High-speed trains: The future of mobility on the Northeast Corridor.

03

DESIGNING A HIGH-SPEED RAIL SERVICE

To remain globally competitive in the 21st century, the Northeast Megaregion needs 21st-century infrastructure. In particular, its intercity rail infrastructure—the Northeast Corridor—is aging and underdeveloped. America's preeminent passenger rail corridor is in need of **a bold paradigm shift** to remain competitive on a global scale. While European and Asian megaregions are increasingly interconnected by trains reaching speeds of more than 180 mph, Amtrak's Acela Express averages only 70 to 80 mph over its route.

This chapter presents a proposal for a revitalized Northeast Corridor, anchored by **two dedicated high-speed rail tracks** between Washington, D.C., and Boston. This innovative proposal maximizes the potential of existing rights-of-way while suggesting several new routes and alignments that can dramatically improve service speeds and reliability throughout the corridor.

By improving service with a new alignment and service plan, the Northeast Corridor has the potential to triple its current ridership by 2040, and to **transform mobility and connectivity** throughout the region, fulfilling its economic potential and promoting sustainable, equitable growth.

CASE STUDY

Acela Express: The Only "High-Speed" Service in the United States

In 1999 Amtrak released a plan for high-speed service in the Northeast. Engineers finished electrifying the Northeast Corridor from Washington, D.C., to Boston, and also made other necessary improvements for high-speed operations, such as removing at-grade crossings with roadways. However, a major difference between U.S. "high-speed" service and that of services in Japan, France and many other countries remained: the American trains still do not have dedicated high-speed track. The new Acela Express high-speed service had to run on 19th-century rights-of-way, constrained by tightly curving track and competing train operations. Accordingly, Acela reaches its maximum speed of 150 mph on only two short sections of the corridor.

Nonetheless, the Acela Express service had an immediate impact on rail's mode share in the Northeast. Before Acela, 64 percent of passengers between New York and Washington, D.C., traveled by air. After Acela began running in 1999, the rail market share grew 53 percent of all air-rail passengers. Similarly, between New York and Boston, Amtrak's mode share increased from 18 percent to 40 percent.[1] These mode shifts are clear evidence that the market exists and that passengers will ride fast trains in the Northeast Corridor.

WHAT IS HIGH-SPEED RAIL?

Americans have had precious few encounters with true high-speed rail service. Internationally, a high-speed service is defined as regularly operates at speeds exceeding 250 kilometers per hour (160 mph). Several systems, including those in France, Japan, Spain and China, operate well above this speed, exceeding 300 kilometers per hour (186 mph), gaining ridership and providing energy-efficient mobility. But in the United States, even the Acela Express, often touted as America's only high-speed service, reaches speeds in excess of 125 mph on limited sections of its route because of the significant limitations of the existing Northeast Corridor.

In this report, high-speed rail refers exclusively to service that operates above 125 mph and the high-speed proposal detailed in this chapter is envisioned (conservatively) for trains operating in the range of 180 mph and achieving average speeds of approximately 150 mph. This allows room for growth: most future high-speed lines, such as HS2 in the United Kingdom and the proposed California High-Speed Rail system are being designed to reach top speeds of at least 220 mph.

THE DESIGN CHALLENGE

The proposal detailed in this chapter is a bold, innovative and forward-looking approach to solving the design challenge of building a dedicated high-speed rail right-of-way along the 454-mile spine of the Northeast Corridor between Washington, D.C. and Boston. The design challenge is to accomplish nothing short of threading a dedicated high-speed rail alignment into the densest region in the country, through several of the largest and densest cities in the United States, while weaving it into one of the most complex and busiest passenger and freight rail systems in the world.

The design seeks to create a system that minimizes construction costs while maximizing benefits and being bold enough in vision and in substance to revolutionize mobility throughout the Northeast. The design team sought to mix an inventive vision with grounded practicality in a way that identifies feasible projects that are challenging to the status quo. The guiding principles of the design are explained in the next section.

This proposal is neither the fastest possible route nor the most forward-looking, best-possible solution, but it is a superior alternative to continued incremental upgrades that invest extensive resources while achieving only marginal benefits.

DESIGN PRINCIPLES FOR HIGH-SPEED RAIL IN THE NORTHEAST

INCREASE CAPACITY: Two new, dedicated high-speed intercity tracks are crucial to freeing up capacity for intercity services and for relieving capacity on crowded commuter rail lines across the Northeast. The eight commuter rail operators, carrying more than 240 million passengers per year, need this capacity to expand their services. Nearly one-third of the NEC already operates at 75 percent capacity or worse.

MAKE TRAVEL TIME COMPETITIVE: Dedicated high-speed intercity tracks will allow rail trip times that are faster than driving and flying times throughout the Northeast, making rail the mode of choice for intercity trips.

MAXIMIZE ACCESSIBILITY AND INCREASE RIDERSHIP: The new high-speed rail alignment maximizes opportunities to connect to local transportation hubs, commuter rail stations and international airports, improving customer accessibility and expanding the rail market.

UTILIZE EXISTING ROW/MINIMIZE TAKINGS: The new alignment follows existing rights-of-way, or utilizes vacant land, industrial sites and utility rights-of-way, to the greatest extent possible in ways that minimize takings of residences and other private property.

CATALYZE DEVELOPMENT: New station locations were deliberately selected to spur new, high-speed-rail-oriented urban development and infill development.

SIMPLIFY AND AMPLIFY LOCAL TRANSIT CONNECTIONS: For too long the Northeast's intercity services have not been well coordinated with local transportation services. The new alignment and station designs directly connect these assets, making transfers and interconnections seamless.

OFFER A HIERARCHY OF SERVICE: Two new, dedicated high-speed tracks will vastly increase the operational flexibility of the railroad. This allows for a wider range of express and local services, offering customers far more choices regarding speed and destinations.

LIMIT CAPITAL COSTS: High-speed rail infrastructure is expensive, but you get what you pay for. The proposed dedicated high-speed alignment balances forward-thinking capital investments with the constraints of the Northeast to create infrastructure that will serve the megaregion for decades to come.

SYSTEM UPGRADE TYPOLOGIES

Urban Core Station

The design process invested particular attention to the types of new station locations, station improvements and track improvements that will be necessary to advance the design principles for high-speed rail in the Northeast. These typologies are explained here.

STATION LOCATIONS

New and existing stations on the alignment largely fall into three categories. These three types help achieve the design goals of catalyzing development, maximizing ridership and accessibility and creating seamless transit connections.

Urban Core Stations serve the central areas of the cities along the corridor. In addition to the five largest cities, this type includes stations serving the cores of Hartford, Conn., Newark, N.J., Wilmington, Del., Providence, R.I., Stamford, Conn., Worcester, Mass., and others.

Regional Connection Station

Regional Connection Stations serve peripheral areas of the major metropolitan stations along the corridor. These stations are often accessible by commuter rail and regional bus networks, as well as being conveniently located near major freeway junctions for excellent accessibility by car.

Airport Stations are a new model for the Northeast, where high-speed rail service connects together the region's major airports, ready to deliver passengers to the airport terminals or whisk passengers to their ultimate destinations. In addition to the existing connections at Newark and Baltimore-Washington, proposed stations will serve Philadelphia International, John F. Kennedy and MacArthur airports.

Airport Station

STATION IMPROVEMENTS

Appropriate station design, particularly track and platform layout, is an essential element in moving trains as efficiently and safely as possible. Existing stations on the Northeast Corridor must be upgraded (and new stations designed) to host a combination of commuter rail and long-distance trains. Not all stations will be served by high-speed rail (Type IV), and some stations are solely dedicated to high-speed rail (Type I). Many existing stations will entertain commuter service on outer tracks, with high-speed rail on inner tracks (Type II and Type III).

Type I stations are completely dedicated to high-speed rail. Stopping trains pull off the high-speed tracks to stop at the station; nonstop trains proceed through the station at consistent speeds on separated tracks between the passenger platforms. New high-speed stations at Baltimore Charles Center, Philadelphia International Airport and Tolland/UConn are examples of this approach. These stations can also accommodate high-speed commuter services, following the model of the U.K.'s Javelin service.

Type II stations host high-speed trains and commuter rail. These designs are similar to Type I, with high-speed rail in the center and commuter rail to the outside of station platforms. This allows for simple cross-platform transfers between commuter rail and high-speed rail. Stations in Odenton, Md., Newark, Del., Cornwells Heights, Pa., and MetroWest outside of Boston are examples of this model.

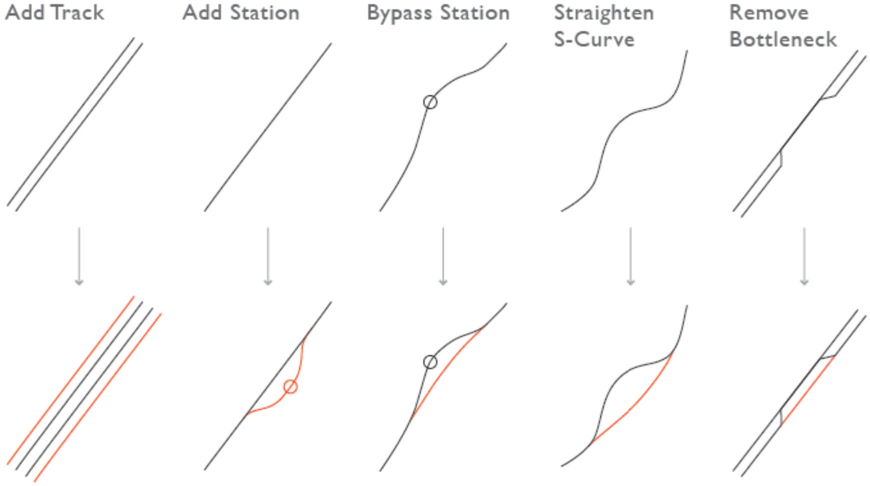
Type III stations are similar to Type II stations, except Type III are located in areas with constrained rights-of-way. New Carrollton, Md., BWI Airport and Aberdeen, Md., are examples of stations have little room for outward expansion, so providing separated tracks above or below existing stations is necessary. Thus, nonstop high-speed trains utilize an aerial structure or tunnel to safely bypass the station.

Type IV stations will continue to serve commuter trains, allowing high-speed trains to bypass the station through a tunnel or on an aerial structure. Examples of Type IV include the many small commuter stations along the Long Island Rail Road, such as Wyandanch, Deer Park and Brentwood.

TRACK IMPROVEMENTS

When designing for a high-speed track within or near the existing right-of-way, several different types of improvements are proposed, as represented by the diagrams below. These track improvements serve particular design goals: Types I, III and V offer capacity expansion and dedicated HSR tracks; Type II offers new market access for rail; and Types I, IV and V offer speed improvements over current conditions.

