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Positive Train Control (PTC): Overview and Policy Issues

Jeffrey Peters
Purdue University, peters83@purdue.edu

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Jeffrey C. Peters
Research Associate

John Frittelli
Specialist in Transportation Policy

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Summary

The Rail Safety Improvement Act of 2008 (RSIA08) requires implementation of positive train control (PTC) on railroads which carry passengers or have high-volume freight traffic with toxic- or poisonous-by-inhalation hazardous materials. PTC is a communications and signaling system that has been identified by the National Transportation Safety Board (NTSB) as a technology capable of preventing accidents caused by train operator or dispatcher error. PTC is expected to reduce the number of accidents due to excessive speed, conflicting train movements, and engineer failure to obey wayside signals. It would not prevent incidents due to trespassing on railroads' right-of-way or at highway-rail grade crossings, where the vast majority of rail-related fatalities occur.

Under RSIA08, PTC is required on about 60,000 miles of railroad track by December 31, 2015. Many railroad companies are uncertain of their ability to fully implement PTC by this deadline. The Federal Railroad Administration (FRA) estimates full PTC implementation will cost approximately $14 billion. Although the larger freight railroads are well along in planning for PTC, some smaller railroads and commuter lines have not yet identified sources of funding for implementation.

PTC uses signals and sensors along the track to communicate train location, speed restrictions, and moving authority. If the locomotive is violating a speed restriction or moving authority, on-board equipment will automatically slow or stop the train. A more expansive version of PTC, called communications-based train control (CBTC), would bring additional safety benefits plus business benefits for railroad operators, such as increased capacity and reduced fuel consumption. However, CBTC is not currently being installed by any U.S. railroad, due to the additional cost and to uncertainty about implementation of PTC before the 2015 deadline.

Two bills introduced in the 112th Congress, the Moving Ahead for Progress in the 21st Century Act (MAP-21; S. 1813), as approved by the Senate, and the American Energy and Infrastructure Jobs Act (H.R. 7), approved by the House Transportation and Infrastructure Committee, would have extended the deadline and made other policy changes. No language relating to PTC was included in the final surface transportation bill (P.L. 112-141) enacted on July 6, 2012. However, existing law requires the U.S. Department of Transportation (DOT) to report to Congress about the status of PTC implementation by December 31, 2012. If it wishes to reexamine the PTC mandate, possible options for Congress include

- postponing the implementation deadline;
- considering whether to make dedicated radio spectrum available to the railroads for PTC implementation and, if so, how to compensate current license holders of that spectrum;
- examining possible alternatives to PTC and their potential to create barriers to competition in the rail freight market; and
- providing federal financial support for PTC implementation by making PTC projects eligible for funding under the Railroad Rehabilitation and Improvement Funding Program or by appropriating other funding to FRA, as authorized in RSIA08.

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Introduction

Following several high-profile train accidents, Congress passed the Rail Safety Improvement Act of 2008 (RSIA08; P.L. 110-432), which mandated positive train control (PTC) on many passenger and freight railroads by December 31, 2015. The law does not describe PTC in technical terms, but defines it as a risk mitigation system that could prevent train accidents by automatically stopping trains when a collision or derailment is imminent.

While PTC promises benefits in terms of safety, its implementation entails substantial costs and presents a variety of other policy-related issues. These include the interoperability of individual railroads' systems, sufficient radio spectrum to support PTC, and the possibility that PTC could be a barrier to market entry.

Freight and commuter railroads have raised concerns about their ability to meet the deadline imposed by Congress. In the 112th Congress, measures to relax the deadline were approved by the Senate and by the House Transportation and Infrastructure Committee, but were not included in the Moving Ahead for Progress in the 21st Century Act (MAP-21; P.L. 112-141), the surface transportation bill signed by President Obama on July 6, 2012. The U.S. Department of Transportation (DOT) is required to submit a report to Congress about the status of PTC implementation and possible risk mitigation options by December 31, 2012.

Rail Safety and PTC

The United States railroad network comprises both freight and passenger operations. The seven largest operators by revenue, known as the Class I freight railroads, own about two-thirds of the nation's 140,810 miles of trackage (see **Figure 1**).[1] These companies include BNSF, Union Pacific (UP), Norfolk Southern (NS), Kansas City Southern (KCS), Canadian Pacific (CP), Canadian National (CN), and CSX Transportation (CSXT). The remaining trackage is controlled by Class II or regional freight railroads; Class III or short-line railroads; state and local government agencies; and Amtrak, the federally owned passenger operator.

In many situations, both passenger and freight railroad companies operate over track owned by other railroads. This may occur under orders issued by the federal Surface Transportation Board or under voluntary agreements between carriers. Amtrak also has the right to operate trains using its own equipment over freight lines.[2]

The majority of freight railroad lines have a single track with passing sidings at various locations to allow trains to pass. Trains may operate in either direction along a track. High-volume corridors may have multiple lines that typically operate in a single direction to increase both operating capacity and safety.[3]

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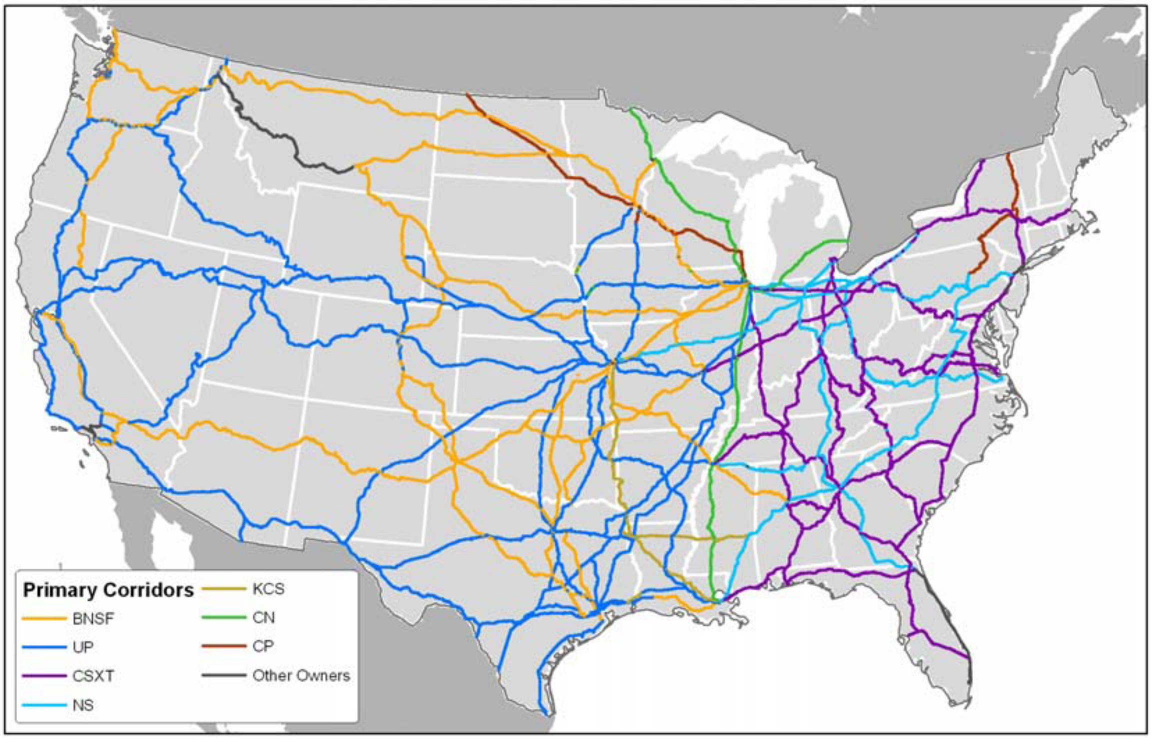
[1] U.S. Department of Transportation, "National Transportation Statistics," http://www.bts.gov/publications/national_transportation_statistics/html/table_01_01.html.

