



MODERNIZING THE MTA'S SIGNALING SYSTEM WITH ULTRA WIDEBAND HOW HUMATICS PILOTED UWB WITH THE MTA

THE CHALLENGE

The Metropolitan Transit Authority (MTA) challenged Humatics to propose Ultra Wideband (UWB) train positioning solutions. The pilot would have to prove three things, all within one year: they would have to be viable for train control; meet MTA environmental requirements; and be safety-certifiable.

OUR SOLUTION

Over the course of 10 months, Humatics deployed its Rail Navigation System in partnership with the MTA on 5.5 miles of track in Brooklyn, NY and on four R143 subway train sets, successfully completed functional train control testing and collected terabytes of positioning data for algorithm development.

WHAT WE FOUND:

- Humatics Rail Navigation System is safety-certifiable**
 Meeting all conditions to pursue safety certification including a robust architecture, strict positioning performance metrics, and proof that the tech can be integrated with existing train control systems to ensure its a viable replacement.
- Quicker and less expensive train installation and maintenance**
 UWB train installation is four days per train with no under-vehicle access required. No equipment is mounted underneath the train reducing maintenance costs.
- Environmental and climate resilience**
 UWB technology is proven to work in all weather conditions and installed to minimize flooding impacts
- Clearer trackbeds**
 UWB beacons are installed above the trackbed ensuring they remain out of the way of workers and are less likely to be blocked or moved
- Humatics Rail Navigation System provide real-time health monitoring**
 Real-time insights into wayside infrastructure
- Humatics Rail Navigation System requires fewer UWB beacons**
 Maintain position coverage and accuracy, minimizing maintenance and installation effort
- Continuous navigation throughout the entire right of way**
 Enables additional applications in work-train tracking and maneuver optimization, Capital Construction General Order (GO) efficiency, and worker protection systems. Improving GO efficiency by a meager 1%, for example, could yield up to \$35 million savings annually and reduce service disruption.

The New York City Subway has been the heart of New York City for over a century--always-on, moving six million people per day throughout a complex network of more than 600 miles of rail. With increasing ridership demands and unpredictable climate and emergency events, it has become increasingly important to help the riders to get on their way, on-time, anytime, reliably.

However, the subway's signaling infrastructure sits at the center of the system in a state of disrepair. Dating back to the mid-1900s, over 80 years ago, the signaling infrastructure not only negatively impacts on-time performance and train reliability, but limits capacity on a system expected to accommodate more people year after year.

The Metropolitan Transit Authority (MTA) has installed modern signaling systems over the course of the past fifteen years which have yielded significant improvements, but these systems simply can't be implemented fast enough to improve subway performances needed to accommodate rapid urban growth.

Improving navigation within the system, however, could take some of the burdens off of signaling improvements to deliver more service and better on-time rates.

In 2019, Humatics deployed its Rail Navigation System in collaboration with Siemens and the MTA across 5.5 miles of track on the Canarsie Line in Brooklyn New York, and on four R143 subway trains.

The pilot proved to be extremely successful.

Humatics proved that UWB technology is safety- certifiable, meeting all conditions for certifications across the system; it is hearty enough for the New York City transit environment, holding up against the stresses of use.

Humatics Rail Navigation System is quickly installed, in a matter of hours, meaning riders spent less time waiting for the completion of capital work; it is storm-resistant, mounted five to nine feet above the floor to reduce the chance of flooding; and it reduces maintenance needs by replacing complex and easily-breakable hardware.

Modern Signaling Technology

To initiate the transformation of its transit signaling system, the MTA has implemented Communications Based Train Control (CBTC). CBTC is the worldwide modern signaling standard used to minimize headways, increase capacity and improve reliability over legacy signaling systems.

At the highest level, CBTC has three core functions: navigation, train control, and communications.

Navigation uses discrete transponders installed in the middle of the trackbed and surveyed to identify their exact positions. Equipment mounted underneath the vehicle reads the transponders to determine their exact locations, while other sensors collect information on speed.

Train control uses this navigation information, pairing it with track maps and other data to control the train for speed, braking and maintaining safe headways.

CBTC communications then give a full, system-wide picture of activity, reporting vehicle position to operations centers and onboard train control computers.

Transponders mounted in the trackbed in between the rails are 'read' by an antenna installed under the train. These transponders are exposed to the environment and prone to misplacement during routine maintenance activities.

Similarly, undercarriage CBTC equipment, composed of a variety of sensors and antennas, suffers the tracks' wear-and-tear.

Maintenance for this equipment can be difficult, requiring re-installation which could involve taking up space in an already full maintenance depot.

Humatics can augment CBTC's precision, installation time and reliability. Currently, CBTC's navigation system can take longer to install than an industrial-grade UWB navigation system.

FREQUENTLY ASKED QUESTIONS

What is Ultra Wideband (UWB)?

UWB is a radio frequency technology that uses a very large bandwidth to transmit and receive information used to calculate precise locations. Humatics uses a technique called Two Way Time of Flight (TWToF) along with proprietary algorithms to provide industry-leading ranges over 1,600 feet and precision within one inch.