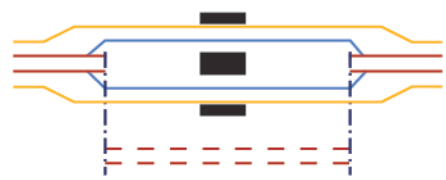
Type I Add Track | **Type II** Add Station | **Type III** Bypass Station | **Type IV** Straighten S-Curve | **Type V** Remove Bottleneck



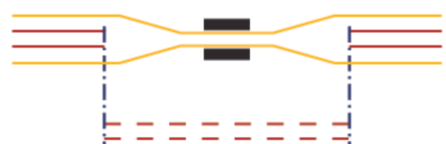
Type I
Basic High-Speed Station

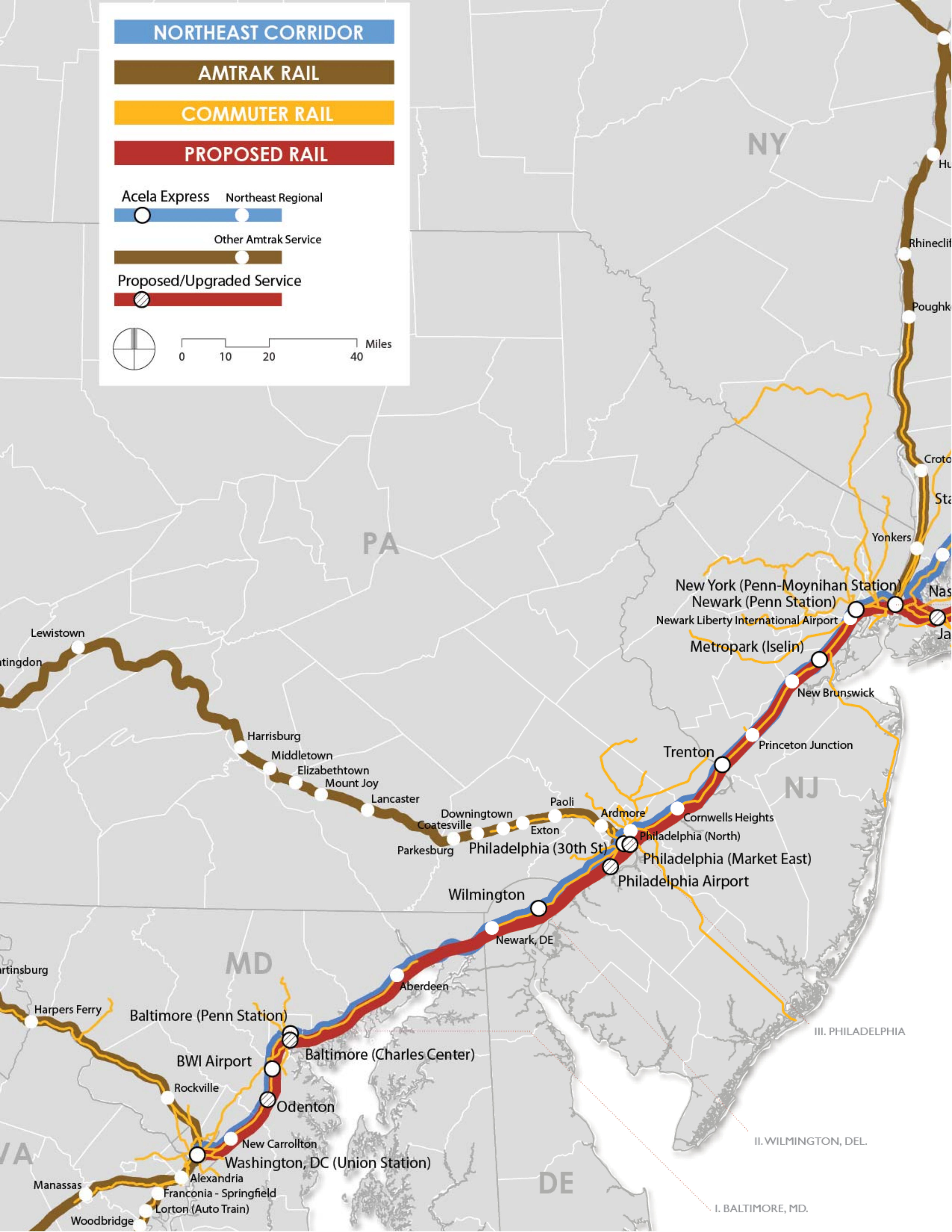
Type II
High-Speed + Commuter Station
(w/ Station Bypass)

Type III
High-Speed + Commuter Station
(in Constrained ROW)



Type IV
High-Speed Bypass of Commuter Station
(in Constrained ROW)





NORTHEAST CORRIDOR
AMTRAK RAIL
COMMUTER RAIL
PROPOSED RAIL
Acela Express
Northeast Regional
Other Amtrak Service
Proposed/Upgraded Service
Miles
0
10
20
40
NY
PA
NJ
MD
DE
Lewistown
Harrisburg
Middletown
Elizabethtown
Mount Joy
Lancaster
Downingtown
Coatesville
Parkesburg
Exton
Paoli
Ardmore
Philadelphia (30th St)
Philadelphia (North)
Philadelphia (Market East)
Philadelphia Airport
Cornwells Heights
Trenton
Princeton Junction
New Brunswick
Metropark (Iselin)
Newark Liberty International Airport
Newark (Penn Station)
New York (Penn-Moynihan Station)
Yonkers
Rhinecliff
Wilmington
Newark, DE
Aberdeen
Baltimore (Penn Station)
Baltimore (Charles Center)
BWI Airport
Odenton
New Carrollton
Washington, DC (Union Station)
Rockville
Harpers Ferry
Alexandria
Franconia - Springfield
Lorton (Auto Train)
Manassas
Woodbridge
III. PHILADELPHIA
II. WILMINGTON, DEL.
I. BALTIMORE, MD.

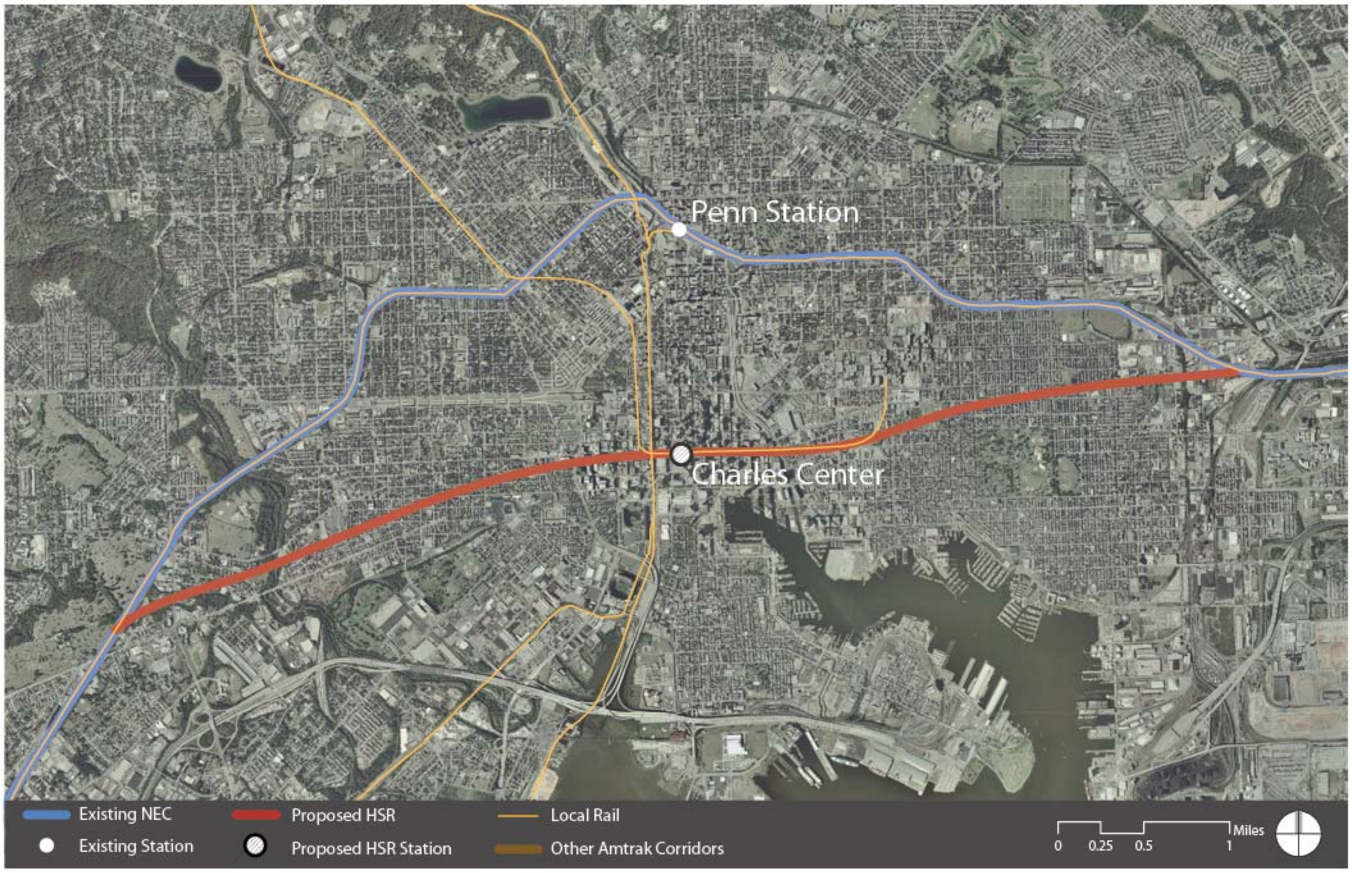
NORTHERN END — NEW YORK TO BOSTON

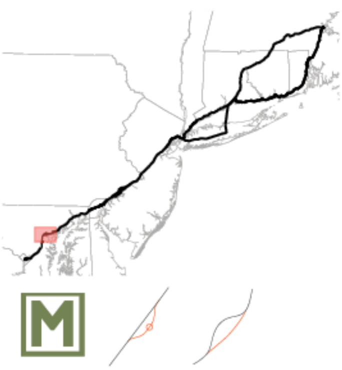
There are two potential routes for a new two-track, dedicated, high-speed service from New York to Boston. The first would require upgrading the existing corridor along inlets, rivers and historic waterfront communities. This section is particularly congested, and it would require significant use of tunnels and viaducts to bypass curves, movable bridges and other obstructions.

