

Assessing Increased Rail Speeds in the Northeast Corridor
Regional Plan Association
America 2050
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EXECUTIVE SUMMARY

The Northeast Corridor (NEC) is the most highly traveled route in the United States, and the only one with train service that currently operates above the Federal Railroad Administration's designation of high speed rail, 110 mph. This service, Amtrak's Acela, operates at much lower speeds than premier international systems, exhibiting the large gap in rail technology America has with its peers worldwide. This difference is the result of a lack of funding for rail systems in the United States. There are many proponents of HSR who want to see it in the NEC, but is this the right step for improving mobility in the Northeast Megaregion and inducing a mode shift from air and car?

Studying the NEC's current infrastructural state and consulting stakeholders involved with NEC operations and development informed the conclusion that incremental infrastructural upgrades and improved frequency can achieve significant benefit. This decision was weighed against building a separated HSR corridor and an HSR corridor adjacent to the current tracks. Acela's success exhibited that true HSR is not necessary to have significant ridership, as already it captures more than half of the air-rail market out between both New York-Washington and New York-Boston market pairs. Travel time improvements of a half hour between these endpoint cities are possible through improved infrastructure and realignment of targeted segments, and it is believed that this alone will gain significant ridership. Investing more money in a dedicated HSR corridor is not perceived as feasible because of the corridor's dense character that would require significant property acquisition coupled with the resulting strong negative reaction from these affected communities. Construction of true HSR has obstacles to its actual construction, whether building in a new or the existing corridor. These projects with higher costs focusing on speed do not necessarily translate to a higher ridership, and this is not believed by many to be the best path to improved intercity rail service in the NEC.

INTRODUCTION

Rail has the opportunity to play a larger role in connecting the northeast as the region grows. Increased highway congestion and delays at major airports generate the need for another means of intercity travel. Amtrak's Acela service is currently providing this alternative, running from Washington D.C. to Boston on the Northeast Corridor (NEC). It draws criticism, however, for only reaching top speeds of 150 mph on just 33.9 miles of track along its entire 457 mile corridor. Congress recently authorized Amtrak for \$14.4 billion over five years which will play a large role in bringing the NEC back to a state of good repair. The recent stimulus package also allocates \$1.3 billion for Amtrak and an additional \$8 billion specifically for high speed rail.

These funds help in increasing speeds on particular segments, and perhaps allow for the development of higher speed train sets, above and beyond Acela.

Amtrak's ridership has grown in this corridor and across the country recently and reported having its sixth straight record breaking fiscal year in 2008. The increase in ridership shows steady demand for intercity travel and adds to the call for high speed service. The recent economic recession has not left Amtrak untouched, hampered growth has resulted in reduced fares on the Acela trains in order to attract riders, but even with the downturn hopes are high that interest in fast intercity rail travel will remain strong. Introducing true high speed rail (HSR) to the NEC, with speeds upward of 200 mph, would have a large impact on the megaregion, and is one option to capitalize on the growth in ridership. Such a system on its own dedicated right of way could allow higher speeds and more frequent service. Operations would be competitive with speeds seen in Europe and Japan which draw significant ridership. Seeing it implemented would be the realization of the drafters' dream of the of the 1965 High Speed Ground Transportation Act which appealed for high speed rail in America. Importantly it would not just be a competitor to air traffic, but if priced appropriately, would become the obvious mode for intercity travel within the megaregion.

An HSR system in the Northeast Megaregion is not only a benefit for the users, but is better for the environment as well. The carbon emissions of HSR are much less than that for air and automobile travel, 60 percent and 50 percent less respectively. Transporting more with less, this technology is the most sustainable choice for increasing users' mobility. It consumes less energy per passenger mile than all other modes aside buses. The case for HSR's construction is bolstered by its "green" advantage.

Discussion about the NEC mostly focuses on improving service for Acela and regional train sets in operation. Critical measures were identified as "must do" in order to bring the corridor up to a state of good repair. This could be achieved by upgrading the infrastructure along the NEC. Basic infrastructure repair initiatives include the replacing of the B&P tunnel in Baltimore, upgrades to bridges, full completion of the installation of Positive Train Control, and upgrades to track and signals. Additional work that can help increase speeds requires further investment. This consists of the installation of constant tension catenary, track upgrades at stations, and additional bridge and tunnel improvements that will allow higher speed operations. The recent legislation included a mandate for Amtrak to study the investments needed to reduce trip times in the corridor. Thus the goal is to operate Acela at higher speeds in order to have 15 and 30 minute faster travel times by improving the track it currently runs on.

The goal of this project was to determine what the best way is for HSR to be a role player in improving rail travel in the northeast. Of importance is how to best meet the needs of the population, strengthen the intercity connectivity, and be a feasible funding initiative. At the heart of it, it's a focused study on how to improve rail for the corridor, whether it be through speed, frequency, or both in an effort to improve the rail experience. Part of the project considers what a dedicated HSR corridor would look like and what upgrades to the existing NEC could create significant reductions in travel time. New service would be in addition to that of Acela, and could replace Acela entirely. A dedicated right of way for HSR in the NEC has the potential to dominate the air-rail market, and improve mobility for those living in the northeast megaregion.