[2] See CRS Report R42512, *Passenger Train Access to Freight Railroad Track*, by John Frittelli.

[3] Cambridge Systematics, *National Rail Freight Infrastructure Capacity and Investment Study*, Final Report, September 2007, p. 25, http://www.aar.org/~/media/aar/Files/natl_freight_capacity_study.ashx.

For safety purposes, train dispatchers and signals along the track provide the engineer with the authority to travel on a certain track segment to prevent collision with other trains. Some long stretches of track in remote areas use only one main line without any signalization. This is called "dark territory." In this case, railroads rely on communications with dispatchers to provide authority. Dispatchers are also responsible for assigning priority when more than one train requires use of a particular segment of track.

Figure 1. National Network of Class I Railroads



Source: Cambridge Systematics, Inc., National Rail Freight Infrastructure Capacity and Investment Study, September 2007.

Note: This map shows the Class I railroads in the United States. Not all lines shown are subject to the PTC implementation mandate.

According to the Federal Railroad Administration (FRA), an average of 2,000 derailments and 205 train collisions, resulting in 422 injuries and 12 fatalities, occurred annually from 1998 to 2009, excluding accidents at highway-rail crossings.[4] The number of incidents may increase as operations in both freight and passenger rail expand, despite a reduction in total track length. However, the majority of train-related fatalities are due to interactions with vehicular traffic at highway-grade crossings or trespassing on railroad property rather than train collisions or derailments. In 2009, 4 fatalities occurred from train collisions or derailments, 247 fatalities occurred at highway-rail grade crossings, and 417 fatalities resulted from trespassing on railroad property or right-of-way.[5]

[4] Federal Railroad Administration, Office of Safety, *Railroad Safety Statistics,* Annual Report, April 1, 2011, pp. 4-20.

[5] Ibid., pp. 4-5.

While most incidents are minor, several high-profile accidents led Congress to consider increased rail safety. Most notably, the head-on collision of a Metrolink commuter train and a Union Pacific freight train in Chatsworth, CA, led to 25 fatalities and over 100 injuries in 2008. The cause of the crash was determined to be negligence by the commuter train engineer. PTC was specifically identified by the National Transportation Safety Board (NTSB) as a technology that could have prevented Chatsworth and other similar accidents by providing a safeguard against human error.[6]

Interest in PTC dates to at least 1990, when the NTSB placed it on its initial "Most Wanted List of Transportation Safety Improvements."[7] The High-Speed Rail Development Act of 1994 directed FRA to issue a progress report on positive train control. In 2004, FRA submitted a cost-benefit analysis of PTC at the request of Congress.[8] That study showed that as of 2004, the costs of PTC outweighed the direct safety benefits, but the agency's letter to Congress stated, "we believe PTC will be more affordable in the future."[9]

The Federal Railroad Safety Improvement Act of 2007, introduced in the 110th Congress, mandated implementation of PTC in specific circumstances.[10] The Chatsworth train accident on September 12, 2008, expedited the legislative process, and the bill was signed into law October 16, 2008, as the Railroad Safety Improvement Act of 2008 (RSIA08). RSIA08 requires "each Class I railroad carrier and each entity providing regularly scheduled intercity or commuter rail passenger transportation" to implement PTC on all segments or routes of railroad tracks that (a) carry frequent passenger or commuter service, or (b) carry more than 5 million gross tons of freight per year and also are used for transporting poison-by-inhalation hazardous materials (PIH).[11] At the time the law was signed, this mandate covered approximately 70,000 miles of railroad track.

During the FRA rulemaking process, it became apparent that rail companies could change the routes of trains carrying PIH to avoid the PTC requirement on some track segments. A Senate bill was introduced to forego mandatory PTC implementation on lines that will not be transporting passengers or hazardous materials by the end of 2015.[12] This was estimated to eliminate the PTC mandate on 10,000 of the 70,000 track-miles initially covered. The bill was not enacted, but FRA approved such a change in its amended final rule, effective July 13, 2012.[13] The American Short Line and Regional Railroad Association proposed several changes to the FRA final rule, including eliminating the PTC requirement for trains traveling less than 20 miles on PTC-required track and

[6] National Transportation Safety Board, *Collision of Metrolink Train 111 With Union Pacific Train LOF65-12 Chatsworth, California*, RAR 10/01, September 12, 2008.

[7] National Transportation Safety Board, Office of Public Affairs, "NTSB unveils new 'Most Wanted List,'" press release, June 23, 2011, p. 1, http://www.ntsb.gov/news/2011/110623.html.

[8] U.S. Congress, House Committee on Appropriations, *Conference Report on the Consolidate Appropriations Resolution*, To accompany H.J.Res. 2, 108th Cong., 1st sess., 2003, H.Rept. 108-10 (Washington: GPO, 2003), pp. 1286-1287.

[9] Letter from Betty Monro, Federal Railroad Administration Acting Administrator, to Sen. Robert Byrd, Ranking Member, Committee on Appropriations, August 17, 2004, http://www.fra.dot.gov/downloads/safety/ptc_ben_cost_report.pdf.

[10] H.R. 2095, S. 1889.

[11] P.L. 110-432, §104.

[12] S. 301, 112th Congress.

