



## THE CHALLENGE

For many transit agencies, the path to safer, more reliable train operations runs directly through Automatic Train Protection. ATP is not a luxury — it is the foundation of modern train control, providing the critical safety functions that protect passengers, operators, and infrastructure from the consequences of human error. Yet for agencies that don't require the full complexity of a Communications-Based Train Control system, the traditional answer has been an uncomfortable one: either invest in a full CBTC program — with its multi-year timelines, significant capital cost, and extensive infrastructure disruption — or continue operating with aging signaling systems that carry inherent safety limitations.



### THE ATP IMPERATIVE

Piper's Automatic Train Protection changes that equation — delivering the critical safety functions of ATP through an overlay approach that works alongside your existing signaling infrastructure, without the cost, complexity, and disruption of a full CBTC program.

## PIPER'S APPROACH: ATP OVERLAY (ATP-O)

*An overlay design that works alongside your existing signaling infrastructure*

Piper's ATP solution is built around an overlay design — referred to as ATP-O — that assumes retention of your existing signaling system and adds a layer of vital, CENELEC SIL-4 (Safety Integrity Level 4) certified protection on top of it. This approach is similar in concept to how Positive Train Control (PTC) operates on freight and intercity rail: the existing infrastructure stays in place, and the ATP system works alongside it to enforce critical safety rules.

At its core, ATP-O uses Piper's Rail Positioning System — the same multi-sensor platform of Ultra Wideband (UWB), solid-state LiDAR, and GPS-RTK that underpins Piper's Vital Train Positioning solution — to continuously determine the precise location, speed, and direction of every train on the network. That positioning data feeds directly into Piper's onboard Safety PLC, which monitors train behavior against a set of protection rules and initiates braking when those rules are breached.

<p><b>FOUNDATION</b> <b>Existing Signaling</b> Your current infrastructure stays in place. No rip-and-replace. Operations continue normally throughout deployment.</p>	<p><b>LAYER 1</b> <b>Multi-Sensor Positioning</b> UWB, TrackSight™ LiDAR, and GPS-RTK deliver continuous SIL-4 certified position and speed for every train.</p>	<p><b>LAYER 2</b> <b>Safety PLC — ATP-O</b> Onboard Safety PLC monitors protection rules in real-time and initiates braking automatically when any rule is breached.</p>	<p><b>RESULT</b> <b>Automatic Train Protection</b> Comprehensive, SIL-4 rated protection competitive with full CBTC — deployable in a fraction of the time and at a fraction of the cost.</p>
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Piper's ATP solution is designed to operate across a wide range of rail environments — from light rail and streetcar networks to heavy rail and commuter operations. The multi-sensor positioning platform adapts to each environment: UWB for underground and GPS-denied areas, GPS-RTK for above-ground mainline operations, and TrackSight™ LiDAR for train-centric positioning where wayside infrastructure must be minimized.

## KEY PROTECTION FUNCTIONS

Nine vital protection functions, each enforced through the onboard Safety PLC and supported by SIL-4 certified positioning

### ONBOARD SAFETY PLC — THE ENFORCEMENT LAYER

Every protection function is enforced through Piper's onboard Safety PLC, which receives continuous positioning data from the multi-sensor platform, monitors train behavior against a defined set of protection rules, and initiates braking automatically when those rules are breached. Operators receive progressive advisories before any automatic intervention is applied.



**Piper Train Operator Display** — Real-time collision avoidance and warnings delivered to the operator.



**Piper front sensor assembly** — UWB tag and TrackSight™ LiDAR mounted on the train bonnet.

#### CA Collision Avoidance

Real-time separation monitoring

Utilizing real-time position data for all trains in service alongside the track database, the system continuously monitors separation between trains and anticipates potential conflicts. Operators receive progressive advisories as safe separation thresholds are approached, with full service braking applied automatically if advisories are ignored.

#### OS Overspeed Protection

Continuous speed monitoring against track database

The system continuously monitors train location and speed, comparing onboard telemetry against a database of track data — including grade, civil speed limits, and proximity to other vehicles and hazards. Braking curves are accurately calculated at all times. Operators receive speed advisories, with full service braking enforced when train speed becomes hazardous.