Given the high costs and political uncertainties associated with this first option, this report outlines an alternative right-of-way that would simultaneously solve the problems of curvy, difficult existing alignment while connecting now-isolated communities to the corridor. This proposed alignment proceeds east from New York across Long Island, then north through a new three-track tunnel under Long Island Sound to New Haven. From there it travels inland to Hartford, then along the I-84 corridor toward Worcester, and finally east to Boston along the Massachusetts Turnpike. At the same time, full Amtrak service will be retained or expanded along the existing Shore Line, with New Haven becoming the new linchpin of the northern end.

SOUTHERN END — WASHINGTON TO NEW YORK

The southern half of the dedicated high-speed rail line relies mostly on the existing right-of-way from Washington's Union Station to New York's Penn-Moynihan Station. Here, the physical challenge is primarily an urban one—the tricky alignments through Philadelphia and Baltimore limit speeds for the whole line. Solving two problems with one change, the proposed alignments utilize tunnels to dramatically improve speeds through these cities while also creating new downtown stations in areas ripe for economic development. Further linkages include direct service to Philadelphia International Airport and improved regional connections.





Improvement and Station Typologies

DETAILED ALIGNMENT PROPOSALS

1. BALTIMORE

The most severe speed restrictions on the southern end of the existing Northeast Corridor occur in Baltimore. For example, speeds are limited to 30 mph or less in the 140-year-old Baltimore and Potomac Tunnel on the western approach to Penn Station. Further, Penn Station itself is weakly linked to Baltimore's core downtown. To vastly increase speeds, improve infrastructure and offer better multimodal connections, the proposed route uses a new tunnel to serve downtown Baltimore directly at the new Charles Center Station.

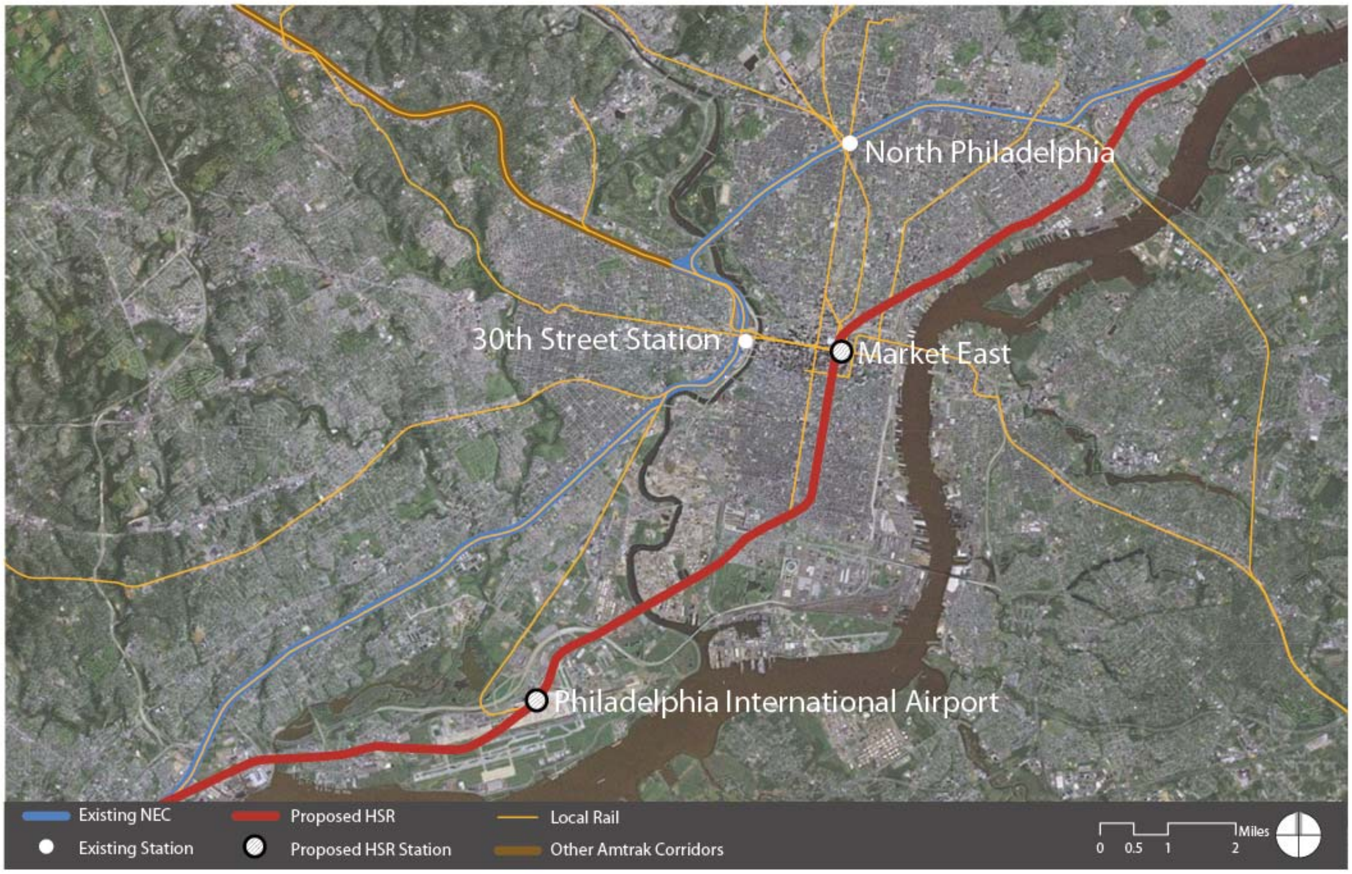
- Project Length: 7.1 miles
- Current Top Speed: 30-55 mph[2]
- Proposed Top Speed: Up to 150 mph
- Key Benefits: New downtown core station with better accessibility to existing transit; replace obsolete tunnels
- Current Annual Ridership: 986,000 passengers[3] (Penn Station)
- Projected Annual Ridership (2040): 1.9-2.8 million passengers
- Major Capital Projects: Tunnel along Wilkens Avenue, Redwood Street and Orleans Street; New Charles Center Station; replace obsolete tunnel

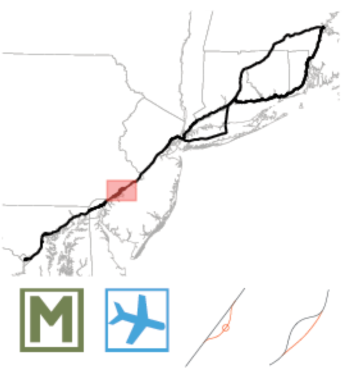
II. WILMINGTON, DEL.

The tight curves immediately surrounding Wilmington Station restrict current speeds to 30 mph, which is not a major problem for trains stopping at Wilmington but hinders nonstop trains. While Wilmington will see increases in total train service from the HSR proposal, nonstop trains will bypass these curves by using an existing freight right-of-way.

- Project Length: 5.1 miles
- Current Top Speed: 30-70 mph
- Proposed Top Speed: Up to 180 mph
- Benefits: Allow for higher speeds by bypassing station and curves; improve direct travel times between Washington and New York
- Major Capital Projects: Acquire freight right-of-way; build two bridges and some track on aerial structures

Improvement and Station Typologies



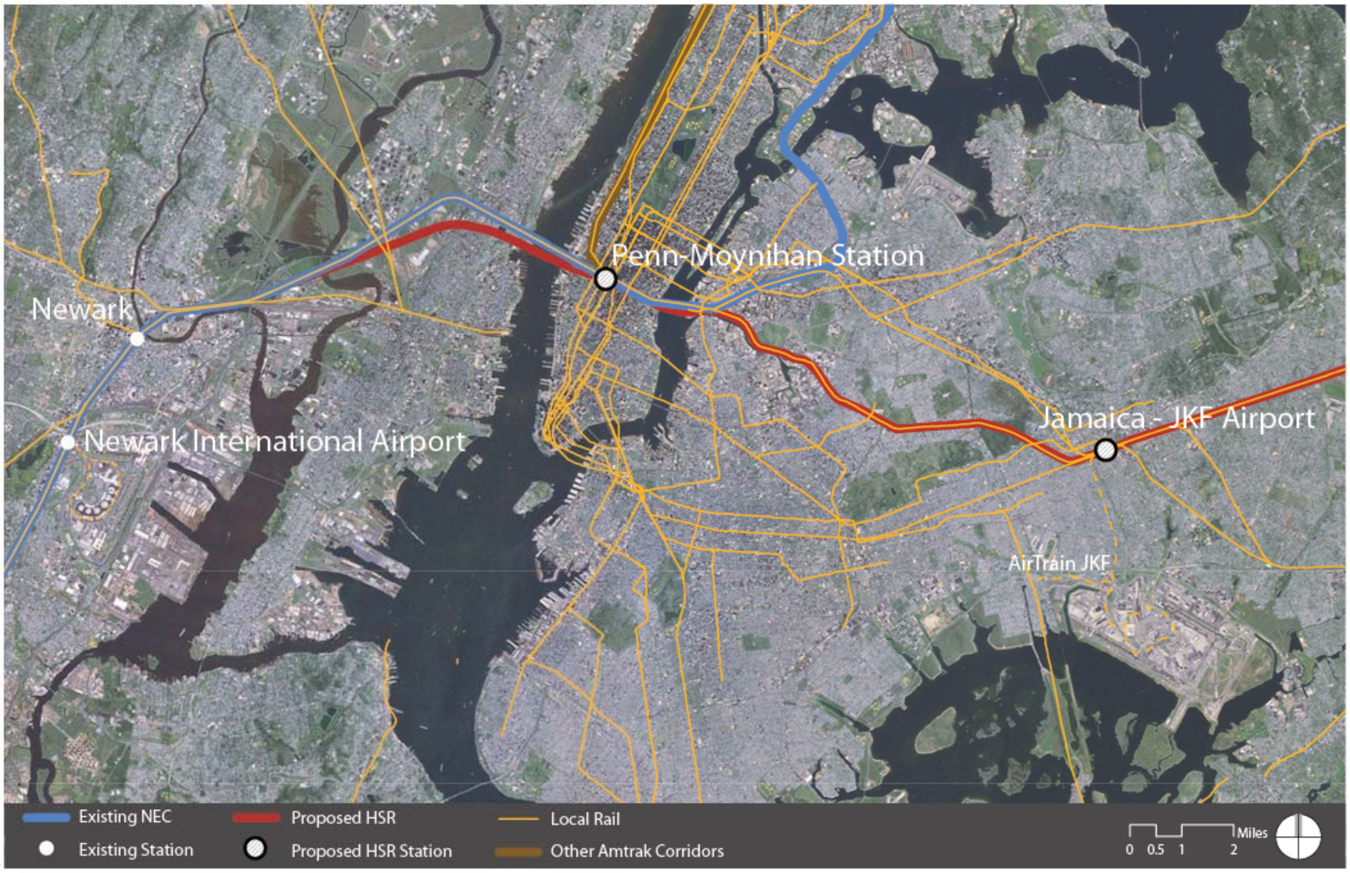


Improvement and Station Typologies

III. PHILADELPHIA

The proposal through Philadelphia includes two new intercity rail access points for the region, while retaining service at Philadelphia's majestic 30th Street Station. The new alignment serves the airport, then continues in a tunnel under Philadelphia to a new station at Market East in Center City. Directly connected to the region's transit infrastructure and steps from major business and tourist destinations, Market East HSR could unlock the potential of this underperforming portion of Philadelphia's downtown.