[13] Federal Railroad Administration, "Positive Train Control Systems Amendments (RRR)," 76 *Federal Register* 52918, August 24, 2011.

extending the deadline for Class II and III railroads to employ PTC-equipped locomotives until 2020. FRA approved these changes in an amended final rule.[14]

In the 112th Congress, bills to delay the PTC implementation deadline were considered in both houses of Congress. As approved by the Senate, the Moving Ahead for Progress in the 21st Century Act (MAP-21; S. 1813) would have allowed DOT to extend the December 31, 2015, deadline for any railroad in one-year increments until December 31, 2018, if it deemed full implementation infeasible and if the railroad had made a good-faith effort to comply. The bill would have allowed use of Railroad Rehabilitation and Improvement Financing (RRIF)[15] for PTC implementation.

The American Energy and Infrastructure Jobs Act of 2012 (H.R. 7), which was adopted by the House Transportation and Infrastructure Committee but was not approved by the House of Representatives, would have extended the deadline for PTC implementation to December 31, 2020, and would have allowed railroads to adjust PIH routes until 2020 to reduce the extent of track affected by the PTC mandate. The bill also would have allowed railroads to implement alternative strategies on track that does not transport passengers where the "alternative risk reduction strategy that would reduce the risk of release of poison- or toxic-by-inhalation hazardous materials to the same extent the risk of a release of poison- or toxic-by-inhalation hazardous materials would be reduced if positive train control were installed on those tracks."[16] While the provision would have allowed flexibility on the part of the railroads, alternative safety measures might interfere with the goal of interoperability and could raise costs for smaller railroads that might need to conform to multiple safety systems.

The final version of the 2012 surface transportation bill, signed by President Obama on July 6, 2012, as P.L. 112-141, did not change existing law concerning PTC. However, the issue remains of interest to Congress. As required by RSIA08, DOT must report on PTC implementation to the House Transportation and Infrastructure Committee and the Senate Commerce, Science, and Transportation Committee by December 31, 2012.

The Basics of PTC

PTC is defined in federal law as a "system designed to prevent train-to-train collisions, over-speed derailments, incursions into established work zone limits, and the movement of a train through a switch left in the wrong position."[17] The federal government has imposed no specific technical requirements, allowing railroads to adopt whatever PTC systems seem best suited to their particular needs. However, all PTC systems share certain characteristics, including use of radio communication to provide in-cab signals to the train engineer and the ability for the dispatcher to stop a train in an emergency.[18]

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[14] Federal Railroad Administration, "Positive Train Control Systems," 75 *Federal Register* 2704, January 15, 2010.

[15] Railroad Reinvestment and Improvement Funding (RRIF) provides direct loans and loan guarantees up to a total of $35 billion to improve or develop new rail equipment and facilities, and refinance outstanding debt.

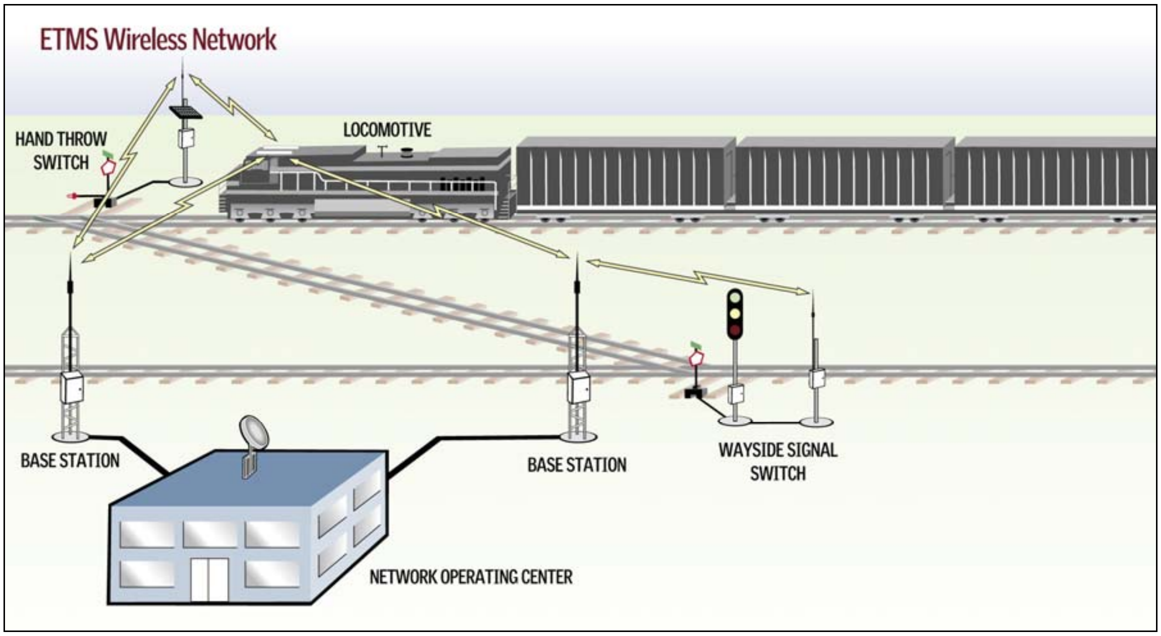
[16] H.R. 7, §8401, p. 805.

[17] 49 C.F.R. §236.

[18] Federal Railroad Administration, The *North American Joint Positive Train Control (NAJPTC) Project*, Research Results, April 2009, p. 2.

Most U.S. railroads currently plan to implement what is referred to as an "overlay-type" system, in which the sensors, signals, and transponders are installed over existing track.[19] The network operating center sends one-way communication in the form of speed restrictions and moving authorities to a train as it passes over a transponder embedded in the track. This information requires integration with existing signals, switches, sensors, and other wayside infrastructure. The network operating office does not track real-time train location, but rather receives notice whenever a train passes the wayside infrastructure. **Figure 2** illustrates PTC hardware and communication pathways in an overlay-type system architecture.

Figure 2. Example PTC System Architecture



Source: Meteorcomm LLC, ETMS Wireless Network, 2011.

Note: Meteorcomm supplies communication equipment for the Electronic Train Management System (ETMS), which several large freight companies are planning to implement. This diagram shows a two-way communications based PTC system, although most railroads are installing one-way systems that comply with the law.

[19] Jeff D. Young, Lisa C. Wilson, and Denise E. Lyle, *Interoperable Electronic Train Management System (I-ETMS) Positive Train Control Development Plan (PTCDP)*, Union Pacific Railroad, Norfolk Southern Railway, and CSX Transportation, Inc, FRA-2010-0060-0002, June 1, 2011.

