PTC on Amtrak

What does the FRA consider PTC to be?\(^1\)

According to the FRA, Positive Train Control (PTC) is a technology that performs four basic core functions which are: prevent train-to-train collisions, prevent overspeed derailments, prevent incursion into established work zones to avoid casualties or injuries to roadway workers and prevent movement through a switch not in the proper position. There is not a single type of PTC system, as long as a system satisfies the requirements set forth in the Rail Safety Improvement Act of 2008 (RSIA) it can be certified and accepted by the FRA as PTC compliant.

PTC is not a system intended to provide for a wholly automated train operation. An engineer is still relied upon to properly operate a train according to the operating authorities and limitations granted to the train. PTC then enforces those limitations if the engineer does not operate accordingly.

PTC is a processor-based/communications-based train control system that can be a non-vital overlay system, a vital overlay system, a stand-alone system or a mixed system.

What PTC systems will Amtrak use?

By the time PTC systems are fully deployed in 2015 Amtrak will operate over three different PTC Systems; ACSES, I-ETMS and ITCS.

ACSES

ACSES (Advanced Civil Speed Enforcement System) was developed by Alstom Signaling for Amtrak’s Northeast Corridor. At the same time ACSES was under development for Amtrak, Ansaldo, was developing Advanced Speed Enforcement System (ASES) for New Jersey Transit. At the time all parties agreed that since the two systems were to be based on compatible transponder technology, the two systems should be kept interoperable. For reasons beyond the scope of this paper, NJT’s ASES failed to take root at that time and development ceased in 2008. Today, NJT is deploying Alstom’s ACSES system but the ASES name remains for the NJT implementation.

Amtrak has implemented ACSES on the NEC, in sections, between Boston and Washington, DC. ACSES supplements the existing cab signal/automatic train control system on the NEC, providing full PTC functionality in support of operations up to 150 mph. The ACSES architecture represents one of the two major PTC architectures that will be deployed in the United States. Other railroads adapting ACSES as their PTC architecture include: MBTA, Metro North, Long Island Rail Road, New Jersey Transit and SEPTA.

\(^1\) From FRA web site http://www.fra.dot.gov/rrs/pages/fp_1521.shtml
ITCS
From FRA http://www.fra.dot.gov/rrs/pages/fp_1265.shtml “FRA joined with Amtrak and the State of Michigan to install an Incremental Train Control System (ITCS) on Amtrak's Michigan line between Chicago and Detroit. Currently installed on over 60 miles of track in the territory between Niles and Kalamazoo, Michigan, this project includes using advanced high-speed highway-rail grade crossing warning system activation using radio communication rather than track circuits. ITCS monitors highway-rail grade crossing warning (HGCW) system health through communications between the locomotives and the crossings. Depending on the condition of the HWGC system, ITCS imposes and enforces appropriate speed restrictions. In revenue service for Amtrak since January 2002, the maximum train speed for passenger train operations in ITCS territory is currently 95 mph. ITCS has completed the necessary system upgrades to support operations up to 110 mph after final review and approval of the system validation and verification”. In 2010 Amtrak began the expansion of ITCS to include the entire Michigan Line, Porter Indiana to Kalamazoo, Michigan approximately 97 miles total. Today Amtrak is in the final stages of testing (along with the FRA) the expanded sections and expects to have testing completed in September 2011.

I-ETMS
Amtrak’s long distance inter-city trains operating outside of the Northeast Corridor and the Michigan line will operate as tenants on the rights-of-way of the many freight railroads. The development of Interoperable Electronic Train Management System (I-ETMS) began under other acronyms and precedes both ITCS and ACSES by at least 10 years. But, it was not until the passage of the RSIA of 2008 that I-ETMS got real traction and the four major freight railroads (UP, BNSF, Norfolk Southern and CSX) formed a joint venture to procure 220 MHz spectrum and develop specifications for an interoperable PTC system that would still meet the unique requirements of each railroad. I-ETMS became a subset of PTC specifications developed around the train management product from Westinghouse Air Brake Technologies Corporation (WABTEC). Every railroad adopting the I-ETMS PTC system has applied a unique name to their PTC project resulting in a host of acronyms in the I-ETMS camp. These I-ETMS systems should be interoperable in that a locomotive equipped with any I-ETMS system will be able to operate over a right-of-way equipped with the same or any other I-ETMS system. I-ETMS PTC systems being deployed by the four major freight railroads include: ²

² Other I-ETMS implementations include:
METRA ETMS is the Chicago METRA implementation of PTC.
SCRRA (Southern California Regional Rail Authority) (MetroLink) is deploying Vital I-ETMS.

