U.S. Department of Transportation
Federal Railroad Administration

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POSITIVE TRAIN CONTROL

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National Space-Based PNT Advisory Board Meeting – June 2019

Outline

1. What is Positive Train Control (PTC) and Why is it being Implemented?
2. What does PTC do?
3. The Interoperable Electronic Train Management System (I-ETMS)
4. Use of Non-Us GNSS signals for PTC

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What is Positive Train Control?

PTC is a technology capable of automatically controlling train speeds and movements, should a train operator fail to take appropriate action in the prevailing conditions.

PTC MUST reliably and functionally prevent train-to-train collisions, overspeed derailments, incursions into established work zone limits, and movements of trains through switches in the wrong position.

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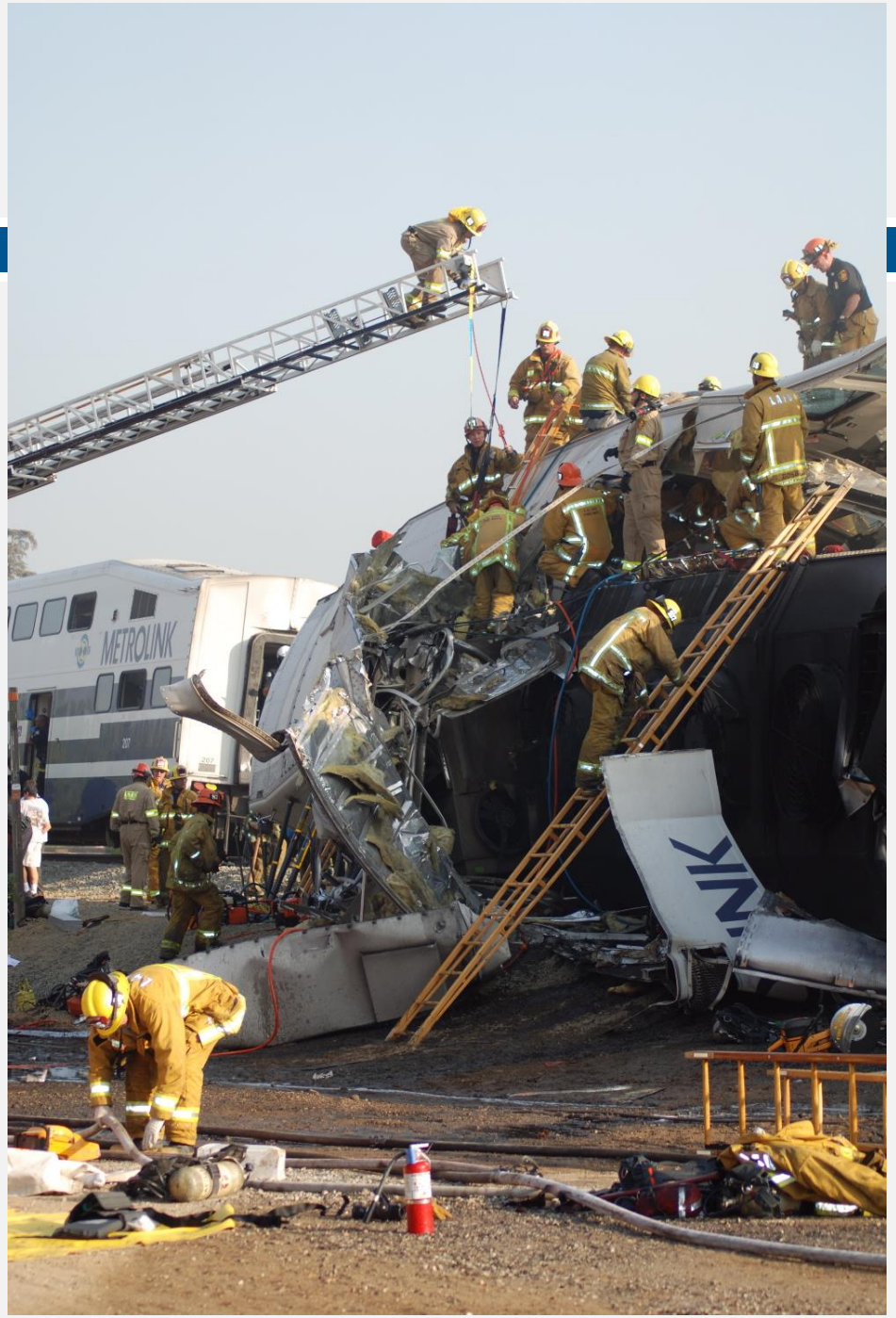
Why PTC?