Communication between wayside infrastructure, transponders, and trains is delivered through analog radio signal. Wireless communication options that provide greater data transfer capability, such as Wi-Fi, are not currently practical. Equipment on the train receives information from transponders to alert the train operator to current and upcoming signals, movements, and work zones. The train has equipment capable of superseding train engineer authority, so that the PTC system can slow or stop the train to prevent incident in the event of human error.

A more expansive variant of an overlay-type system is communications-based train control (CBTC). CBTC is a more sophisticated computer-aided dispatching framework which requires train information to be sent to a central location, which then disseminates the information to all entities in the network.[20] In this architecture, Global Positioning System (GPS) is used to track train location and speed, with other instrumentation providing location and speed coverage when the GPS cannot locate a signal. These additional components provide greater precision as well as system redundancy in the event of failure. Similarly, GPS and radio communication similar to cell phone technology can be used to indentify work zone locations along specific lengths of track. CBTC is based on digital rather than analog technology, facilitating interoperability among systems used by different railroads.

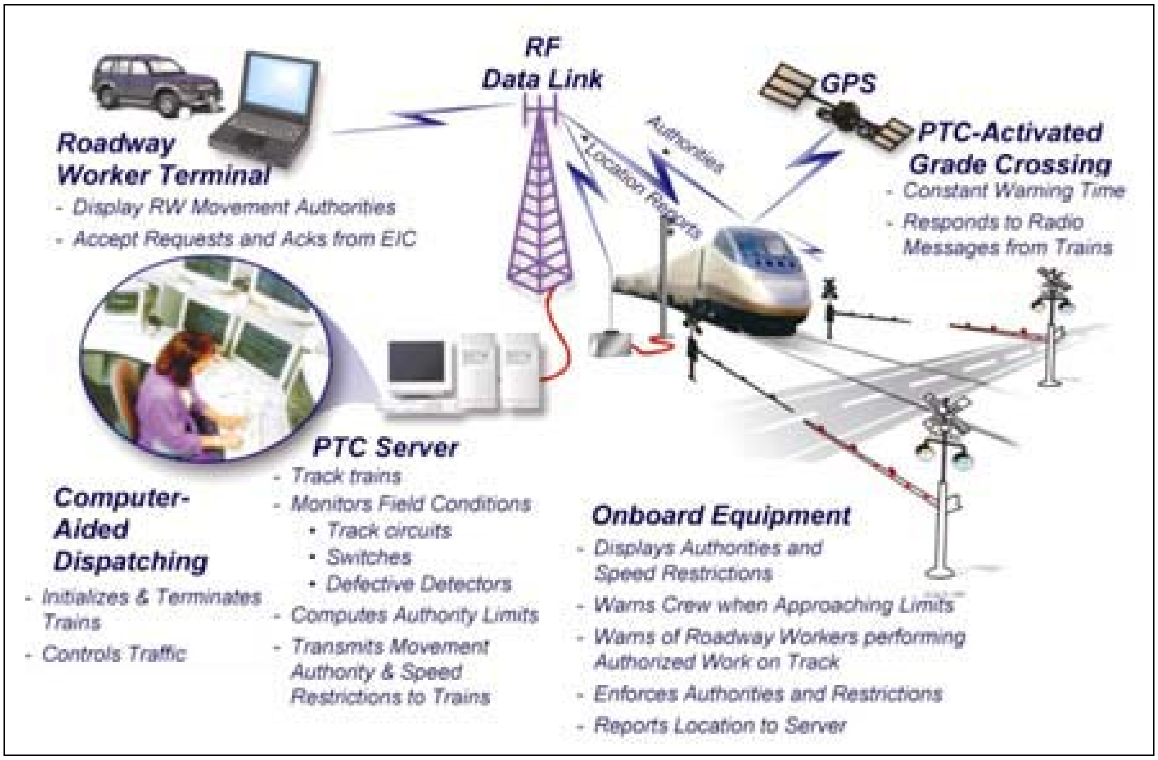
With CBTC, central control automatically tracks the movements of all the trains in the network, sends speed restrictions and movement authorities to individual trains, and checks for potential derailment and collisions (see **Figure 3**). The system uses location and speed information to determine headway distance and the necessary braking distance required to prevent potential incidents. Braking distance can be several miles for large freight trains and is dependent on factors such as train speed, reaction time, wheel-rail friction, brakes wear, track conditions, track grading, mass, and mass distribution of the train.[21] All these variables are processed with a complex braking algorithm to ensure an emergency stop prior to a collision without excessive speed restriction leading to inefficient operation.

The greater capability of CBTC makes it suitable for very high speed passenger lines, and CBTC is being instituted on some European rail lines for that reason. However, the system requires seamless communication coverage along the entirety of PTC-equipped track, as temporary communication loss can pose safety risks. The need for constant communication also requires significant investment in either radio towers or fixed transponders. These requirements raise the capital cost, making CBTC more expensive than an overlay-type system.

[20] There are many ways of designing the system architecture to support PTC communication. In the context of railroad operations with dispatchers, a system architecture with central control is the most plausible design.

[21] David Barney, David Haley, and George Nikandros, "Calculating Train Braking Distance," This paper appeared at the 6th Australian Workshop on Safety Critical Systems and Software (SCS '01), Brisbane, 2001, pp. 23-29, http://129.96.12.107/confpapers/CRPITV3Barney.pdf.

Figure 3. Communication-based Train Control (CBTC)



Source: Federal Railroad Administration, Research Results, North American Joint Train Control (NAJTC) Project, April 2009

Note: Two-way data communication and computer-aided dispatch are the primary subsystems which distinguish full CBTC from PTC.

The CBTC system potentially offers greater business benefits to railroad operators than an overlay-type system. For example, the real-time, two-way communication of train locations combined with speed restrictions and moving authorities can lead to more efficient scheduling, increased capacity, and fuel savings. Nonetheless, U.S. railroads appear to have concluded that the advantages of communication-based train control are not worth the additional cost of installing it at the present time.

It is important to note that both overlay-type systems and CBTC systems are designed principally to reduce collisions between trains. The systems do not address intrusion into railroad right-of-way. Currently, there is no requirement that they be capable of detecting and notifying trains about crossing-gate failures, vehicles blocking tracks, or trespassers. However, such capabilities could be incorporated into PTC systems in the future.