Is UWB a replacement for legacy train control systems?

No, UWB is not a train control system in and of itself. The Humatics Rail Navigation system serves as a one-to-one replacement for legacy localization equipment such as transponders, transponder interrogator antennas, wheel sensors, and accelerometers while providing precise location information that is processed for train control operations.

What is the difference between Humatics UWB and the UWB that cell phone providers are advertising?

Ultra Wideband in the cell phone provider space refers to 5G high bandwidth millimeter waves that operate at various frequencies for data transmission in consumer and commercial grade services. Humatics provides industrial-grade localization UWB technology that uses proprietary hardware and algorithms to provide highly precise and accurate range/distance measurements.

How Does Humatics' Rail Navigation Solution Work?

Serving as a "drop-in" replacement for train control navigation, the Humatics Rail Navigation System operates similarly to GPS, but for the built environment. Humatics systems consist of proprietary industrial-grade UWB beacons embedded within the train and the fixed wayside infrastructure on the track. The system provides precise location through always-on real-time ranging between the beacons on the train and on the wayside.

Regarded as the pioneer in UWB technology, Humatics industrial-grade UWB offers ranges of up to 1600 feet, precision down to an inch, and robustness against radio frequency (RF) challenges such as multipath and interference. This always-on system uses real-time positioning providing a unified location layer for an entire transit system, allowing system operators and workers to locate trains, assets, and people in real-time.

FASTER INSTALLS, LESS MAINTENANCE, ROBUST

The MTA Pilot has been a rousing success, with faster installation times and less maintenance needed to keep the system in a state of good repair.

Clean Track Beds and Simple Installation

UWB Beacons are mounted several feet above the track bed, as opposed to on the tracks themselves - meaning it's more likely to be storm resistant and less likely to cause delays around flooding and other climatic events in support of climate resiliency efforts.

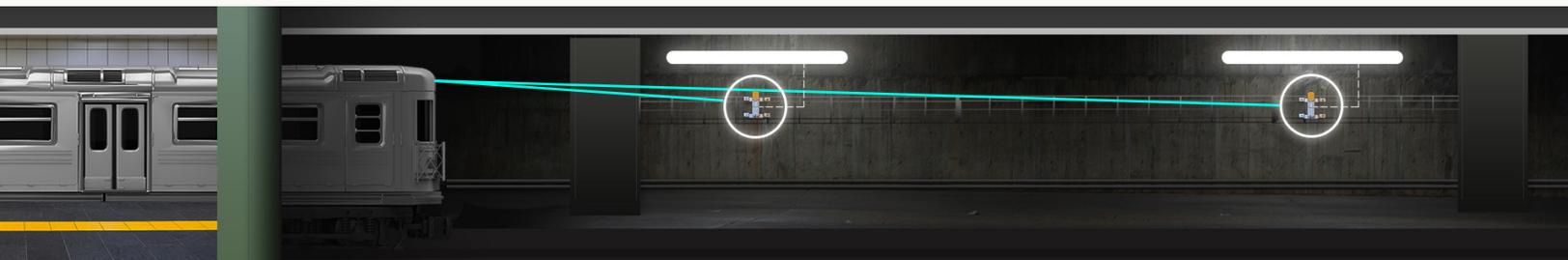
Installed on any infrastructure available - from tunnel walls, chain-linked fence to custom fixtures, simple, standard mounting mechanisms are employed to reduce training requirements and speed up installations.

Faster installation onboard

Similarly, embedding Humatics onboard equipment in the operator cab provides easy access for maintenance and decreases installation time to just four days. Installing the equipment within the train protects the technology from the wear-and-tear associated with undercarriage positioning reducing required maintenance activities.

Robust

Humatics Rail Navigation System has proven itself to survive the harshest transit environments and weather conditions. Designed for ruggedness, the Humatics Rail Navigation system passed all environmental testing required to operate in the MTA system.



To provide precise speed and position, the Humatics Rail Navigation System UWB beacons are installed along the trackside five to nine feet off the ground and within the enclosed bonnet of the train. Humatics UWB beacons on the train and on the wayside communicate using a technique called Two Way Time of Flight, to calculate ranges, or distances, which are delivered to the Humatics onboard computer. Humatics' sensor fusion technology within the onboard computer uses AI algorithms to then combine ranges with train acceleration data, providing an output of precision location, position, and speed. Humatics real-time location data can then be integrated with a train control computer and uploaded onto the cloud-enabling applications beyond train control, continuous analysis, monitoring, and algorithm improvement.

The MTA 2019 UWB Pilot

The MTA challenged Humatics to propose UWB-based train positioning solutions. The pilot would have to prove three things, all within one year: They would have to be viable for train control; meet MTA environmental requirements; and be safety-certifiable.

The project was aggressive in both scope and schedule --- equipping miles of track and going from proposal to substantial completion in 10 months. Success required meeting strict positioning performance metrics, ensuring installation time and maintenance costs were improved over traditional systems, and integrating UWB positioning with existing train control systems to demonstrate UWB as a viable replacement.

MTA's UWB pilot represented the largest, most ambitious deployment of UWB technology ever.