Chatsworth, CA

September 12, 2008

25 Deaths, 135 Injuries



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PTC is Required by Statute

- Congress passed the Rail Safety Improvement Act of 2008 (RSIA), requiring PTC systems to be fully implemented by December 31, 2015 on:
  - Class I railroads' main lines that transport poison- or toxic-by-inhalation hazardous materials and
  - Any main lines with regularly scheduled intercity or commuter rail passenger service
- In October 2015, Congress extended the deadline for full implementation by at least three years to December 31, 2018, and required FRA to approve any railroad's request for an "alternative schedule and sequence" with a final deadline not later than December 31, 2020, if a railroad demonstrated it met certain statutory criteria by December 31, 2018.

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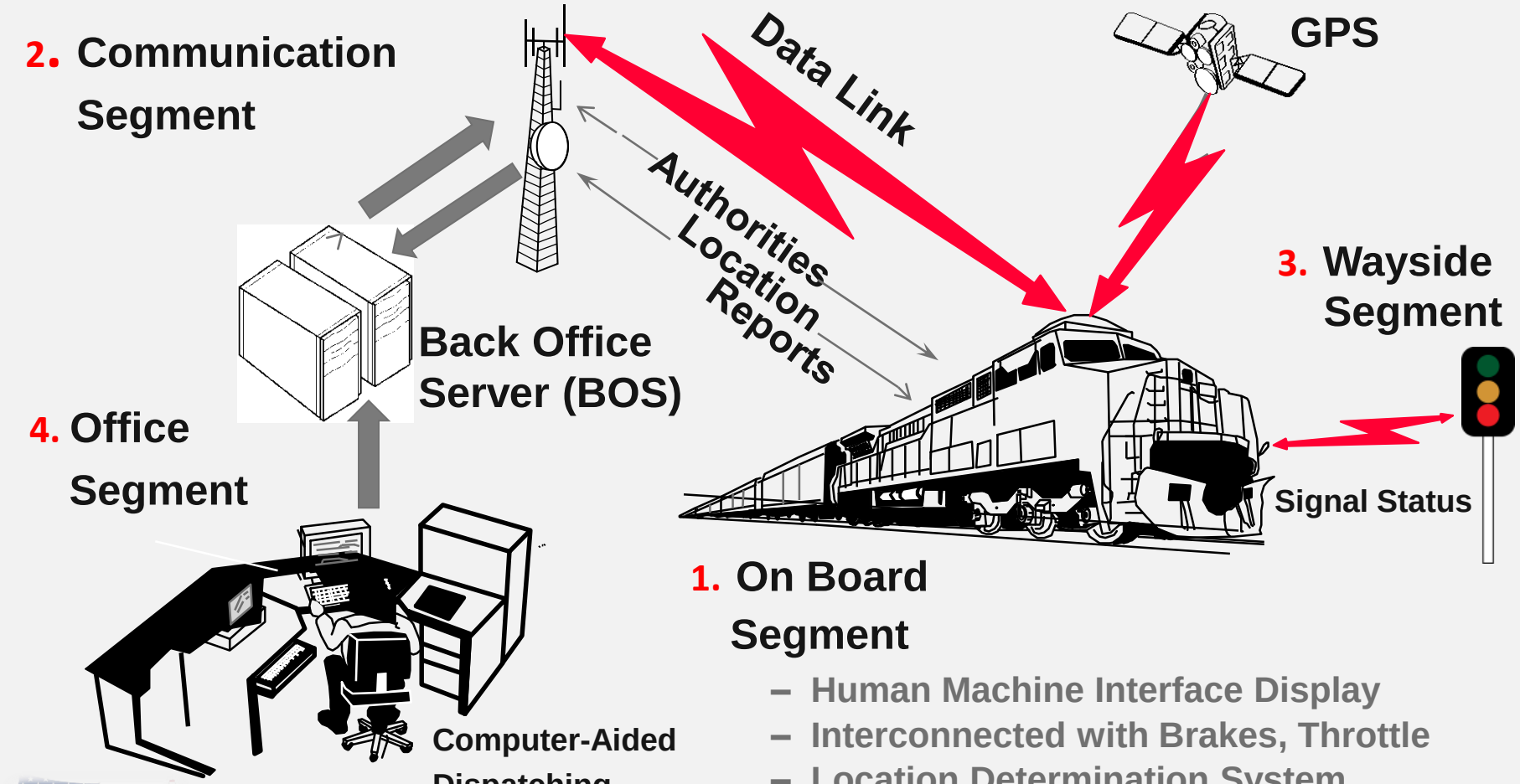
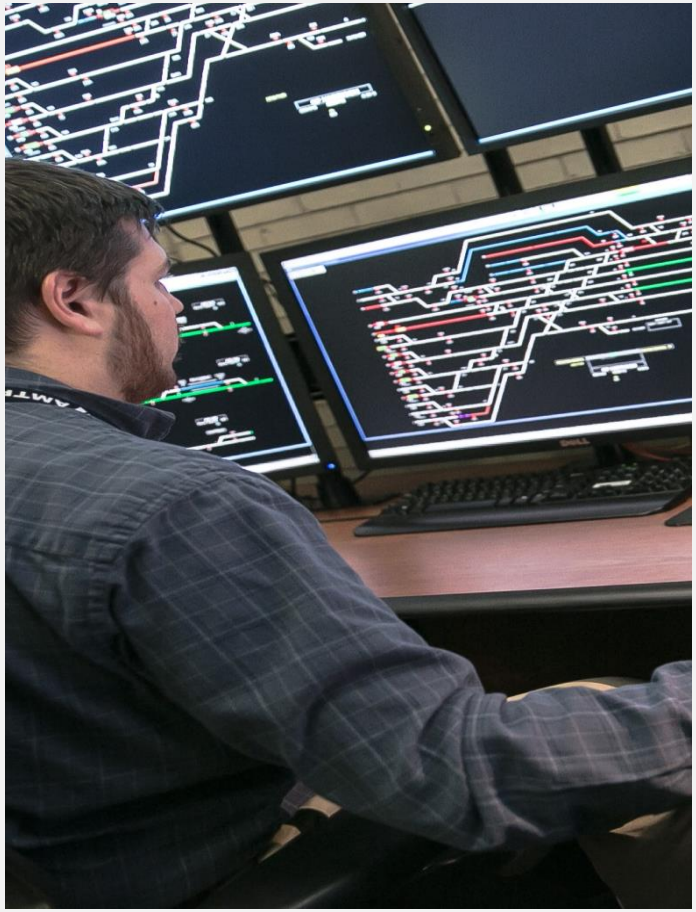
Overview of a PTC System



What does PTC do?