#### RS Red Signal Overrun Protection

Automatic enforcement at restrictive aspects

The system detects the aspects of all signals in the territory and transmits this information to the train operator in real-time. When a train approaches a restrictive signal aspect and onboard advisories are ignored, the system applies a full service brake function automatically — preventing signal overruns that can lead to dangerous conflicts.

#### RB Rollback Protection

Detection of unintended movement

The system detects small fluctuations in train movement and enforces a brake action in response to unintended rollback — a particular risk on grades and at station stops where trains may begin to move in an unintended direction before departure.

#### WZ Work Zone Protection

Real-time TSR and work zone enforcement

Piper's onboard navigation computer can be updated in real-time with Temporary Speed Restrictions (TSRs) and work zone locations, enforcing protection rules automatically as trains approach and traverse active work zones.

#### ET End-of-Track Protection

Consistent safety layer across track limits

Positioning data covers the full extent of the network including track limits. End-of-track protection is enforced in the same manner as red signal protection — providing a consistent safety layer across the territory without separate detection hardware.

#### PC Parted Consist Protection

Coupling & decoupling detection

The dual-ended ranging design of the Rail Positioning System provides simultaneous positioning data from the front and rear of the train. This data is used to measure consist length and trigger braking from both units (A1/A2) automatically in the event of an unintended decoupling.

#### DI Departure Interlocks

Optional integration with door controllers

For crew-operated trains, Piper can integrate ATP-O with third-party door controllers to enforce departure interlocks — ensuring all doors are properly secured before the system permits the train to proceed on its route.

#### EB Emergency Braking

Automatic or manual activation integrated with Safety PLC

Integration with Piper's Safety PLC provides emergency braking functionality that can be activated automatically in response to the breach of any critical protection rule, or manually by the operator when required. The emergency braking function is independent of other protection layers and operates as a last-resort safety backstop.

# HOW THE SYSTEM WORKS

ATP-O is built around three integrated layers — carborne, wayside, and back office — working together to deliver continuous, vital-rated train protection



**LAYER 1**  
**Carborne**  
 Onboard sensors, computing & enforcement

**Front sensor assembly** — UWB Sensor and TrackSight™ LiDAR on the front of a light rail vehicle.

Each train is equipped with Piper's multi-sensor positioning assembly, an Onboard Control Unit (OBCU), and a Safety PLC — continuously determining position, speed, and direction and enforcing protection rules in real time.

**UWB Tag (ETLS™)**

Front and rear bonnet-mounted. Ranges with wayside anchors for inch-level positioning in tunnels and GPS-denied areas.

**TrackSight™ LiDAR**

Train-centric solid-state LiDAR for positioning, obstacle detection, and worker detection — no wayside infrastructure required.

**GPS-RTK Receiver**

Centimeter-level above-ground positioning. Seamlessly hands off to UWB/LiDAR underground.

**Safety PLC & OBCU**

Fuses all sensor inputs into one validated output. Enforces ATP-O protection rules and commands braking when any rule is breached.



**LAYER 2**  
**Wayside**  
 Fixed anchors & RTK base stations

**UWB anchor** — Mounted to tunnel wall with Piper's custom bracketry. No trackbed equipment required.

Wayside equipment provides the fixed reference infrastructure that carborne sensors range against. All hardware is installed on tunnel walls, girders, and poles — never on the trackbed, eliminating disruptive track possessions during installation.

**UWB Anchors**

Mounted on tunnel walls and wayside structures. Installed under flagging — no General Orders required.

**GPS-RTK Base Stations**

Deployed approximately every 50 miles along the right of way. 35 stations currently cover the entire Northeast Corridor.

**Wayside Interface Units**

Interface with existing signals to relay aspect data to onboard systems in real time — supporting red signal overrun protection without modifying existing infrastructure.



**LAYER 3**  
**Back Office**  
 Network management, monitoring & configuration

The Piper back office provides real-time visibility across the entire network — managing configurations, distributing track database updates, monitoring system health, and logging all protection events for audit and review.

**Fleet Manager**

Real-time map of all train positions, movement authorities, and track points of interest for control room operators and maintenance supervisors.