The Humatics Rail Navigation System successfully integrated with the onboard train control system, performed formal train control operations as part of functional testing and, through a rigorous and extended data collection period, proved the ability to locate trains within a few inches meeting the accuracy and precision requirements.

The Humatics Advantage

Backed by a 30-year legacy in Ultra Wideband, Humatics technology offers the most precise, secure, robust and low power rail navigation system on the market. These advantages have made Humatics UWB the "technology of choice" for two of the four winners in the signaling category of the MTA Genius Challenge.

MTA PILOT BY THE NUMBERS

5.5

MILES OF
REVENUE TRACK

242

WAYSIDE BEACONS
average spacing of 300ft /
maximum spacing of 900ft

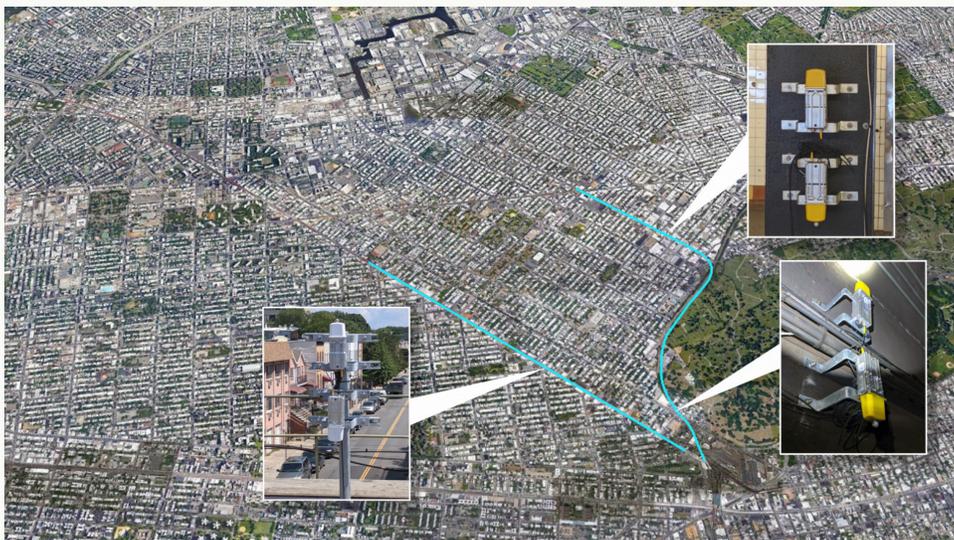
600K+

HOURS
of wayside equipment
uptime to date

4 days to install per
R143 train

Location accuracy to a
foot or less

Contract start to install
completed in **5 months**



The Humatics Rail Navigation System was deployed along the Canarsie Line in Brooklyn, New York



Capital Construction Operating Picture Reduces Go Costs



Worker Protection Ensures Employee Safety

As a navigation company, Humatics leverages its sensor fusion capabilities to apply the right sensors to the challenge at hand: inertial measurements, LIDAR, and cameras when appropriate. Humatics sensor fusion algorithms are designed and built in-house and provide estimates of the train's position and speed as well as continuous uncertainty calculations, enabling use in safety-critical applications.

Software applications such as real-time and historical data visualizations, analytics, and machine learning algorithms enable optimal decision making and identify inefficiencies and bottlenecks. These key features provide futureproof solutions that are easily integrated with third parties.

What's Next

Signaling is just the beginning of potential uses for UWB technology. A single, unified location system could help solve a variety of high-priority problems, such as rider safety, improving reliability, reducing system maintenance, expediting completion of capital programs, and enhancing safety.

Speed up capital projects by helping locate materials, work vehicles, and maintenance issues:

- Lack of visibility into where work trains are and when they will be onsite results in wasted time and project delays. Improving capital construction efficiency could yield up to \$35M savings a year with only a 1% improvement and reduce service disruption.
- Right now, workers mostly use paper records and walkie-talkies to locate materials and work trains within the system. UWB can be used to quickly identify where these critical assets are, in real-time, and get them to the site faster.
- UWB can also be used on the opposite side of the maintenance equation: helping workers precisely identify, or geo-tag, where maintenance needs are to reduce wasted time and maintenance 'misses'.
- In addition to geolocating materials and maintenance orders, UWB could also be used to identify where trains are in rail yards, protecting against incidents by ensuring safe clearances and alerting operators of proper stopping positions.

Protect workers and riders on the tracks:

- Workers identify where they are in the system using antiquated mile markers, that aren't consistent from one line to the next, leading to confusion and disorientation.
- UWB can be used to help workers identify where they are in the tunnel more easily, improving precision from markers Ability to locate a train of interest in an emergency situation.
- Ability to identify the nearest emergency tunnel exits.

Humatics Rail Navigation System Keeps Trains Moving

With the Humatics Rail Navigation System, transit systems can accelerate signal modernization, improve revenue service reliability, reduce system maintenance, expedite completion of capital programs, and enhance worker, rider and system safety through a variety of applications that build upon a single localization foundation.

Would you like to keep your transit system on-time and moving?
To learn more about the Humatics Rail Navigation System, contact transit@humatics.com