Implementation

Motivated by the December 31, 2015, deadline, many of the large railroad companies are currently testing and implementing PTC on selected track segments across the United States. There are also several small-scale projects underway designed to meet specific local needs. Most of the current PTC projects rely on fixed transponders in conjunction with GPS with one-way information communication to the trains to fulfill the baseline PTC requirements. Only a few systems involve two-way communication with real-time information and computer-aided dispatch. The smaller railroad companies and commuter lines, in most cases, are relying on the Class I railroads to implement PTC before investing in their own systems due to the high risk and the cost of developing their own systems.

In the United States, precursors to full PTC capability were developed voluntarily prior to the 2008 mandate. Development of radio-based CBTC systems and coordinated wayside systems used to locate and communicate with trains began in 1983. Although systems developed by the Association of American Railroads and Burlington Northern Railroad achieved technical success, both systems were functional only in fully signalized territory and were deemed not economically viable to deploy on a nationwide scale.

In 1991, Amtrak adopted an automatic train control (ATC) system along the tracks it owns in the Northeast Corridor. That system repeated signalization in the cab and required the train engineer to acknowledge and enforce the speed limit given by the signals to reduce human error. That system was later upgraded with the Advanced Civil Speed Enforcement System, using transponders to send signals to trains and to enforce speed restrictions and stop orders.[22] Amtrak began transitioning to radio-based communication in 2009 to incorporate work zone safety measures required by RSIA08.[23]

In 1999, CSX Transportation began development of a PTC system that uses GPS combined with fixed infrastructure at switching points to provide exact track location information, specifically on parallel lines. This method is particularly useful to improve safety on long stretches of non-signalized track. CSXT is now modifying this architecture to meet the full requirements of PTC. BNSF, Union Pacific, Norfolk Southern, and Chicago's Metra commuter line are planning implementation of similar systems. Norfolk Southern's system is expected to provide for computer-aided dispatch over small segments of track.[24]

Prior to certification and revenue service, each rail company is required to submit to FRA a PTC Implementation Plan (PTCIP), Development Plan (PTCDP), and Safety Plan (PTCSP) and receive approval for each plan in that order. Companies can also receive "type" approvals when using an identical PTC system that has already received approval. This process and implementation of the plans must be completed prior to the deadline of December 31, 2015.

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[22] James Hoelscher and Larry Light, "Full PTC Today with Off the Shelf Technology: Amtrak's ACSES Overlay on Expanded ATC," Proceedings of the 2001 AREMA Conference, Chicago, IL, 2001, http://www.arema.org/files/library/2001_Conference_Proceedings/00022.pdf.

[23] Federal Railroad Administration, "Positive Train Control Overview," press release, February 2, 2009, p. 1, http://www.fra.dot.gov/rrs/pages/fp_1265.shtml.

[24] William Vantuono, "Two new technologies ready to roll," *International Railway Journal*, vol. 48, no. 4 (April 2008), pp. 26-28.

As of June 2012, nearly all PTCIPs have been received. The PTCDP for the system planned for use by UP, CSXT, BNSF, NS, and some other railroads has been approved. Very few other railroads have reached the PTCDP stage, but many can be expected to use the larger railroads' type approvals for their own individual plans. Only one PTCSP for a relatively small railroad has been submitted. As a result of this process, only a very small portion of required trackage currently has PTC infrastructure installed.

Cost and Benefits

FRA estimates the total capital cost of wayside, on-board, radio, and office equipment necessary for full PTC deployment on all affected railroads to be in excess of $10 billion. It projects annual maintenance costs of $850 million.[25] In 2010, fixed-capital investment by U.S. railroads was $11 billion, of which $7.8 billion went for structures and $3.2 billion for equipment.[26] The estimated capital cost of meeting the PTC mandate is thus roughly equal to the railroads' total capital spending in a single year.

The four largest railroad companies account for almost all of the estimated 60,000 miles of Class I track that fall under the PTC mandate. In August 2010, two railroads (CSXT and NS) estimated costs of PTC alone to be over $1.2 billion each.[27]

Smaller freight companies often share track with the Class I railroads. While this presents interoperability challenges, there is opportunity to use the PTC type approvals from the larger companies' development efforts to save cost. This is also the case with shared passenger rail in the Northeast Corridor. Despite this advantage, the infrastructure cost alone for just two of the five largest transit agencies operating on the corridor, Metro-North in the New York area and the Southeastern Pennsylvania Transportation Authority in the Philadelphia area, is estimated at $350 million and $100 million, respectively.[28]

Commuter railroads' cost for installing PTC is likely to be borne primarily by state or local governments. FRA established a railroad safety technology grant fund to support railroads' development and implementation of PTC systems, with $50 million budgeted for each FY2009-FY2013.[29] However, no funds have been appropriated for this program.

Some shippers believe that since the majority of the investment in PTC will come directly from the railroad companies, these costs will likely be passed to customers. They expect price increases due to the cost of PTC implementation, especially if the rail companies are unable to realize business benefits from the new systems. The Chlorine Institute, a trade organization representing

[25] Frank D. Roskind, *Positive Train Control Systems Economic Analysis*, Federal Railroad Administration, FRA-2006-0132, Notice No. 1, July 10, 2009, p. 120.

[26] U.S. Census Bureau, 2010 Annual Capital Expenditures Survey, http://www.census.gov/econ/aces/xls/2010/full_report.html, Table 4a.

[27] CSX Transportation, *CSX Corporation 2010 Annual Report*, Jacksonville, FL, 2010, p. 6; Thompson Reuters, *NSC - Q1 2010 Norfolk Southern Corp Earnings*, Conference Call Final Transcript, April 27, 2010, p. 19, http://www.nscorp.com/nscorphtml/pdf/transcript042710.pdf.

[28] Jeff Stagl, "PTC: Railroads, suppliers still have a ways to go to meet the 2015 positive train control mandate," *Progressive Railroading*, August 2010.

[29] U.S. Department of Transportation, "FRA Announces $50 Million Safety Technology Grant Program," press release, April 7, 2010, http://www.fra.dot.gov/Pages/press-releases/201.shtml.

the chlorine industry, expects the railroad companies to raise costs disproportionately for shipments of poisonous-by-inhalation hazardous materials (PIH), as concern about the safety of PIH transport is perceived as a source of the PTC mandate.[30]

Safety Benefits from PTC Preventable Accidents

Based on analysis of past PTC preventable accidents, FRA estimates $90 million in annual safety benefits will be realized after full implementation of PTC.[31] Safety benefits are calculated by estimating the cost of accidents that are likely to be prevented by PTC, including fatalities and injuries, equipment damage, track damage, off-track damage, hazardous material cleanup, evacuations, wreck cleanup, loss of freight, and freight delay. According to a 1999 FRA estimate, between 1987 and 1997 an annual average of 7 fatalities, 22 injuries, $20 million in property damages, and evacuations of 150 people due to potential hazardous material release could have been prevented by PTC.[32]

Although many serious incidents due to error by train engineers or dispatchers could be prevented by PTC, PTC is expected to prevent less than 2% of the approximately 2,000 railroad collisions and derailments that occur annually. The majority of these 2,000 incidents occur in rail yards and are generally less severe than PTC-preventable accidents.

