple real-world scenarios:

1. **New York City:** In continuous shadow-mode operation on the Canarsie and Jamaica lines since 2019. Multiple hundreds of thousands of hours with no significant operational issues. Passed CBTC functional testing including ATO, ATP, and ATS. Partnering with Siemens and the MTA.
2. **Naples, Italy:** Operating on a test track for 12+ months. Passed all relevant and required testing for positioning performance. Partnering with Hitachi Rail.
3. **Canada:** Performed successful test of sparse deployment architecture with infrastructure only at station stops, switches, and other areas with high precision needs.

SPECIFICATIONS

PERFORMANCE
Provides position, speed, acceleration, direction, and associated uncertainties for vital operations
+/- 5cm vehicle positioning precision under 20mph (32 Kmph), safety-critical train at stop detection
+/- 30cm positioning precision under 200mph (322 Kmph)
Flexible sensor fusion with GNSS, Lidar, Eurobalise, and other commonly used odometry technologies with the capability of adding new sensors over time as needed
Processing algorithms can be hosted on existing onboard computers or separate Humatics processors added to vehicles

RELIABILITY
Wayside Beacon MTBF > 600,000 hours
Carborne Node MTBF > 165,000 hours
Carborne Computer MTBF > 52,000 hours

STANDARDS	
IEC 62278 / EN 50126	Specification and demonstration of reliability, availability, maintainability and safety (RAMS)
IEC 62279 / EN 50128	Software for railway control and protection systems
IEC 62280 / EN 50159	Safety-related communication in transmission systems
IEC 62425 / EN 50129	Safety-related electronic systems for signaling
IEC 62443	Industrial Automation and Control Systems (IACS) cybersecurity
IEEE 1474.1, 1474.4	Communications-Based Train Control (CBTC)
AREMA	Communications and Signals
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests
NFPA 130	Fire protection and life safety requirements for underground, surface, and elevated fixed guideway transit and passenger rail systems.
IEC 61373	Rolling stock equipment – Shock and vibration tests
IEEE 1478	Environmental Conditions for Transit Railcar Electronic Equipment
EN 50121	Railway applications. Electromagnetic compatibility
EN 60529	Degrees of Protection Provided by Enclosures (IP Code)
EN 50125	Railway applications – Environmental conditions for equipment, Part 3: Equipment for signalling and telecommunications

UWB	
Range:	Line of sight, up to 500 meters
Ranging Precision:	Architecture-dependent, can be as low as +/- 2cm
Operating Spectrum:	4 - 4.9 GHz
Unique beacon IDs and channel codes protect transmission and enhance security	
Real-time diagnostics available for ease of maintenance	
FCC Part 15 Compliant	
ETSI EN Compliant	

IMU
Triaxial Accelerometer, Dynamic Range of +/- 40g
Triaxial Gyroscope, Dynamic Range of +/- 2000 degrees/second

CARBORNE EQUIPMENT	
Interface:	Ethernet IP
Navigation Computer Input Power:	5-48 VDC, nominal 37.5V
Power Consumption:	< 15 Watts @37.5V
Ambient Operating Temperature:	-40C to +70C
Mechanical Shock & Operating Vibration:	IEC 61373 Compliant
Ingress Protection:	IP 67

WAYSIDE BEACONS	
Input Power:	5-48VDC
Power Consumption:	< 5 Watts
Ambient Operating Temperature:	-40 to +70C
Mechanical Shock & Operating Vibration:	AREMA Communications and Signal Manual (C&S) Compliant
Ingress Protection:	IP 67