PTC systems that meet the standards set by FRA regulations are required to reliably and functionally prevent:

- ✓ Train-to-train collisions;
- ✓ Over speed derailments;
- ✓ Incursion into an established work zone; and
- ✓ Movement through a main line switch in the improper position.
- ✓ Other functions are applicable within the requirements as specific conditions warrant.
- ✓ Required on most passenger and certain freight routes – with limited exceptions

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Interoperable Electronic Train Management System (I-ETMS)

I-ETMS is designed to:

- ✓ Prevent train-to-train collisions
  - Enforcing stop signals
  - Enforcing “authority limits” (i.e., track a train has permission to occupy)
- ✓ Prevent trains from derailing through excessive speed
- ✓ Prevent trains from entering work zones without proper authorization
- ✓ Prevent movement through an improperly set switch in the main track
- ✓ Provide warning and enforcement at a derail or switch providing access to a main track
- ✓ Provide warning and enforcement in the event of a highway-rail grade crossing warning device malfunction
- ✓ Provide warning and enforcement for a mandatory directive associated “After Arrival Of” train movements

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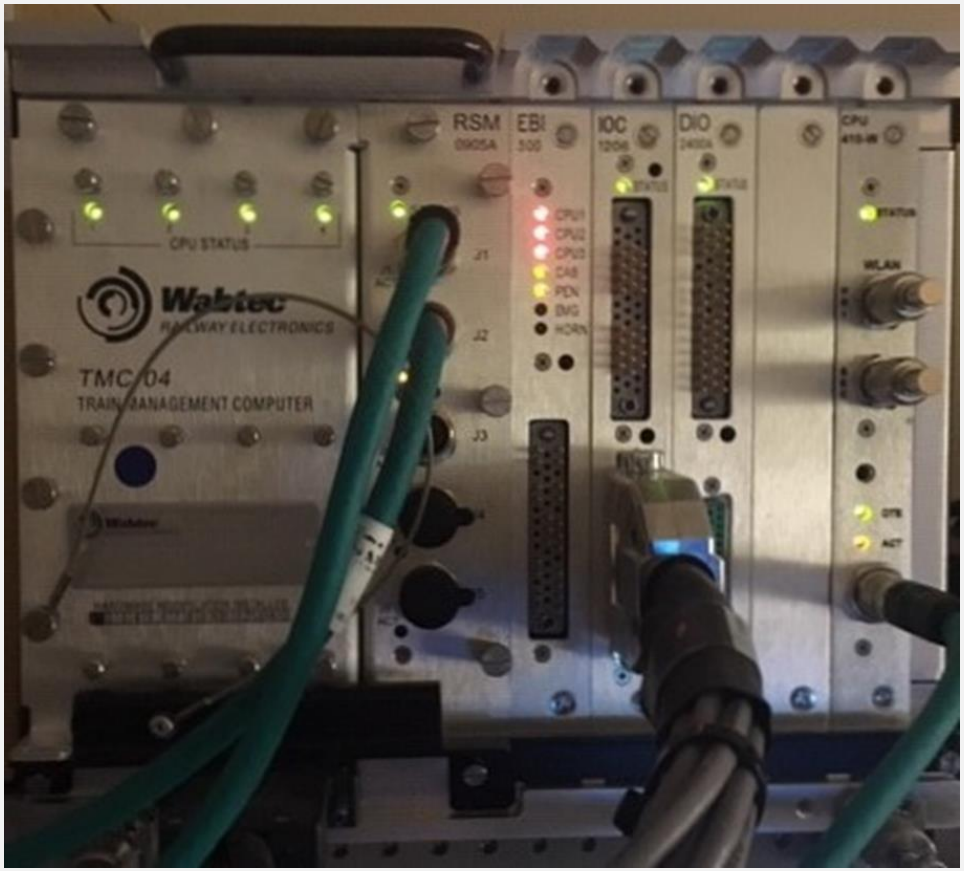
I-ETMS Train Management Computer

The I-ETMS on-board segment employs a Train Management Computer (TMC) that interfaces with the locomotive peripheral devices. The On-Board Computer (OBC) uses a complement of technologies (e.g. GPS, wheel tachometer information, etc.) along with an on-board geo-referenced track database to determine the locomotive's location.