- Project Length: 20.3 miles
- Current Top Speed: 45-100 mph
- Proposed Top Speed: 130-180 mph
- Current Annual Ridership:
    - Airport: N/A; 30th Street Station: 3.88 million passengers
- Projected Annual Ridership (2040):
    - Airport: 800,000-1.2 million passengers; Market East/30th Street Station: 6.3-9.5 million passengers
- Major Capital Projects: Tunnel and aerial structure to access Philadelphia Airport; Philadelphia tunnel to serve Market East; two new full-scale rail stations

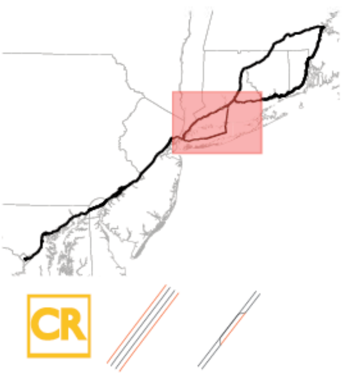


IV. NEW YORK CITY AREA, N.Y./N.J.

Access to New York's existing Penn Station is the major capacity bottleneck in the entire current Northeast Corridor. The proposal envisions a new set of dedicated tunnels serving New York's future Moynihan Station, with the tunnel continuing to the east under the East River and into Long Island. Back above ground, the line serves Jamaica Station, with its direct connections to the Long Island Rail Road and JFK Airport.

- Project Length: 17.0 miles (Newark to Jamaica)
- Current Top Speed: 30-80 mph
- Proposed Top Speed: Up to 150 mph
- Current Annual Ridership:
    - Penn Station: 8.5 million passengers; Jamaica Station: N/A
- Projected Annual Ridership (2040):
    - Penn-Moynihan Station: 10.7-16.1 million passengers; Jamaica Station: 2.0-3.0 million passengers
- Major Capital Projects: Tunnel under Hudson, Manhattan, the East River and parts of Brooklyn and Queens; Moynihan Station and Jamaica Station improvements

Improvement and Station Typologies



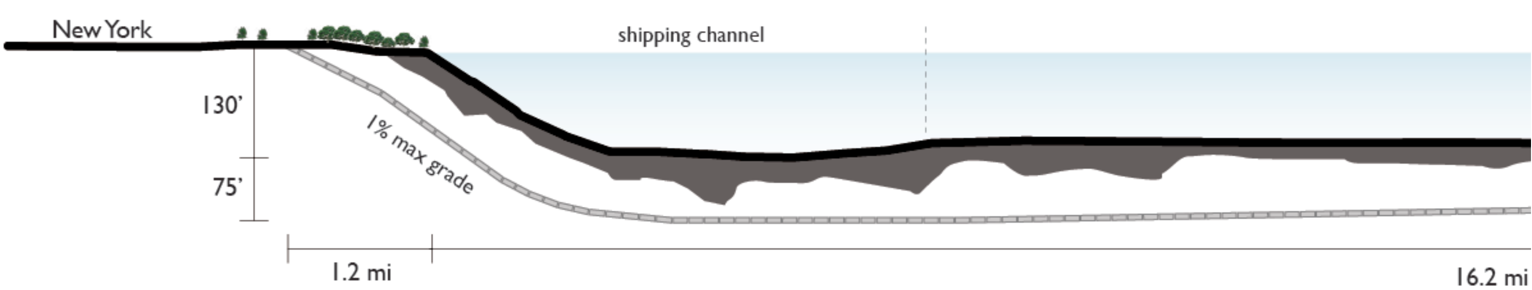
Improvement and Station Typologies

V. LONG ISLAND, N.Y.

The signature investment of the new proposed high-speed rail line is its proposal for direct, high-speed service throughout Long Island, including a major tunnel under Long Island Sound to rejoin the existing Northeast Corridor at New Haven. This project, along with the inland route proposal described below, are central to vastly improving rail travel times on the northern half of the Northeast Megaregion.

The proposed high-speed alignment generally follows existing Long Island Rail Road rights-of-way east-to-west across the island. To minimize land takings, in many cases the high-speed alignment may run in a tunnel under or trench along or within LIRR alignments.

In addition to Jamaica, new stations to serve Long Island's seven million people include Nassau Hub, east of Garden City, which is envisioned as Nassau County's emerging downtown; the Route 110 corridor and

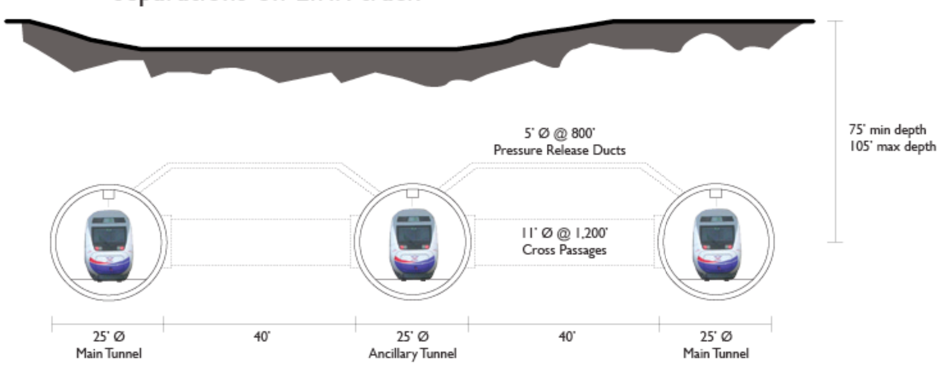


Tunnel Section: the sound is wide (16.2 miles), but shallow (130' max. depth).

Ronkonoma/MacArthur Airport, which presents a unique intermodal station opportunity for access by rail, car and plane. Also, a stop is proposed near SUNY Stony Brook's campus.

The Long Island Sound Tunnel itself is similar to, but not as long or as deep as, the tunnel under the English Channel between Britain and France. This tunnel would actually be three tracks—two serving high-speed rail passenger service, and a third providing freight access to Long Island through specially designed electric-powered freight trains.

- Project Length: 70.3 miles (Jamaica to Milford, Conn., tunnel portal)
- Current Top Speed: 40-90 mph (on existing NEC segment)
- New Top Speed: Up to 180 mph (on Long Island alignment)
- Benefits: Provide five Long Island access points to the Northeast Corridor; vastly improved travel times north from New York
- Current Annual Ridership: N/A
- Projected Annual Ridership (2040): 880,000-1.4 million passengers (excludes Jamaica Station)
- Major Capital Projects: New track; Long Island Sound Tunnel; grade separations on LIRR track



Tunnel Section: 2 main tubes and 1 ancillary tube.

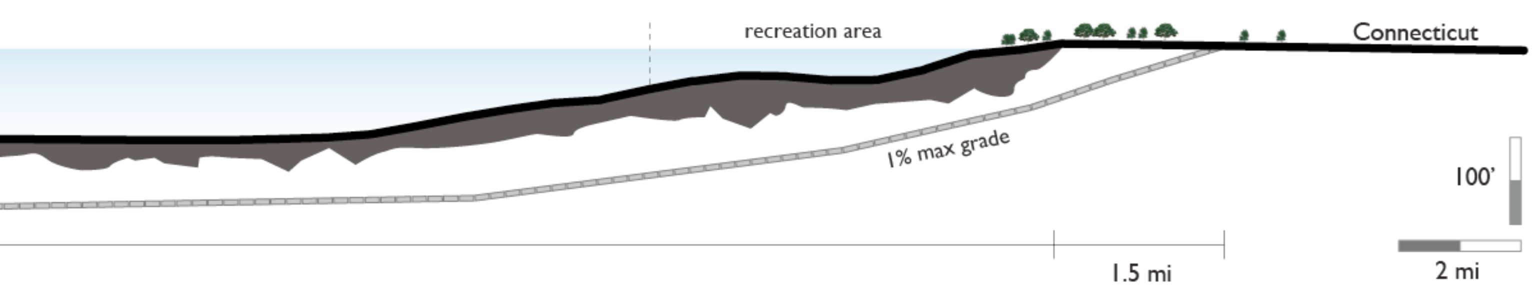
LESSON FROM LONDON

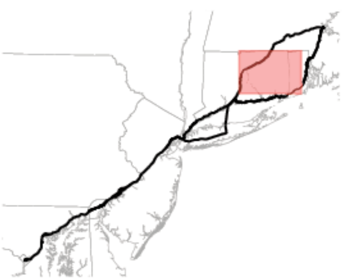
Channel Tunnel: High-Speed Link Between France and the United Kingdom

The Channel Tunnel, also known as the "Chunnel," runs from Folkestone, England, to Sangatte, France, and allows for a high-speed connection between London, Paris, Brussels and other destinations in Europe.

The construction of the tunnel was finished in 1994 at a total cost of $21 billion. The total length of the steel-and-concrete tunnel is about 31 miles. Completion of the Chunnel took about six years from the time actual boring started until the first services were operational. With trains allowed to reach speeds around 100 mph in the Chunnel, the total end-to-end travel time is just 20 minutes.