**Track Database Management**

Centralized management of track geometry, speed profiles, and work zone configurations. Updates pushed to onboard systems in real time.

**Health & Event Monitoring**

Continuous monitoring of onboard and wayside equipment health. Protection events — advisories, brake interventions, faults — logged for post-event review and safety reporting.

**Piper Dashboard** — Real-time monitoring of train locations and various transit points of interest.

**LIGHT RAIL & STREETCAR**  
 UWB and TrackSight™ LiDAR provide positioning where wayside infrastructure must be minimized. Applicable to at-grade, embedded track, and mixed-traffic operations.

**HEAVY RAIL & SUBWAY**  
 UWB is primary in underground environments, with GPS-RTK above ground and TrackSight™ LiDAR providing redundant positioning and obstacle detection.

**COMMUTER & REGIONAL RAIL**  
 GPS-RTK provides centimeter-level above-ground accuracy across long corridors, with UWB covering tunnel segments and terminals.

**YARDS & COMPLEX JUNCTIONS**  
 UWB and TrackSight™ LiDAR deliver primary positioning in GPS-degraded yard environments, where precise track identity and low-speed protection are critical.

# BENEFITS OF PIPER AUTOMATIC TRAIN PROTECTION

<p><b>Vital-rated safety at lower cost</b>          SIL-4 certified protection functions delivered through an overlay approach, leveraging existing signaling infrastructure — reducing capital and program costs significantly compared to full CBTC.</p>	<p><b>Faster path to protection</b>          Incremental deployment means safety benefits are realized sooner. Agencies don't have to wait for a full network cutover to begin protecting trains and passengers.</p>
<p><b>Proven positioning foundation</b>          Built on the same multi-sensor platform already deployed at major US operators — not a new or unproven architecture.</p>	<p><b>Adaptable to your network</b>          Multi-sensor positioning adapts to underground, elevated, and at-grade environments. Applicable to light rail, streetcar, heavy rail, and commuter operations.</p>
<p><b>Compatible with your future</b>          Designed for interoperability with CBTC systems and expandable over time. Your ATP-O investment is protected as your network modernization program evolves.</p>	<p><b>One integrator, end to end</b>          Piper designs, supplies, installs, and supports the complete ATP system. One accountable partner from contract award through revenue service.</p>

**SAFETY STANDARDS**   CENELEC EN 50126   EN 50128   EN 50129   EN 50159   AREMA C&S 11.5.1   IEEE 1478   **SIL-4 — TÜV SÜD**

## DEPLOYMENTS



**MBTA Green Line test train** — Night testing of Piper's ATP system on the Green Line network, Boston.

### MBTA — GREEN LINE TRAIN PROTECTION SYSTEM

Piper was awarded the contract for the Green Line Train Protection System (GLTPS) by the Massachusetts Bay Transportation Authority — currently being deployed to deliver Automatic Train Protection across the network. Provides collision avoidance, red signal overrun protection, and overspeed protection using Piper's SIL-4 certified UWB, TrackSight™ LiDAR, and GPS-RTK positioning platform.

Collision avoidance, red signal overrun, and overspeed protection · Triggers warnings and enforces full service braking for hazard detection

UWB — ETLS™   TrackSight™ LiDAR   GPS-RTK   Currently Deploying

**MTA New York City**  
 Positioning Foundation — 7/Flushing & Canarsie Lines

**UWB Train Positioning** — Piper UWB Anchors, mounted to wayside survey markers, range with the train's UWB devices.

Piper's UWB positioning platform validated in shadow mode alongside the MTA's revenue CBTC system. Demonstrated 2–4 inch positioning accuracy — exceeding the 6-inch specification — across 4,000+ hours of operation.

UWB   PIDS   2–4" accuracy   4,000+ hours

**Amtrak Northeast Corridor**  
 Positioning Foundation — Full Multi-Sensor Platform

**460 installations** — Piper team celebrates milestone deployment across the Northeast Corridor (NEC).

Full multi-sensor positioning platform deployed across Amtrak's Northeast Corridor. 35 GPS-RTK base stations cover the entire NEC, with UWB positioning in all tunnel segments.

UWB   TrackSight™   GPS-RTK   35 base stations