Non I-ETM PTC systems:
CAS is the Alaska Railroad PTC system
TRAIN SENTINEL is the Ohio Railroad Systems implementation of PTC.
PATH CBTM is the PTC system for the Port Authority of New York and New Jersey (PATH)
1. ETMS - BNSF’s “Electronic Train Management System” is a non-vital implementation of PTC.
2. VTMS - Union Pacific’s “Vital Train Management System” is, as the name implies, a vital implementation of I-ETMS.
3. CBTM - CSX’s “Communications Based Train Control” system.
4. OTC - Norfolk Southern’s “Optimized Train Control” system.

How do ACSES and I-ETMS perform the four basic core functions of PTC?

Prevent train-to-train collisions.
Historically one of the heaviest traveled rail corridors in the US, the Northeast railroads have for many years depended on ATC (Automatic Train Control) with cab signaling to prevent train to train collisions. Because this protection was already in place, ACSES was developed without separate and additional train to train collision protection. For this reason, ACSES as it is installed today must be installed with ATC to be considered an FRA compliant PTC system. Some Northeast commuter railroads with track not equipped with ATC have proposed variations on ACSES that would include this protection in ACSES without a separate ATC system. This work is still under development. Other Commuter railroads are simply installing ATC as part of their PTC system.

Prevent over speed derailments.
In all PTC system, the locomotive’s PTC processor must host a database with the location of all civil and temporary speed restrictions. The PTC processor must also know its location, speed and direction of travel. A braking algorithm is used to compute a braking curve for each speed change. This braking curve is enforced if the operator (Engineer) fails to act.

ACSES accomplishes this by loading the database onto transponders deployed between the rails and distributing the transponders along the entire length of the railroad at fixed locations in advance of the point of the Permanent Speed Restriction (PSR). The train reads the data from these transponders while en-route. The transponders also include location information that includes track identification, and information that determines direction of travel.

Temporary Speed Restrictions (TSR’s), in all cases (ACSES, ITCS and I-ETMS), are sent to the locomotive processor via radio. ACSES TSR’s are referenced to the Right of Way Mile Post and Chaining. I-ETMS and ITCS TSR’s are referenced to GPS locations.

I-ETMS preloads civil data information over the air in advance of the trip for the entire route. Location and direction of travel are provided by an on board GPS. Database download will normally be performed over a wideband RF link, but could, if necessary, be performed over the 220 MHz link.
Prevent incursion into established work zones.
On the Northeast corridor Amtrak uses “Signal Blocking” to protect work zones. This is part of Amtrak’s PTC plan, but is external to ACSES. Signal Blocking involves taking the affected track out of service and locking the “signal” at the entrance to the affected track to “stop”. With ATC it is not possible for a train to enter the work zone. This works well on the Northeast Corridor where the rights-of-way are equipped with multiple tracks in parallel and traffic can use other tracks to flow past the out-of-service track.

Many freight lines are single track and maintenance must be performed “under traffic”. I-ETMS prevents unintentional incursion into a work zone by creating a “limit of authority”. This forces the train approaching a work zone to stop short of the entrance to that work zone. The Employee in Charge (EIC) of the work zone is then required to release the train to proceed through the work zone after first clearing up the work and providing for the safety of the employees under his charge.

Prevent movement through a switch not in proper position.
Within the interlocking, ACSES provides this protection by forcing the approaching train to stop outside the interlocking until the switches are properly aligned and the route through the interlocking is clear. It should be noted that the route is almost always established and the signal displayed before the train reaches braking distance from the interlocking. If the route is clear ATC will use the coded track circuit to allow the train to proceed and ACSES will use the radio to inform the train of its route through the interlocking.

Outside the interlocking, the siding switches are electrically locked in the normal position while a train is approaching on the main track. If the siding switch is in position to allow a train to enter the main track from the siding, the signal at the preceding interlocking will prevent any train on the main track from approaching the siding switch.

I-ETMS individually monitors each switch and broadcasts the position of the switch to all trains within radio coverage. The on board processor, knows which switches are on its track and proceeds only if the switches are properly aligned.
ACSES PTC Deployment

The following illustrations are intended to portray the approximate areas of Radio Frequency (RF) interest of those railroads which will be deploying ACSES, and have indicated an interest in using spectrum that the FCC might make available for PTC and are overlaid on the Amtrak Northeast Corridor footprint. These illustrations were created by Amtrak from published data and have not been checked by the respective commuter agencies for accuracy.

Amtrak Northeast Corridor including Metro North between New Rochelle, NY and West Haven, CT.
MBTA Commuter Rail Service area in Eastern Massachusetts.
MTA Commuter Rail Service area including Metro North Railroad and Long Island Rail Road.
New Jersey Transit Commuter Rail Service Area.
SEPTA Commuter Rail Service area.