I-ETMS Track Database

The track database contains data elements, some of which are safety-critical, that provide information required to support the I-ETMS navigation function and enforce authorized train movement. These elements include:

- ✓ Geographic location and characteristics of track(s);
- ✓ Permanent (civil) speed limits of track;
- ✓ Location and type of wayside signals or Cab Signal aspect change points;
- ✓ Location of all switches;
- ✓ Location, configuration, and fouling points of switches;
- ✓ Location of all switch clearance points (main and siding);
- ✓ Location of any inside switches equipped with switch circuit controllers;
- ✓ Location of all crossings;
- ✓ Location of mileposts, including integer mileposts;
- ✓ Location of station signs;
- ✓ Location of all signals;
- ✓ Location and attributes of highway crossings at grade; and
- ✓ Attributes relevant to the method of operation on track, e.g. signaled, cab signals present and integrated with I-ETMS, etc.

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I-ETMS Track Database

FRA requires that the position of each data element in the onboard I-ETMS track database, also called critical features, be verified against its actual physical location.

Each critical feature in the onboard I-ETMS track database must not differ from the feature's actual position by more than 2.2 meters.

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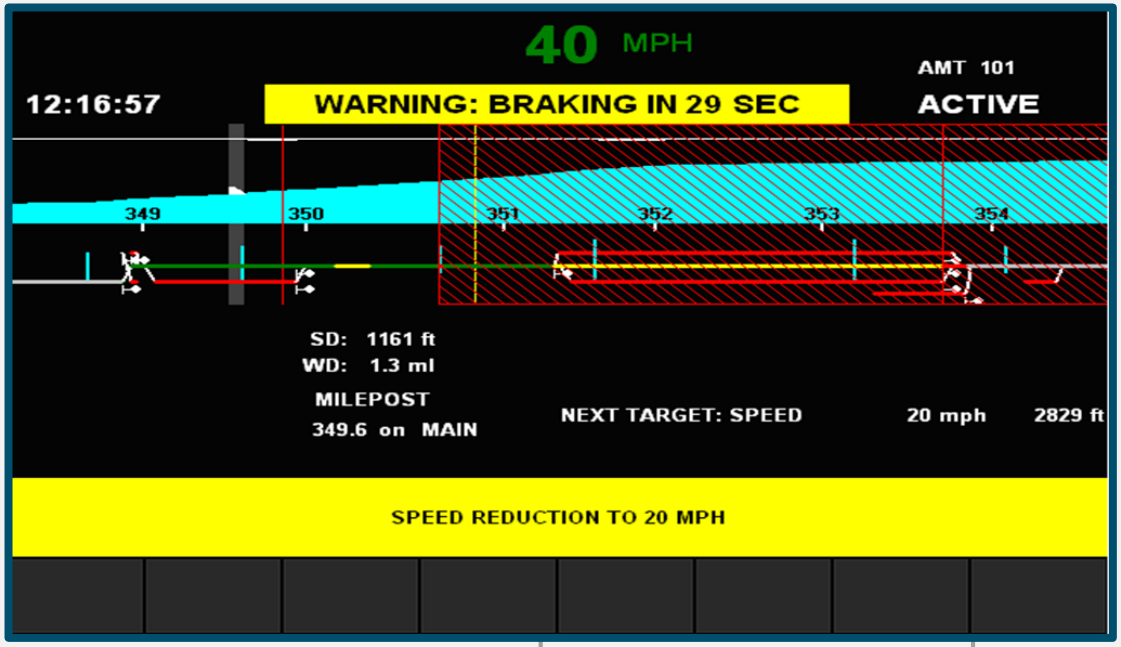
I-ETMS Predictive Speed Enforcement



If a train comes within Warning Distance of a speed restriction, and I-ETMS predicts train speed will exceed speed limit by 5mph or more when the train enters the restriction, a "Speed Reduction To XX mph" message will display along with the time remaining to enforcement braking.

If the engineer takes no action, computer will apply the brakes at the appropriate time, bringing the train to a stop.

Engineer will not be able to recover from a "penalty application" until the train has stopped.