While the costs and safety benefits are projected with some confidence, there is disagreement regarding the potential business and social benefits of PTC. This makes a full cost-benefit analysis of PTC-related issues difficult. Business and social benefits are expected to come from increased railroad efficiency, reductions in logistical costs, and diversion of freight from truck to rail. However, these benefits are predicated on the functionality of full computer-based train control and not PTC alone. Computer-aided dispatch has the potential to increase capacity and reduce fuel consumption. This can reduce railroad operating costs, lead to faster, less-expensive delivery, and induce demand from truck freight. This then may lead to social benefits such as reductions in fuel consumption and truck accidents.

FRA projects $4 billion in potential annual business benefits a decade after full PTC implementation. However, the overlay system without CBTC capability currently planned by the railroads is expected to offer little or no business benefit to the railroads. The social benefits of the overlay system are likely to come largely from the anticipated reduction in accidents.[33]

[30] The Chlorine Institute, Inc, "Chlorine Institute Asks Federal Rail Administration to Reconsider Positive Train Control Rule Due to Faulty Cost-Benefit Analysis," press release, March 16, 2010, http://www.chlorineinstitute.org/files/PDFs/2010-03-16%20-%20CI%20PTC%20petition.pdf.

[31] Frank D. Roskind, *Positive Train Control Systems Economic Analysis*, Federal Railroad Administration, FRA-2006-0132, Notice No. 1, July 10, 2009, pp. 140-144.

[32] Railroad Safety Advisory Committee, Federal Railroad Administration, *Implementation of Positive Train Control Systems*, Report, August 1999, https://rsac.fra.dot.gov/meetings/19990908.php.

[33] Frank D. Roskind, *Positive Train Control Systems Economic Analysis*, Federal Railroad Administration, FRA-2006-0132, Notice No. 1, July 10, 2009, pp. A-1-A-16.

Policy Issues

Interoperability

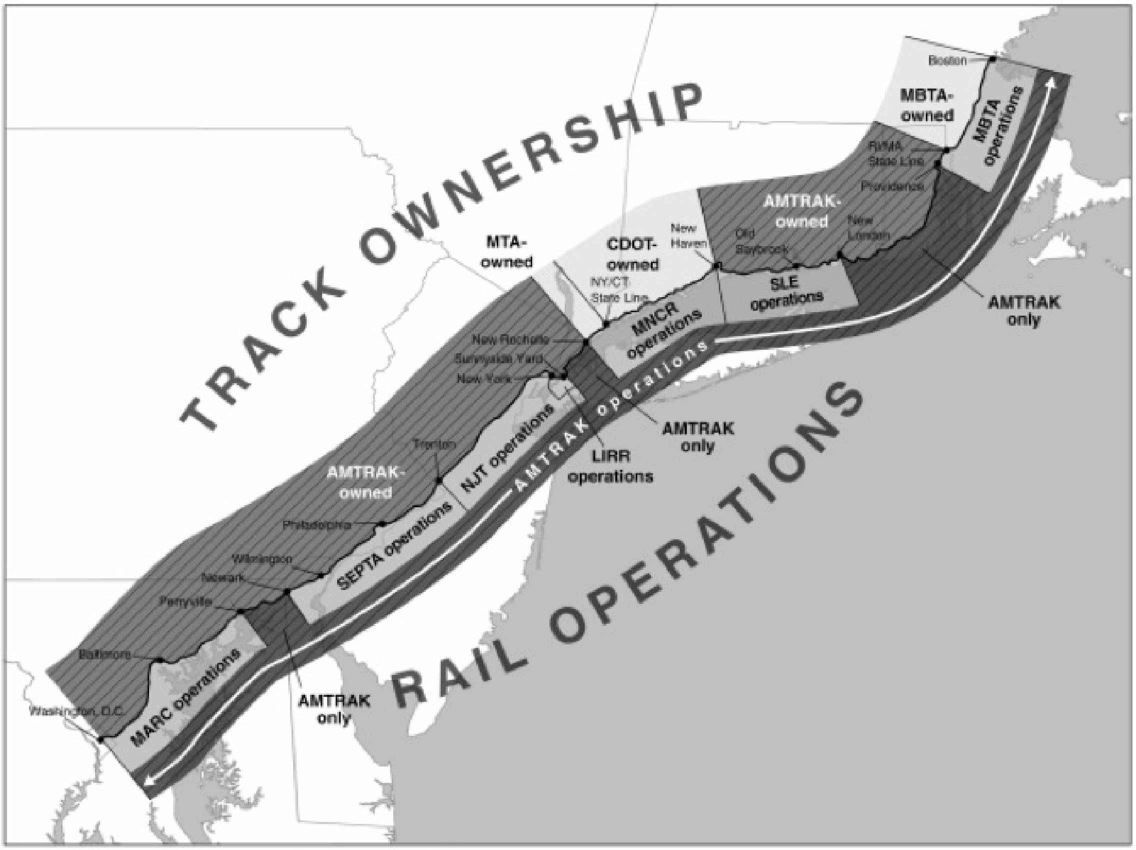
The freight rail transportation network has two primary components: the track and the freight service. In some cases, the service is provided by the same company that owns the track. However, since shippers' needs do not correspond to railroads' track ownership, freight operators trade trackage or haulage rights and share revenue from the shipper. FRA regulations require that railroads' PTC systems be interoperable so that any train operating on PTC-equipped track can communicate with the host railroad's PTC system.

Prior to RSIA08, several railroad companies were developing communication-based train control independently for their own business reasons, and were not concerned about interoperability. The federal mandate has required changes in these plans in the interest of interoperability. UP, CSXT, and NS have received FRA "type approvals" for Interoperable Electronic Train Management Systems (I-ETMS) in which the PTC system itself is approved for development.[34] This makes it likely that the systems installed by these railroads will be highly compatible. BNSF, which has a precursor ETMS system in place, has type approval for that system, which is to be updated to I-ETMS when software becomes available.

