

Seamless and Universal
GPS Coverage Extension

SubWAVE™

for Rail

GPS Coverage Extension to support **underground operations**

As the **standard of location worldwide**, GPS positioning is used outdoor by rescue forces to **locate emergency calls**, and by the public to benefit from **guidance**.

With SubWAVE™, it is now available underground as well.

Improving Management

With GPS signal available underground, workers, vehicles and equipments are easily trackable. This real-time view of the assets positions in the network enables real flow optimization.

Safety of the workers is improved as well since SubWAVE™ leverages their GPS-enabled PMR

devices. Collision with trains can be avoided and non-responding worker rapidly located and rescued. As for equipment, GPS tracking can save precious time to find them, and even offer them an efficient anti-thief protection.

Even outside, GPS signal can be weakened by canopies of depots

or stations. This interruption of GPS service may induce lack of compliance towards safety regulations. With SubWAVE™, those specific areas can be provided with a continuity of service to enable PTC active management, both improving traffic and complying with regulations.



Increasing Performance

With GPS emulated underground, SubWAVE™ allows efficient monitoring of traffic flows. Knowing the exact position of every train in real-time, both underground and outside, traffic can be drastically optimized. Any unexpected slowdown or stop is immediately spotted and precious time to adjust is saved.

Moreover, GPS is the backbone of autonomous applications outdoor. Extending its coverage underground, SubWAVE™ enables autonomous driving trains, both for public transport or maintenance operations.

Those maintenance operations benefit as well from GPS

positioning, since spotted default like rail geometry can be precisely located with GPS coordinates, sharable with any GPS-enabled equipment.



Seamless outside/inside transition



Locate vehicles, workers and equipments



PTC active enabled in depots with poor GPS coverage



Optimizing & monitoring flows



GPS-based Rail Geometry Maintenance



Enabling autonomous driving applications

Underground GPS Coverage to support passenger safety & experience

As the **standard of location worldwide**, GPS positioning is used outdoor by rescue forces to **locate emergency calls**, and by the public to benefit from **guidance**.

With SubWAVE™, it has become available everywhere.

Extended Safety

To enhance rescue forces response to emergencies, many safety regulations enable dispatch centers to collect the caller's information. Latitude, longitude and altitude are some of them, and GPS provides them natively on every smartphone, used 80% of the times in emergency calls.

By emulating GPS underground, SubWAVE™ can provide this crucial piece of information to dispatch centers, and help saving precious time and lives.

Moreover, rescue forces are constantly positioned with GPS, to help dispatch centers affect

resources with efficiency. With SubWAVE™, this monitoring is extended underground and rescue forces can even benefit from guidance to optimize their ETA, enhancing their response time.



Enhanced Experience

GPS positioning of trains underground not only enhances traffic management: it offers precious information to share with passengers.

This feed of information can be used by passengers to better plan their journey, particularly if they

use multimodal transportation services: they can include underground trains with the same precision as if they were outside.

And with GPS available indoors, all the usual services used by the public outdoor becomes available underground. Native guidance

apps like Google Maps or Waze can be used without any additional software to install, and provide efficient itinerary considering all the parameters available.



Emergency calls location



Rescue forces optimized action



Passenger information in real-time



Guidance services with native apps



SubWAVE main benefits



SubWAVE™ is a real-time GPS emulator providing signal in facilities out-of-range from natural GPS.

Using telecom network to broadcast, SubWAVE™ emulates GPS signal matching real coordinates, computable by standard chipsets.

Since almost every portable device has a GPS positioning feature, SubWAVE™ allows majority of trackers to keep working underground.

Zone-based or continuous along a path, SubWAVE™ enables efficient positioning, everywhere.

Extension of Universal technology



- ▶ Real-time GPS emulation allowing continuity of GPS service where it cannot naturally get



- ▶ Seamless transition between outdoor and underground Receivers will not even notice they switched to Synthetic GPS

Easy implementation



- ▶ Use of existing telecom infrastructure GPS signal is broadcast through leaky feeders used for coms, or antennas



- ▶ Compatible with existing equipment P25, TETRA equipment, or even smartphones equipped with standard GPS chipset

Built to evolve with your requirements



- ▶ Software-defined-radio architecture allowing remote updates New GNSS constellations, algorithms enhancing precision, etc.

They trust us



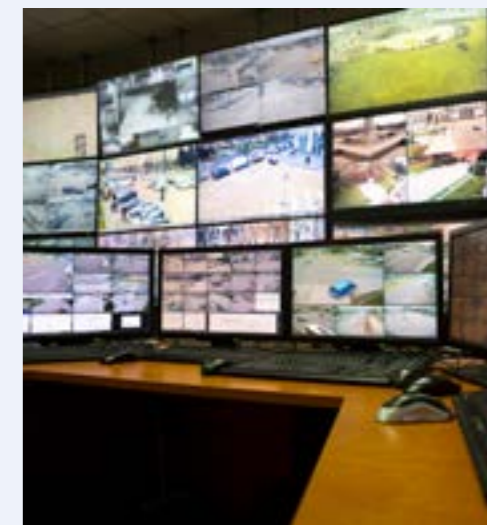
Coordinating Safety Forces in entire Stockholm transportation network with GPS

To coordinate safety forces action throughout Stockholm's transportation network, SL uses GPS to position its teams on ground. This positioning allows the operator to call on the closest team from an incident to intervene fastly and accordingly.

By providing real-time GPS signals in stations and tunnels,

SubWAVE™ enables this use of GPS underground as well.

It allows precise monitoring of assets locations at all times, both above and underground. Third parties like Rescue Forces, or even the public dialing an emergency call benefit from this too, saving precious lives, time, and money.



Enabling trucks platooning in road tunnels by providing GPS signal underground

To develop the truck platooning technology, the "Tunnel du Mont Blanc" operator needs GPS signal to conduct tests in its facility. This GPS feed will be used by trucks to locate themselves along the tunnel and then be able to add a vehicle-to-vehicle (V2V) communication to coordinate with each other, forming a compact autonomous line.

This technique will open the way to autonomous driving protocols based on GPS signal. All users of the tunnel will benefit from this test campaign, as GPS is universal. Guidance services and emergency call location will be extended to the inside of the tunnel, including common apps such as Google Maps or Waze.



Enabling PTC active management in depot with poor GPS reception

Operations did not allow Amtrak Hiawatha trains to select track and be PTC active inside a depot due to poor GPS signal acquisition.

This required the locomotive to occupy main track in a non-enforceable PTC state and was not FRA compliant.

SubWAVE™ solution has offered the GPS coverage extension inside the depot where GPS repeaters do not comply, allowing locomotives to be located and be PTC (positive train control) active to meet safety standards.





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