Engineers building the tunnel faced two major challenges: first, to design the longest underwater tunnel ever built (at that point); and second, to convince the public that passengers would be safe in a tunnel that long. To alleviate safety concerns (as well as allow for regular maintenance without disrupting service), the Chunnel actually consists of three tunnels: two that accommodate rail traffic and a smaller service tunnel reserved for emergency access.[4]





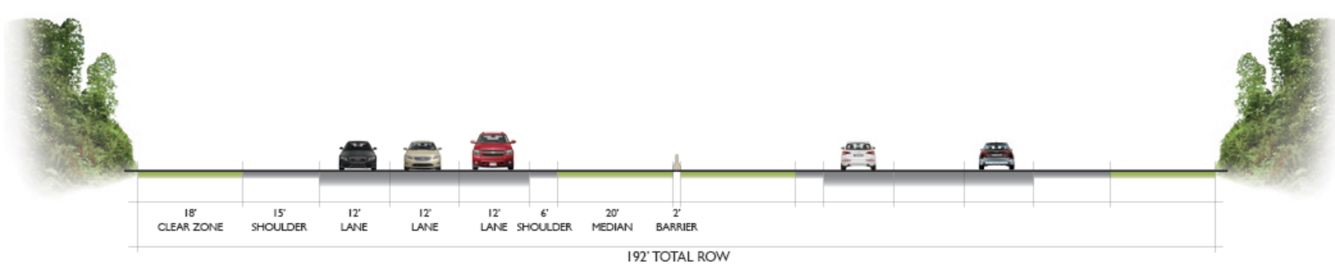
Improvement and Station Typologies

VI. INTERSTATE 84 CORRIDOR, CONN./MASS.

After emerging from the Long Island Sound Tunnel, trains will briefly rejoin the existing NEC to reach New Haven. At New Haven, northbound trains can be routed either along the high-speed I-84 corridor or along the existing NEC line that serves the Connecticut shore and Rhode Island. Similarly, southbound trains reaching New Haven will either take the tunnel to Long Island or serve Stamford and the Connecticut/New York shore along the conventional NEC.

The inland route between New Haven and Boston represents the most significant alignment change of the entire project, creating a new high-speed alignment largely along three interstates (I-91, I-84 and I-90) in Connecticut and Massachusetts.

High-speed trains will travel north from New Haven to serve Hartford, Conn., where they will veer east and follow a brand-new alignment



I-84: Current Alignment

along Interstate 84 through northeastern Connecticut and southern Massachusetts toward Worcester. This section is the second crucial link of the proposed high-speed link between New York and Boston, and will provide excellent through-speeds, but trains will also stop to serve Hartford and a new Tolland/University of Connecticut station.

In many sections of this route, the high-speed alignment may be able to fit directly into the I-84 right-of-way, such as in the median as depicted in the illustrations on these pages. In other sections, the high-speed track may run along one or another side of the freeway or deviate from the freeway routing in order to avoid excessive curves or grades. Some tunnel and viaduct construction is anticipated in order to avoid the most severe grade change as well.

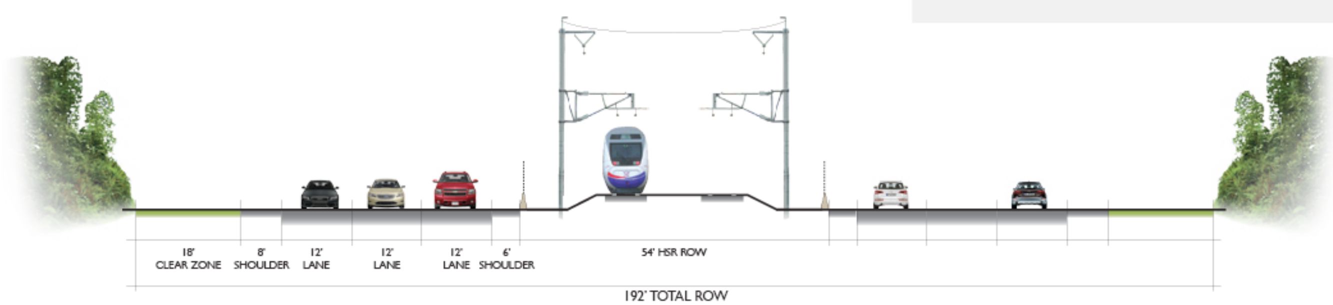
- Project Length: 48.0 miles (Hartford to Worcester rail junction)
- Current Top Speed: N/A
- New Top Speed: 180+ mph
- Benefits: Straight alignment along I-84 corridor; ties Hartford into the Northeast Corridor; service to Tolland/UConn; travel time improvements to Boston
- Major Capital Projects: Build track along highway; occasional small tunnel or viaduct section to accommodate grades

CASE STUDY

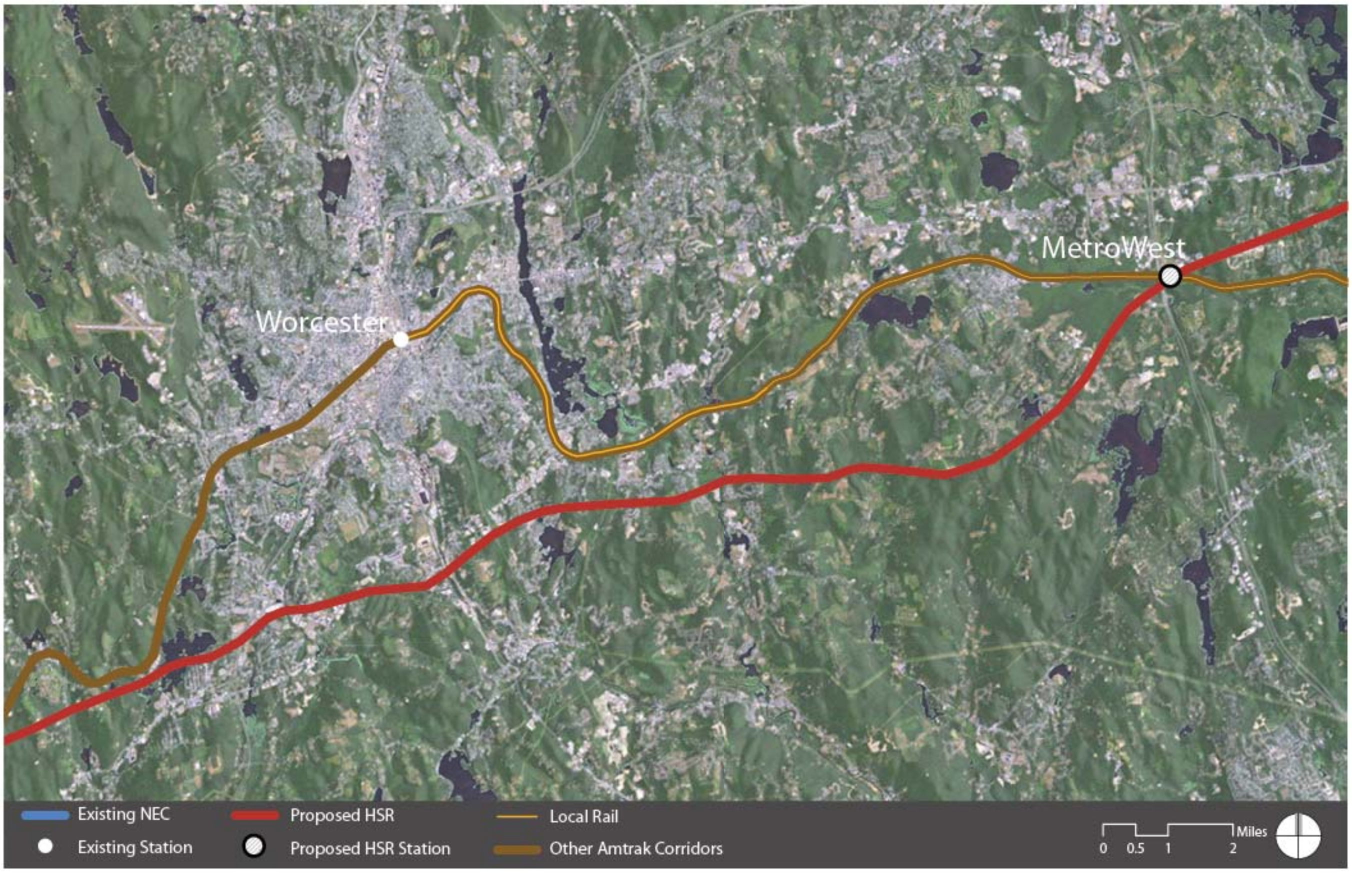
High-Speed Rail on Highway ROW: HSL2, Belgium

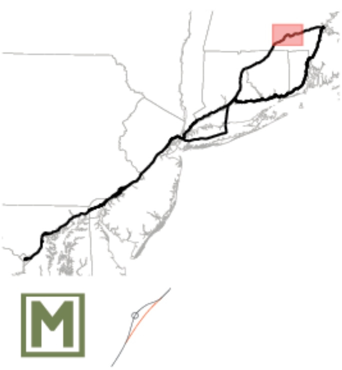
Belgium is a country rich in rail infrastructure, with the Eurostar ICE, TGV and Thalys HSR systems all providing extensive services. Until recently, however, fewer Belgians used rail as their primary mode of transportation than many of their European counterparts. In 2002, the Flemish government attempted to expand the market for rail by upgrading the main lines to accommodate higher speed services and extending lines east into Germany. These lines—known as HSL2, HSL3 and HSL4—were built to host both ICE and Thalys trains.

Like the proposed high-speed route on the NEC, the HSL2 line was built using a combination of existing tracks and additional public ROW—in this case, alongside the E40 motorway. Using the motorway had two great benefits: First, it utilized land already owned by the Flemish government, and second, it allowed high-speed trains to run on the long, straight, flat corridors on which the motorway system was built. In fact, trains reach their fastest speeds along this route, unimpeded by tight curves or grade changes. The E40 corridor is similar to I-84 in Connecticut, and provides a clear example of using existing resources more efficiently to reduce costs and minimize land takings.[5]