Interoperability issues pertain to passenger service as well. In the Northeast Corridor, Amtrak operates on Amtrak-owned track and track owned by regional transit authorities and vice versa. **Figure 4** illustrates the necessity for interoperable PTC systems to prevent disruption in service. Amtrak began PTC development prior to RSIA08 and has provided the PTC standard and type approval for transit authorities utilizing the corridor. The freight companies and Amtrak are now working to ensure interoperability between their respective systems.

[34] Letter from Jo Strang, FRA Associate Administrator for Railroad Safety/Chief Safety Officer, to Jeff D. Young et al., Union Pacific Railroad Assistant Vice President, Transportation System, August 26, 2011, FRA Type Approval (FRA-TA-2011-02) for the Interoperable Electronic Train Management System (I-ETMS).

Figure 4. Track Ownership and Rail Operations in the Northeast Corridor



Source: Government Accountability Office, GAO—06-470, *Commuter Rail Issues Should Be Considered in Debate Over Amtrak*, April 2006.

Communication Spectrum

One aspect of interoperability involves the communications links between wayside equipment, locomotive, and the network office. Various types of equipment owned by many different railroads must be able to communicate on any track equipped with PTC. It would be most efficient to utilize a single radio frequency band across the entire PTC system to minimize the cost of radio receivers and network equipment, although a system with multiple frequencies is possible.

The radio frequency band to be used for communication must be known prior to equipment purchases. PTC-220 LLC, a consortium of the Union Pacific, Norfolk Southern, CSX, and BNSF railroads, has purchased licenses to some frequencies in the 220 MHz range,[35] and is requesting the Federal Communications Commission (FCC) to reassign additional spectrum in the 220 MHz band to the railroads for the purpose of PTC. The FCC has designated spectrum in the 220 MHz range mainly for commercial uses and has auctioned licenses to various parties.

[35] Spectrum is segmented into bands of radio frequencies and typically measured in cycles per second, or hertz. Standard abbreviations for measuring frequencies include kHz—kilohertz or thousands of hertz; MHz—megahertz, or millions of hertz; and GHz—gigahertz, or billions of hertz.

Furthermore, along with Amtrak and other railroads, the consortium has requested additional 217-222 MHz spectrum and appropriate license and rule changes, claiming 220 MHz will be insufficient in congested areas.[36] Although frequencies may be available in various bands, the railroads prefer the 217-222 MHz range due to compatibility with current infrastructure and the radio communication technology they have chosen to employ (I-ETMS).[37] Because of uncertainty over spectrum needs, the FCC issued a public notice seeking comments from stakeholders on May 5, 2011, but has not instituted a formal rulemaking process regarding PTC radio spectrum issues.[38]

The railroads' requests for dedicated spectrum for PTC raise a number of policy issues. Licenses to much of the spectrum requested by the railroads have been purchased by other entities in FCC auctions. While the FCC is empowered to reallocate spectrum if necessary for public safety, reassignment for PTC would effectively represent a forced transfer of licenses from some private parties to others. In comments submitted to the FCC, some current licensees of spectrum in the 218-219 MHz range asserted that it is unfair to reallocate spectrum to which they have purchased rights in a competitive bidding process. They also believe the railroads have identified 220 MHz as the core spectrum for PTC without sufficient investigation into their specific radio communication needs or possible alternatives. They contend the railroads can lease spectrum from primary license holders without FCC action.[39]

The railroads counter that leasing spectrum for PTC from existing license holders could raise their costs by creating captive demand for a limited amount of spectrum. A related problem stems from the fact that some of the railroads required to install PTC are commuter lines owned by state or local government agencies. These agencies may have difficulty raising the funds to obtain desirable frequencies in competitive auctions; indeed, the FCC normally assigns frequencies to government agencies at no cost.

Avoiding Barriers to Market Entry

There are several ways the PTC mandate could be used as a barrier to market entry for the railroads. First, installing track will now be more expensive due to the need to incorporate PTC wayside equipment, which is expected to add approximately $50,000 per mile to the $1 million to $3 million per mile cost of installing new rail lines. On-board PTC equipment is expected to cost around $55,000 per locomotive, which represents only a minor increase in the cost of a new $2 million locomotive but is substantial compared to the $75,000 cost of used locomotives operated

[36] Association of American Railroads, *Comments of Association of American Railroads*, Federal Communications Commission, WT Docket No. 11-79, June 20, 2011, http://apps.fcc.gov/ecfs/document/view?id=7021688770.

[37] It should be noted that the radio communication supplier for ETMS is MeteorComm, a wholly owned subsidiary of BNSF, and BNSF is a member of PTC-220, LLC. MeteorComm, "MeteorComm™ Powers BNSF's Electronic Train Management Communications," press release, January 19, 2007, http://meteorcomm.com/downloads/MCC_PSPApproval.pdf.

[38] Federal Communications Commission, Wireless Telecommunications Bureau Seeks Comment on Spectrum Needs for the Implementation of the Positive Train Control Provisions of the Rail Safety Improvement Act of 2008, WT Docket No. 11-79, Washington, D.C., May 5, 2011, http://fjallfoss.fcc.gov/edocs_public/attachmatch/DA-11-838A1.pdf.

[39] The Coalition of 218-219 MHz Service Licensees, *Reply Comments of The Coalition of 218-219 MHz Licensees*, Federal Communications Commission, WT Docket No. 11-79, July 11, 2011, http://apps.fcc.gov/ecfs//document/view.action?id=7021691731.

by some short line railroads.[40] In addition to capital costs, operating and maintenance costs will increase as well.[41] This could be a barrier to both railroad expansion and startup services.

Another barrier to market entry could arise through the need for interoperability and spectrum compatibility. Hypothetically, if two rail networks have different PTC systems because they do not currently share track or services, it may be cost prohibitive to implement a new service over these two lines. Similarly, one company could upgrade or modify its PTC system, forcing further investment by other companies using its track. Also, if the radio spectrum licenses are owned by certain railroads or a consortium of railroads, they could dictate leasing prices to operate necessary PTC systems on that spectrum for a new railroad or service which is not part of the consortium. Control of spectrum and interoperability issues with PTC could be used as tools to prevent new services on existing lines or even using an interoperable spectrum on new lines.

The possibility that PTC could impede competition may be of particular concern for short line and regional railroads which operate on Class I track. Class I railroads have a legal obligation to accommodate short line railroads, but in some cases may be reluctant to allow short line trains on their networks.[42] The president of the American Short Line and Regional Railroad Association issued the following testimony to the Surface Transportation Board:

> Differential pricing of certain routes or products by class I carriers ... ha[s] eliminated marginal customers who may be a small railroad's only source of business on its line, effectively putting the small railroad out of business. Some small railroads who want to provide service to new customers meet resistance from connecting carriers whose marketing plans are inconsistent with the small railroad's proposed business.[43]

At this point, concerns that PTC could create barriers to railroad competition are hypothetical, as no specific complaints are known to have been presented to FRA or to the Surface Transportation Board, which oversees certain rail competition issues.