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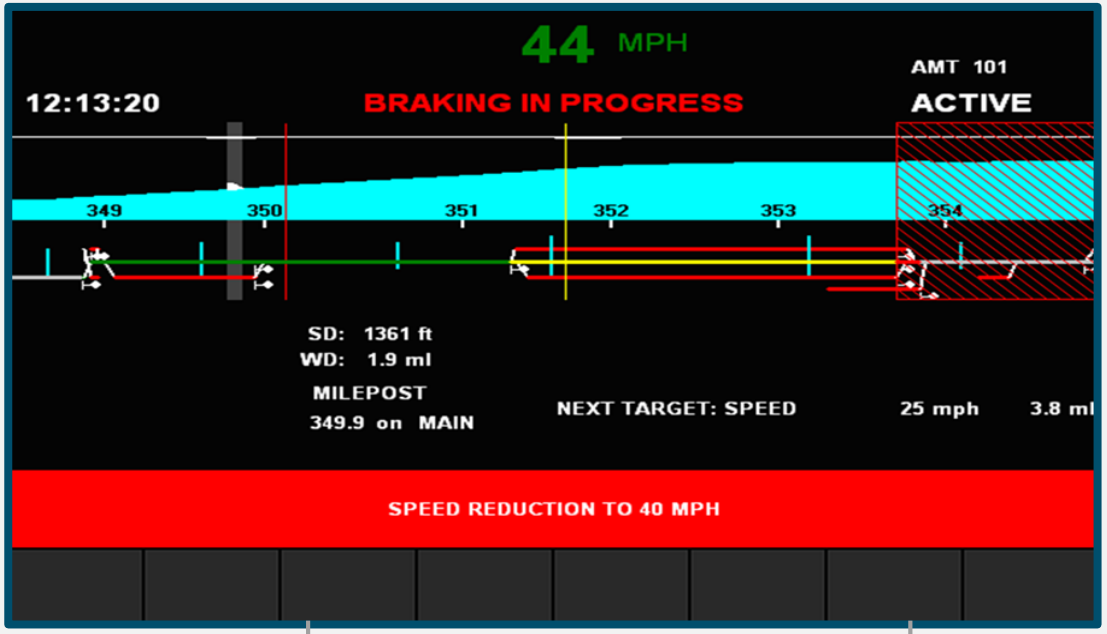
I-ETMS Reactive Speed Enforcement



If a train exceeds maximum speed allowed for the track by 3 mph, I-ETMS will display a warning to indicate the train is over speed and a "*Maximum Speed Is xx MPH"* message.

If the train exceeds the maximum speed allowed for the speed of the current location by at least 5 mph, I-ETMS will apply the brakes and display the "Maximum Speed Is xx MPH" message.

If a penalty brake application occurs, the train MUST be stopped before recovery is permitted.

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Wabtec I-ETMS Video

Alaska Railroad PTC Challenges

The Alaska Railroad Corporation (ARRC) has stated that I-ETMS receives poor GPS satellite coverage due to the high latitude, the flight of the U.S. GPS satellite constellation at a lower latitude and terrain that blocks the sky or causes multi-path.

ARRC currently uses the Wabtec Navigation Sensor Module-04 (NSM04) which only uses the U.S. constellation of GPS satellites.

ARRC has proposed the use of the GoLINC EP with a Precision Navigation Module (PNM) that uses Global Navigation Satellite System (GNSS) as the primary source of the location fix and utilizes GPS (U.S.), GLONASS (Russia), Galileo (Europe) and, BeiDou (China); satellite navigation systems.

Use of Non-Us GNSS signals

The US freight rail industry is seeking greater precision to enhance safety and operational efficiencies including:

- ✓ A precision GPS module can be integrated with the end-of-train device (EOTD) to ensure that the train is still intact, the consist length is known to a high level of accuracy and authority rollup can be automated

- ✓ When initializing where multiple adjacent tracks exist, enhanced GPS precision allows I-ETMS to determine the correct track instead of relying on the current implementation where the track has to be selected from a candidate list by the locomotive engineer.

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