I-84: Proposed Alignment with HSR in Median



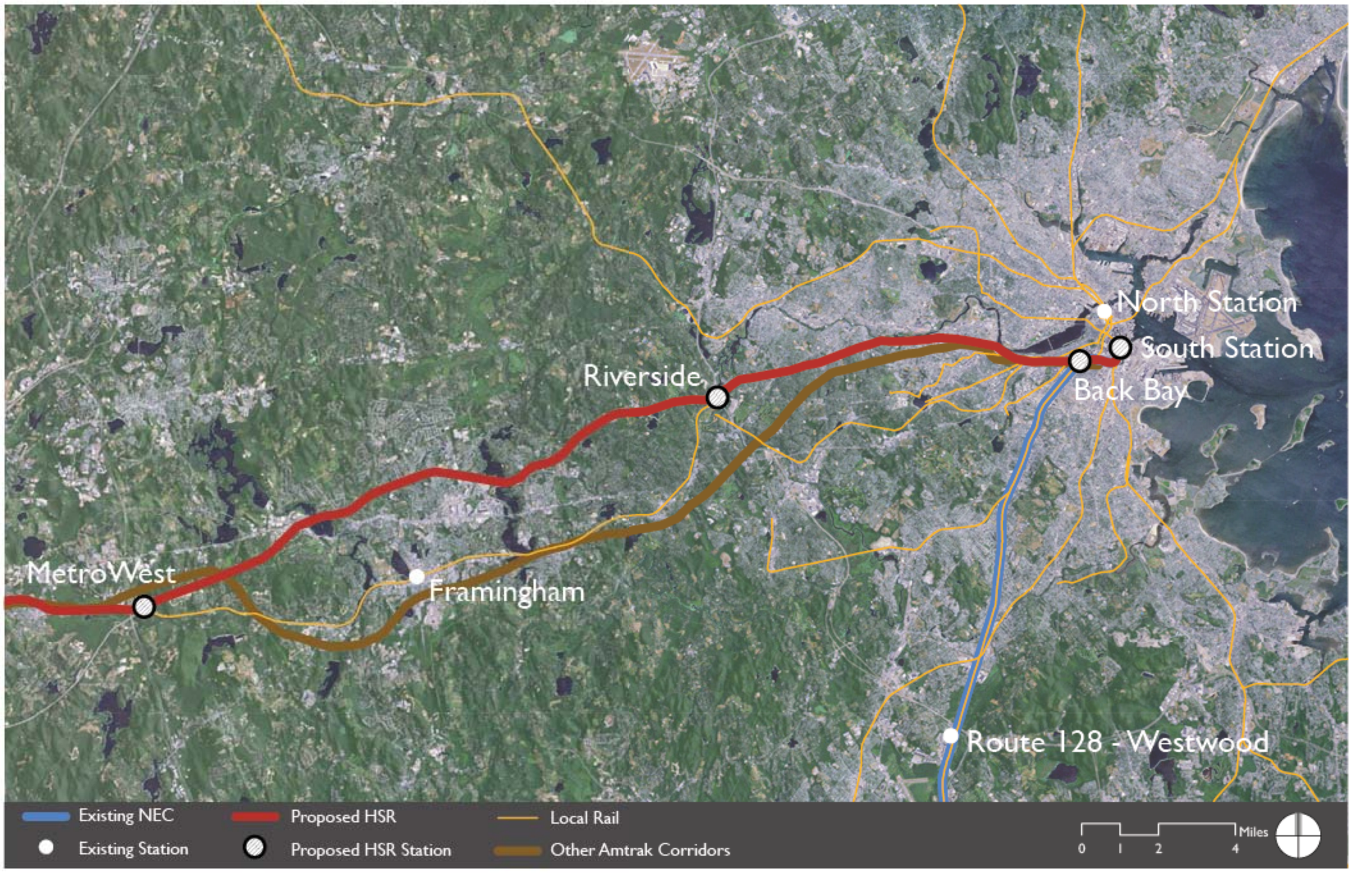


Improvement and Station Typologies

VII. WORCESTER, MASS.

At Worcester, high-speed trains serving the direct Boston-to-New York markets will remain near the Interstate 90 alignment to the city's south; however, many trains will also divert off this alignment to service Worcester directly by running along existing Amtrak track that is shared with commuter services from Boston. Trains making these stops in Worcester will be able to rejoin the high-speed alignment east of the city and proceed to Boston. Thus, travel time for through trains, like at Wilmington, is reduced, but access is still provided to the major rail market in the urban core.

- Project Length: 17.7 miles (high-speed bypass); 21.5 miles (Worcester-serving route)
- Current Top Speed: N/A
- New Top Speed: Up to 180 mph
- Benefits: Option of direct service to Worcester's Union Station or high-speed bypass service to Boston
- Current Annual Ridership: 6,183 passengers (not an NEC service)
- Projected Annual Ridership (2040): 250,000-400,000 passengers
- Major Capital Projects: Build track along highway corridor; new rail junctions to allow service to Worcester



VIII. BOSTON APPROACH

The Boston metropolitan area gains two new stations on the new high-speed rail alignment while retaining service at its two urban core stations, Back Bay and South Station. The tightly constrained high-speed alignment parallels the Mass Pike (I-90), most likely in an aerial structure and then in a highly optimized train environment allowing maximum intercity and commuter train capacity when nearing the urban core stations.

The new MetroWest station, sitting at the junction of two major freeways, will be one of the most accessible stations by car in the entire high-speed system in addition to connecting to commuter rail services. At Riverside, an extension to Boston's Green Line could connect urban transit, commuter rail, automobile access and intercity trains at one location.

- Project Length: 28.1 miles (I-495 to South Station)
- Current Top Speed: Down to 15 mph near South Station
- New Top Speed: Up to 180 mph, still slow at South Station
- Benefits: Increased interconnections between intercity and commuter/local rail transit; additional intercity capacity for Boston

Improvement and Station Typologies

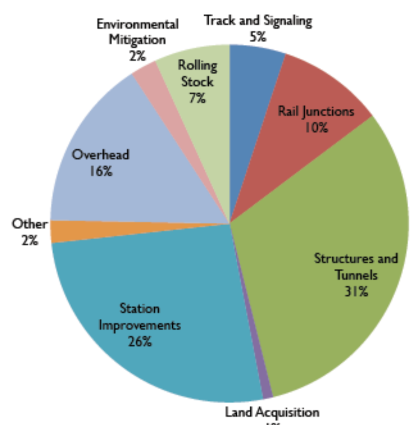
CAPITAL COST ESTIMATES

The proposed high-speed rail line will requires significant investment in rail infrastructure and technology over multiple years. Capital costs for the new line were estimated by geographic segment and type of investment, and are summarized in the table below.

In total, the order-of-magnitude cost estimate for the new high-speed rail system is just under $100 billion.

Costs in Millions of USD	Track and Signaling	Rail Junctions	Structures and Tunnels	Land Acquisition	Station Improvements	Other	TOTAL
Washington - Baltimore	$ 300	$ 350	$ 2,100	$ 2	$ 4,300	$ 1,000	$ 8,100
Baltimore - Philadelphia Int'l Airport	$ 700	$ 300	$ 2,400	$ 2	$ 1,300	$ 1,500	$ 6,200
Philadelphia Int'l Airport - Trenton	$ 400	$ 2,100	$ 2,200	$ 1	$ 3,500	$ 3,000	$ 11,200
Trenton - New York	$ 600	$ 2,150	$ 5,400	$ 2	$ 5,600	$ 1,000	$ 14,800
New York - New Haven	$ 900	$ 2,250	$ 9,800	$ 5	$ 1,200	$ 2,300	$ 16,500
New Haven - Hartford	$ 300	$ 100	$ 600	$ 1	$ 800	$ 500	$ 2,300
Hartford - Worcester	$ 400	$ 200	$ 500	$ 2	$ 700	$ -	$ 1,800
Worcester - Boston	$ 500	$ 1,050	$ 4,100	$ 5	$ 5,700	$ -	$ 11,400

SUBTOTAL	**$ 71,900**
Overhead/Project Management (25%)	$ 18,000
Environmental Mitigation (3%)	$ 2,200
Rolling Stock (40 train sets)	$ 6,000
TOTAL	**$ 98,100**



Total Capital Expenditures, by Type

ASSUMPTIONS

1. While there is some overlap, many of the state-of-good-repair investments included in the Amtrak Master Plan are still necessary (about $40 billion).

2. Estimated costs are in 2010 dollars.

3. Costs are spread over a 20-year period (see phasing plan).

4. Unit cost assumptions are located in Appendix B.

OPERATIONS AND MAINTENANCE

Globally, some high-speed rail systems are able to turn operating profits on their high-speed rail systems—examples include the Eurostar service between London, Brussels and Paris, and SNCF's TGV operations. Indeed, contrary to a widely held belief that all American passenger rail is unprofitable, Amtrak currently makes a profit of approximately $9 per passenger on its Northeast Corridor services (Amtrak Five-Year Plan, FY 2010-2014). A future high-speed system in the Northeast should also be expected to turn operating profits. To examine the feasibility of this, the studio estimated operations and maintenance costs of a new high-speed line at several levels of potential ridership.

Operating costs were based off a 2003 study of the proposed California HSR system, then increased by 20 percent to adjust for increased costs in the Northeast. All amounts are given in 2010 dollars. The break-even fare indicates the average fare that would be required to sustain the service; some passengers would pay more while other passengers would pay less. IRR stands for internal rate of return, and is a key metric for profitability—the potential for a 17 percent return on investment would attract private capital to system operations.

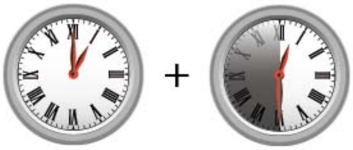
Operations and Maintenance Unit Costs

Track Infrasctructure Costs ($ Per Train Mile)		
Cost Category	**California HSR Plan Estimate**	**Northeast HSR Plan Estimate**
Station Services	$0.64	$0.76
Insurance	$1.56	$1.87
General Support	$1.12	$1.35
Maintenance of Way	$3.34	$4.01
Total Cost per Train Mile	**$6.66**	**$7.99**

System Operation Costs ($ Per Train Mile)		
	California HSR Plan Estimate	**Northeast HSR Plan Estimate**
Train Operations	$7.78	$9.33
Equipment Maintenance	$9.12	$10.95
Marketing and Reservations	$1.64	$1.97
Power	$5.50	$6.60
Total Cost per Train Mile	**$24.04**	**$28.84**

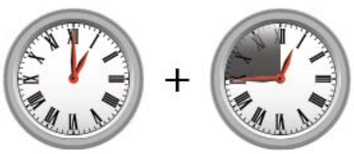
Projected Fare Requirements To Recover Operations and Maintenance Costs

	Minimal O/M Annual Cost Scenario			High O/M Annual Cost Scenario		
Annual Passengers (millions)	**O/M Costs (millions of $)**	**Break-Even Fare ($)**	**17% IRR Fare ($)**	**O/M Costs (millions of $)**	**Break-Even Fare ($)**	**17% IRR Fare ($)**
20	1,118	$55.90	$65.40	1,542	$77.10	$90.21
30	1,318	$43.93	$51.40	1,742	$58.07	$67.94
40	1,538	$38.45	$44.99	1,845	$46.13	$53.97
50	1,693	$33.86	$39.62	2,032	$40.64	$47.55
60	1,758	$29.30	$34.28	2,322	$38.70	$45.28



WAS - NYC: **1** hour **30** mins

PHL - NYC: **37** mins



NYC - BOS: **1** hour **45** mins

Proposed Travel Times: key NEC cities on new express services.

SERVICE PLAN

With the flexibility and capacity offered by new dedicated high-speed tracks, a wide variety of services can be offered on the Northeast Corridor. Four different services are proposed:

- Express: direct service for the most time-sensitive passengers
- Limited: express service connecting the most significant markets on the corridor
- Regional: inland and coastal service serving primary destinations
- Local: inland and coastal service serving secondary destinations

Stopping patterns on these services can be varied to fit the specific ridership demands on the railroad, and can be adjusted over time as those trends change. Individual stops would be served by trains running the stopping patterns indicated by the diagram on the next page.