2015 Implementation Deadline

It remains uncertain whether all affected railroads will be able to comply with the December 31, 2015, deadline for implementing PTC. Many railroads continue to argue that the large capital expenditures required over a small period will divert funding from other uses, including investment in improving the safety of highway-rail grade crossings, where most train-related accidents and fatalities occur.[44]

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[40] Federal Railroad Administration, "Positive Train Control Systems Amendments (RRR)," 77 *Federal Register* 28285, May 14, 2012.

[41] Frank D. Roskind, *Positive Train Control Systems Economic Analysis*, Federal Railroad Administration, FRA-2006-0132, Notice No. 1, July 10, 2009, pp. 115-116.

[42] CRS Report RL34117, *Railroad Access and Competition Issues*, by John Frittelli.

[43] Richard F. Timmons, *STB Ex Parte No. 677: Common Carrier Obligation Hearing*, American Short Line and Regional Railroad Association, Testimony of Richard F. Timmons, Washington, DC, April 25, 2008, p. 2.

[44] U.S. Government Accountability Office, *Rail Safety - Federal Railroad Administration Should Report on Risks to the Successful Implementation of Mandated Safety Technology*, GAO-11-133, December 2010, p. 25.

The effect of the deadline on installation of more advanced systems is disputed. As discussed earlier, PTC and CBTC have different capabilities, but they share similar infrastructure and communication architectures. While CBTC would require additional cost, it might be cost-effective to develop both functionalities simultaneously. Railroads also argue the deadline for PTC has caused railroads to focus on that system rather than on the potential business advantages of a broader CBTC system.[45] Also, some commuter lines have stated interest in extending PTC capability through wireless technology capable of transmitting more data, but investment in these more complex emerging technologies may be deferred due to the approaching deadline.[46]

On the other hand, the PTC mandate institutes a common infrastructure and communication architecture platform that could be used for future CBTC and additional safety feature integration in a coordinated way across disparate stakeholders. Without the PTC mandate it is likely that PTC/CBTC would not have been developed with such a coordinated effort, due to the multitude of stakeholders. FRA has concluded that incremental steps are the preferred way to develop a more complex train control system, such as CBTC.[47]

Options for Congress

The Moving Ahead for Progress in the 21st Century Act (MAP-21; S. 1813) and the American Energy and Infrastructure Jobs Act (H.R. 7) from the 112th Congress both included provisions which amended RSIA08 with respect to PTC. The provisions in these bills were ultimately excluded from the final version of the transportation bill (H.R. 4348), but both provide insight into possible strategies to address some of the policy issues with PTC.

Table 1. PTC Provisions in Unenacted Senate and House Bills in 112th Congress

Bill	Deadline Extension	Safety	Interoperability	Communication Spectrum	Funding	Barrier to Entry
House-Reported H.R. 7	12/31/2020	Full PTC or equivalent alternative	No change	No change	No change	No change
Senate-Passed S. 1813	At FRA discretion for each railroad in one-year increments, not beyond 12/31/2018	Full PTC	No change	FCC/DOT joint report on spectrum needs and availability for PTC required	Eligible for Railroad Rehabilitation and Improvement (RRIF) financing	FCC/DOT joint report on spectrum needs and availability for PTC required

Source: CRS, based on texts of S. 1813 and H.R. 7.

45 Ibid.

46 Jeff Stagl, "PTC: Railroads, suppliers still have a ways to go to meet the 2015 positive train control mandate," *Progressive Railroading*, August 2010.

47 Federal Railroad Administration, The *North American Joint Positive Train Control (NAJPTC) Project*, Research Results, April 2009, p. 4.

Congress has already shown its concern about implementation risk, and the enacted version of MAP-21 requires DOT to report on PTC implementation to Congress by December 31, 2012. The Government Accountability Office has recommended that this report include "an analysis of (1) the likelihood that railroads will meet the PTC implementation deadline; (2) the risks to successful implementation of PTC; and (3) actions Congress, railroads, or other stakeholders can take to mitigate risks to successful PTC implementation."[48]

The most obvious way to mitigate implementation risk would be to extend the 2015 deadline, giving railroads and FRA additional time to make sure PTC will work as intended. S. 1813 and H.R. 7 both would have extended the deadline, albeit in different ways. However, extending the deadline would create a different sort of risk by leaving railroads exposed to PTC-preventable accidents for a longer period of time.

One of the major concerns of railroad companies is the cost of PTC. This is especially true for short line railroads and local commuter services reliant on local and state government funds. RSIA08 authorizes federal grants to railroads to support PTC, but no funds have been appropriated for this purpose. Congress could address this issue by specifically making PTC projects eligible for funding under the Railroad Rehabilitation and Improvement Funding Program, as provided in S. 1813, or by appropriating other funding to FRA.

Congress may wish to consider issues related to spectrum allocation for PTC. S. 1813 called for a joint FCC/DOT investigation of spectrum issues, but no such directive has been enacted. While the FCC has solicited comments about the use of spectrum for PTC, it has not instituted a formal proceeding and is not required by law to do so. Congress could establish deadlines or direct FCC actions on the subject. Alternatively, by not acting, Congress could choose to leave the matter entirely to the FCC's discretion.

Although many more rail-related fatalities occur at highway-rail crossings than from train collisions, these are not specifically addressed in the PTC mandate of RSIA08. Congress could address this by extending the definition of PTC to require coverage of highway-rail crossings. This can be achieved technically within the PTC framework by installing sensors at crossings that would engage the brakes of an oncoming train if a crossing gate were not working properly or if a vehicle is detected on the tracks.[49] While this may require further investment on the part of the railroads and may not be implementable by the current deadline, it may offer more significant gains in terms of safety than train collision prevention alone.

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[48] U.S. Government Accountability Office, *Rail Safety - Federal Railroad Administration Should Report on Risks to the Successful Implementation of Mandated Safety Technology*, GAO-11-133, December 2010, p. 47.

[49] Fred Coleman III, Ronald W. Eck, and Eugene R. Russell, "Railroad-Highway Grade Crossings," TRB Conference Publication, Washington, DC, January 2000.

Author Contact Information

Jeffrey C. Peters
Research Associate
jpeters@crs.loc.gov, 7-6044

John Frittelli
Specialist in Transportation Policy
jfrittelli@crs.loc.gov, 7-7033