With 10 to 12 trains per hour per direction possible in the peak hour, compared to three to five at the peak hour today, the proposed service plan would lead to nearly all destinations on the Northeast Corridor seeing more trains in peak hours as well as more trains throughout the day.

Trains per Hour (Peak) - SOUTH

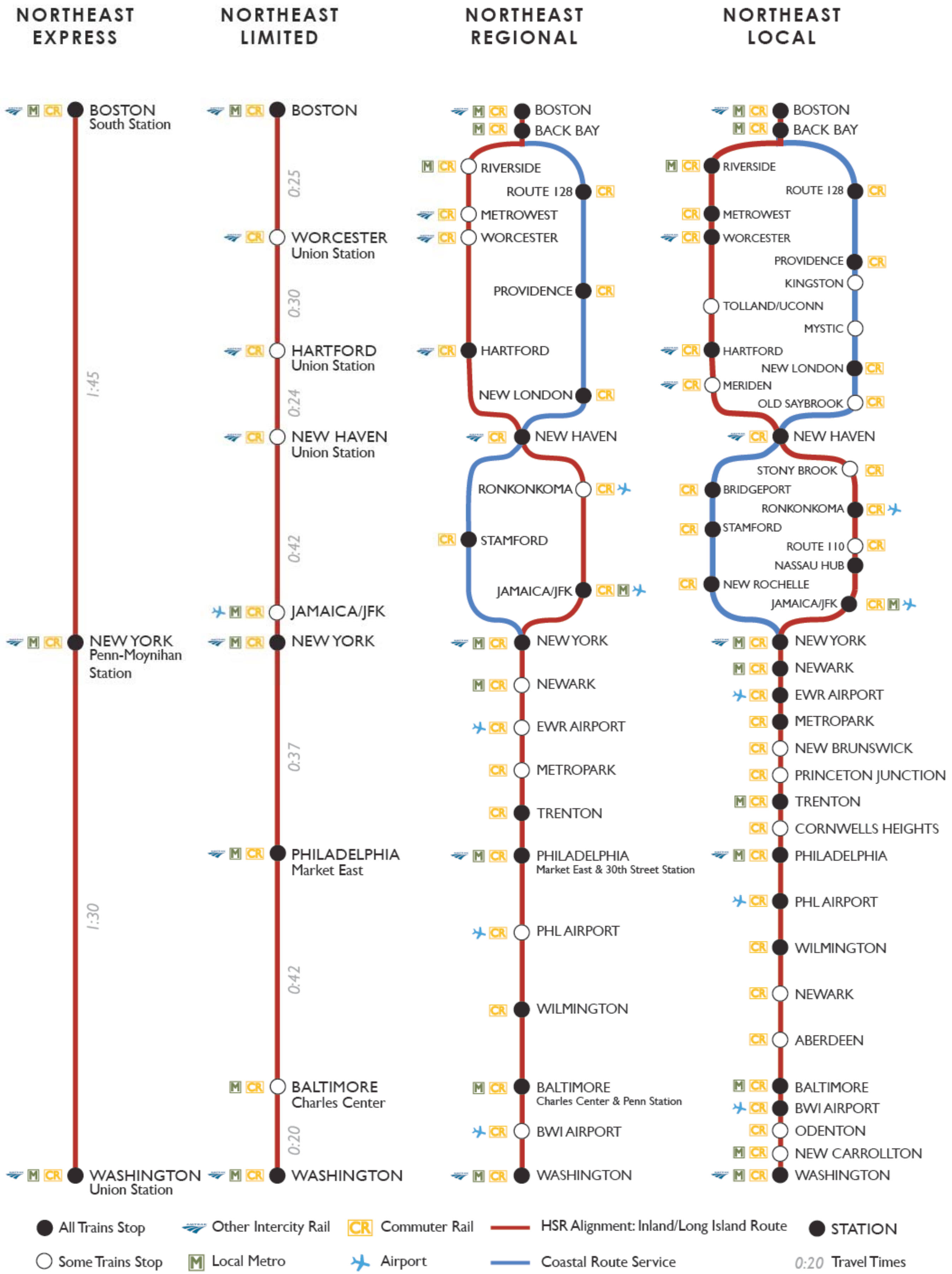
STATIONS	Proposed	Current	Difference
Washington	12	4	8
New Carrollton	4	2	2
BWI Airport	4	3	1
Baltimore Penn Station	3	3	0
Baltimore Charles Center	8	NA	8
Aberdeen	2	<1	2
Newark, Del	2	<1	2
Wilmington	6	4	2
Philadelphia Airport	5	NA	—
Philadelphia Market East	10	NA	10
Philadelphia 30th Street	4	4	0
Cornwells Heights	2	<1	2
Trenton	6	3	3
Princeton Junction	2	<1	2
Metropark	6	2	4
Newark Liberty Airport	4	1	3
Newark Penn Station	6	2	4
New York Moynihan Station	12		12

Trains per Hour (Peak) - NORTH - Proposed Inland Route

STATIONS	Proposed	Current	Difference
Jamaica/JFK Airport	8		8
Nassau Hub	3		3
Farmingdale/Rt. 110	3		3
Ronkonkoma/MacArthur Airport	6		6
Terryville/SUNY Stony Brook	3		3
New Haven	10	2	8
Meriden	2		2
Hartford	5		5
Tolland/UConn	2		2
Worcester	5		5
MetroWest	4		4
Riverside	4		4
Back Bay	8	2	6
South Station	12	2	10

Trains per Hour (Peak) - NORTH - Shore Line Route

STATIONS	Proposed	Current	Difference
New Rochelle	1	<1	1
Stamford	2	2	0
Bridgeport	1	<1	1
Old Saybrook	2	<1	2
New London	4	2	2
Mystic	2	<1	2
Westerly	2	<1	2
Kingston	2	<1	2
Providence	4	2	2
Route 128	4	2	2


NORTHEAST EXPRESS
NORTHEAST LIMITED
NORTHEAST REGIONAL
NORTHEAST LOCAL
BOSTON
South Station
1:45
NEW YORK
Penn-Moynihan Station
1:30
WASHINGTON
Union Station
BOSTON
0:25
WORCESTER
Union Station
0:30
HARTFORD
Union Station
0:24
NEW HAVEN
Union Station
0:42
JAMAICA/JFK
NEW YORK
0:37
PHILADELPHIA
Market East
0:42
BALTIMORE
Charles Center
0:20
WASHINGTON
BOSTON
BACK BAY
RIVERSIDE
ROUTE 128
METROWEST
WORCESTER
PROVIDENCE
HARTFORD
NEW LONDON
NEW HAVEN
RONKONKOMA
STAMFORD
JAMAICA/JFK
NEW YORK
NEWARK
EWR AIRPORT
METROPARK
TRENTON
PHILADELPHIA
Market East & 30th Street Station
PHL AIRPORT
WILMINGTON
BALTIMORE
Charles Center & Penn Station
BWI AIRPORT
WASHINGTON
BOSTON
BACK BAY
RIVERSIDE
ROUTE 128
METROWEST
WORCESTER
PROVIDENCE
KINGSTON
TOLLAND/UCONN
MYSTIC
HARTFORD
NEW LONDON
MERIDEN
OLD SAYBROOK
NEW HAVEN
STONY BROOK
BRIDGEPORT
RONKONKOMA
STAMFORD
ROUTE 110
NASSAU HUB
NEW ROCHELLE
JAMAICA/JFK
NEW YORK
NEWARK
EWR AIRPORT
METROPARK
NEW BRUNSWICK
PRINCETON JUNCTION
TRENTON
CORNWELLS HEIGHTS
PHILADELPHIA
PHL AIRPORT
WILMINGTON
NEWARK
ABERDEEN
BALTIMORE
BWI AIRPORT
ODENTON
NEW CARROLLTON
WASHINGTON
All Trains Stop
Some Trains Stop
Other Intercity Rail
Local Metro
Commuter Rail
Airport
HSR Alignment: Inland/Long Island Route
Coastal Route Service
STATION
0:20 Travel Times

PHASING

THE VITAL FACTS

- **888** track miles
- **87** miles of tunnel
- **53** miles of elevated structure
- **9** new stations
- **20** upgraded stations
- **42** acres new ROW
- **3,330** acres total ROW
- **180+ mph** top speed
- **155 mph** average speed

Finally, the question arises of when and in what order the new high-speed line should be built. Some projects had a logical order: The projects near New York City are a priority because without these capacity expansions, much of the value of other projects would be diminished. Additionally, the northern end segment from Boston to New Haven was prioritized since its construction will give the Northeast its first true taste of high-speed rail, which should help fuel the desire to complete the system.

PHASE 1: ESTABLISHING A FOUNDATION

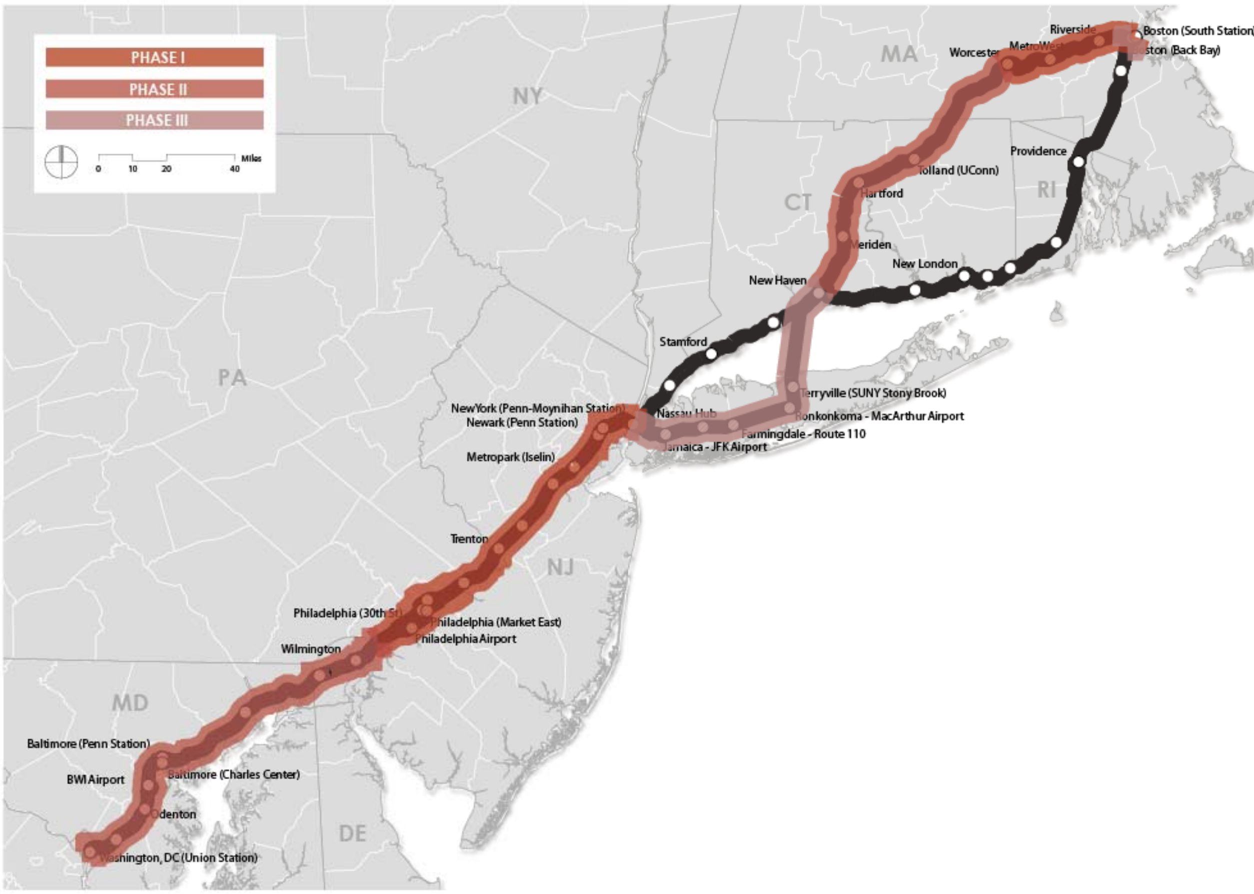
The first phase focuses on making the critical improvements that increase capacity and set the foundation for the improvements of later stages. The focus of the phase is on creating the high-speed alignment between New York and Philadelphia, as well as beginning the tunnel into Charles Center Station in Baltimore. On the north end, the first major project undertaken will be building the high-speed alignment between New Haven and Boston, which when completed will create the country's longest high-speed corridor.

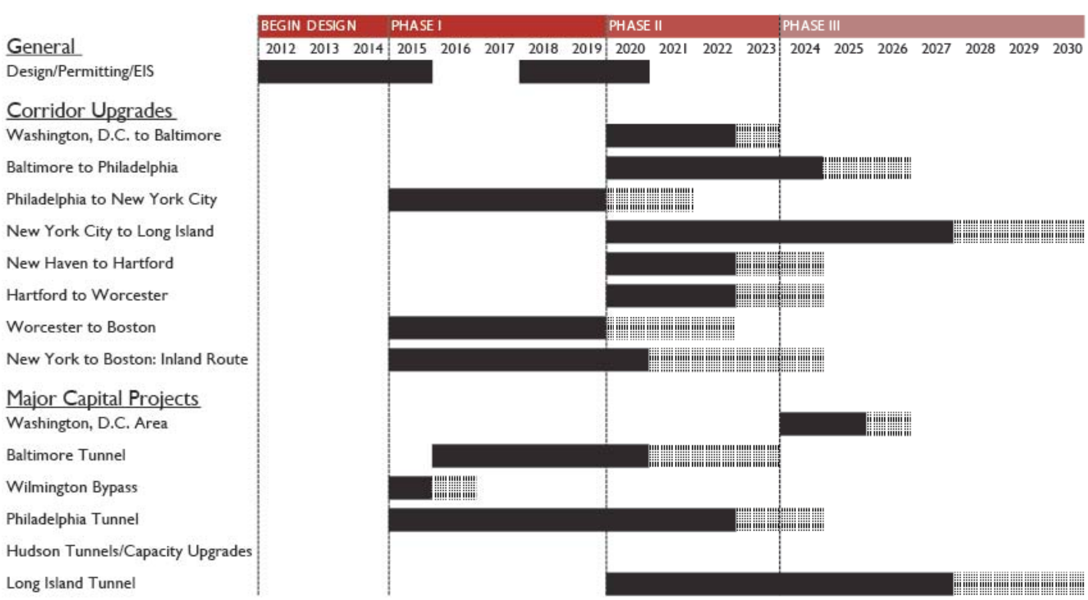
PHASE 2: FINISHING THE SOUTH; BEGINNING THE TUNNEL

By the completion of the second phase, two portions of the corridor will be capable of full high-speed service: the entire southern end from New York to Washington, D.C., and the northern section from New Haven to Boston. Attention will switch in this phase to connecting these two segments through Long Island, with construction along and under the Long Island Rail Road alignment and the start of the Long Island Sound Tunnel linking New York and Connecticut.

PHASE 3: A COMPLETED LINE

The last phase will see the completion of the high-speed line through Long Island and the connection through the Long Island Sound Tunnel, allowing full high-speed service along the entire Northeast Corridor. With the completion of the tunnel, the "figure eight" pattern of service on the northern end will be operational, offering faster speeds and higher-quality services to passengers originating along the coastal route through connections in New Haven.


PHASE I
PHASE II
PHASE III
Miles
0
10
20
40
NY
PA
MA
CT
RI
NJ
MD
DE
Boston (South Station)
Riverside
Worcester
Providence
Hartford
Meriden
New Haven
New London
Stamford
New York (Penn-Moynihan Station)
Newark (Penn Station)
Metropark (Iselin)
Trenton
Philadelphia (Market East)
Philadelphia Airport
Wilmington
Baltimore (Penn Station)
BWI Airport
Farmingdale - Route 110
Jamaica - JFK Airport


BEGIN DESIGN
PHASE I
PHASE II
PHASE III
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
General
Design/Permitting/EIS
Corridor Upgrades
Washington, D.C. to Baltimore
Baltimore to Philadelphia
Philadelphia to New York City
New York City to Long Island
New Haven to Hartford
Hartford to Worcester
Worcester to Boston
New York to Boston: Inland Route
Major Capital Projects
Washington, D.C. Area
Baltimore Tunnel
Wilmington Bypass
Philadelphia Tunnel
Hudson Tunnels/Capacity Upgrades
Long Island Tunnel

LESSON FROM LONDON

Javelin Service: High-Speed Commuter Rail

In December 2009, the U.K. launched its first domestic high-speed service, popularly known as Javelin. The nearly £6 billion investment links more than a dozen commuter stations in southeastern England to London's St. Pancras International Station. The service utilizes existing HS1 tracks and runs at 140 mph.

This service has dramatically changed commuting in southeastern England. Ashford International is only 37 minutes from St. Pancras (instead of an 80-minute 55-mile trip), and towns far east such as Canterbury and Folkestone are now just an hour trip from London. The high-speed commuter service provides an extra 200 trains across the region, which increases the capacity of the network by five percent.

The Javelin service between Stratford (site of the 2012 Olympic Games) and St. Pancras is touted as a critical factor in London's successful Olympic bid. This commute takes just seven minutes on the high-speed trains compared to 25 minutes on London's Underground subway.[6]

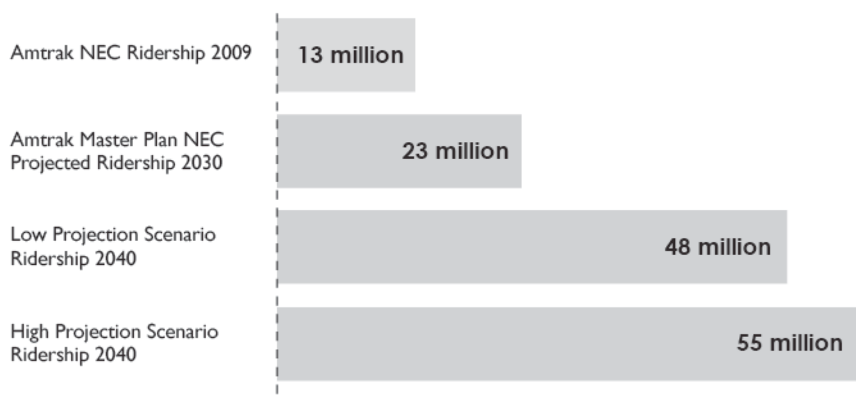
RIDERSHIP PROJECTIONS

A major benefit to increasing the frequency of trains and adding capacity to the system is the increase in populations served by rail. Ridership on a high-speed system is projected to at least double ridership by 2040.

Ridership estimates are calculated using a linear population projection model based on growth estimates for counties in the Northeast, plus growth assumptions based on the type of station and location (airport, new station, university, suburban hub, etc.). For new high-speed stations, current ridership from existing commuter rail data is extrapolated to estimate high-speed ridership potential.

An important component factored into the ridership projections is diverted and induced ridership. Diverted passengers are calculated as a percentage of people who shift trips from air or driving to high-speed rail. Induced demand estimates how many people will use high-speed rail simply because it is a new service. Induced riders would not have otherwise made the trip.

Current ridership and market size, and 2040 ridership projections by station, are located in Appendix B.



Ridership Projections: possible scenarios.

CHALLENGES

This proposal, which recommends significant alignment adjustments and bold new construction on the current Northeast Corridor, carries with it a complex array of challenges. While any large public project will face a number of challenges, the sheer scale of the Northeast Corridor, the complexity of its current infrastructure systems, and the density of its cities will make these challenges particularly acute.

PHYSICAL

To construct two dedicated high-speed rail tracks, the proposal uses existing freight and passenger rail infrastructure, its associated right-of-way (ROW), and additional public ROW along interstate highway or utility corridors. Where use of these is impossible—because of speed, size or ownership constraints—more complicated solutions are necessary. Generally, the project calls for four types of construction: upgrading the existing NEC network; connecting the NEC to unused freight and passenger rail infrastructure; acquiring land and building new infrastructure; and tunneling in areas with high population density or under major geographic barriers like the Long Island Sound.

FISCAL

Perhaps the greatest challenge facing the project is money. At nearly $100 billion, it represents the largest investment in infrastructure in the Northeast in decades—and the first time such a project has been attempted since the postwar interstate era. But when viewed from a broader perspective, construction of the corridor would represent only about three percent of the megaregion's annual GDP, and the cost would be spread over a decade or more. Further, the investment has the potential to be transformative, making the economy of the Northeast more competitive and dynamic in a manner that far outweighs its cost.

POLITICAL

The Northeast Corridor passes through eight states and the District of Columbia, and the successful implementation of high-speed rail service will depend on them working together. That is, it must somehow balance the interests of 16 U.S. senators, 99 U.S. representatives, hundreds of state senators and representatives, federal and state departments of transportation, hundreds of counties, thousands of municipalities, and dozens of multistate or special-purpose organizations, such the Environmental Protection Agency. The political challenge of making this happen is difficult, and will require a strong belief in the overall vision as well as an ability to find ways for each group to gain benefits from HSR.