Even without a separate right of way for HSR, choke points can be removed and capacity increased with proper choosing of upgrades.

The report comes at a time when HSR is making news. The Rail Safety Enhancement Act of 2008, proposed by Representative John Mica, which was passed in October, includes a request for proposals for express service on the NEC: two hours or less between Washington, D.C. and New York City. Part of this provision is for the exploration of HSR in the northeast by private entities, with the performance measure set as a time improvement of at least 25 percent. Additionally, Senator John Kerry penned the High-Speed Rail for America Act of 2008 in November which would establish an Office of High-Speed Passenger Rail within the Federal Railroad Administration. Financial support would only be available for systems that are reasonably capable of operating above 150 mph. This act however did not move forward before the end of session. Lastly, the February 2009 American Recovery and Reinvestment Act pushed by President Obama includes \$8 billion for HSR specifically.

The framework for this proposal is in line with the goals of America 2050. The proposed work would be a component of a world class multimodal transportation system aimed at increasing connectivity for all members of society. Higher speed rail would provide economic and social opportunities across the northeast megaregion. A great benefit would be seen by business travelers, who are the primary users of the current high speed trains. By adding additional capacity for intercity travel, high speed rail will reduce the load on all the connecting modes and improve the experience for all users. Increasing connectivity in the region will give a boost to the economic engine of the northeast megaregion.

OBJECTIVES

The goal of this project is to assess the options for HSR in the northeast megaregion. In this report, references to true HSR refer to a world-class system capable of speeds above 200 mph. The top issue is if a new ROW should be established, and if so, where. Three alternatives are in consideration:

1. Construct a right of way separate from the current NEC.
2. Construct a right of way adjacent to the current NEC.
3. Targeted infrastructure improvements to add capacity to current tracks.

Although Alternative 1 would require significant acquisition of properties, some believe it is the only option for seeing true HSR. Alternative 2 would need to be examined for its feasibility, to ensure there is space for such a new line in the crowded existing right of way. Alternative 3 would attempt to bring the current tracks up to a level that train sets would operate at closer to maximum speeds and reduce intercity travel times significantly. The three alternatives are depicted in Figure 1. It will be seen whether time improvements can be improved and sustained on the aging infrastructure in the region.

Figure 1: Alternatives Considered for HSR



Alternative 1

Alternative 2

Alternative 3

For HSR to be successful, it will need to integrate into the current systems already in operation. Ensuring connectivity between the numerous commuter rail lines throughout the corridor is essential. Additionally, how, or even should, major airports be connected to the HSR line. It is essential though that intermodal linkages occur for HSR, regardless of the corridor selected.

The study will examine to what extent the corridor should be upgraded for faster service. The NEC is currently composed of a main trunk line running from Boston to Washington, D.C., as well as three branch corridors: Harrisburg to Philadelphia, New Haven to Springfield, and New York to Albany. The primary corridor is commonly referred to as having a north and south end, split in the center at New York City. As an example of selective implementation, the south end New York to Washington D.C. line, which currently garners over half of the trips taken by air and rail, could be implemented prior to the north end from New York to Boston. Although doubtful that the three branches would see HSR immediately (not even Acela currently serves these lines), how these lines could be integrated into a new system will be considered. Also to be explored is the possibility of running HSR through Springfield and Hartford as opposed to Providence and New London.

HYPOTHESIS

It is reasonable to marvel at the HSR systems in Europe and Asia and ponder when those technologies will come to the United States. Popular news outlets and supporting politicians are fond of making comparisons to these systems, and make the strong call to bring faster rail to the densest corridors around the country. The arguments made for these systems are strong because of the wide-ranging reasons they are backed by: the largest economy in the world is not leading the charge in rail technology, HSR train systems are better for the environment than automobiles and use less surface area, and HSR can reduce congestion on highways and in the skies.

The initial hypothesis was in support of true HSR in some fashion for the NEC. After reading the background literature on HSR in the Northeast and across the country, I felt the reasons to build a line, especially as a way to link the megaregion and add additional capacity for such movements, were robust. I understood why some argue against it, centering primarily on the extreme high cost and difficulty in placing a line. My largest concern was that rail systems in the U.S. repeatedly go over budget and many times fail to hit ridership estimates.

It was my belief though that because of the success of the NEC, ridership here would meet expectations. Additionally, investment in new technology was the proper step to develop a stronger Northeast Megaregion. If the corridor did not seem to have too many issues along the

tracks or a suitable new corridor could be found, I felt true HSR should be brought to the megaregion.

METHODOLOGY

Google Earth Identification

In order to identify what physical difficulties exist in expanding the NEC, I examined satellite imagery of the entire corridor. I used Google Earth for this purpose because of the ease of access to the images, and the ability to mark identified issues on the maps. By slowly progressing along the corridor, it is possible to locate structures, bridges, roads, and waterways that would be a problem. After making a mark on the map, I recorded important information about that feature. Afterwards, I exported all of these marks into GIS in order to analyze their distribution.

I had to determine the necessary width for an expansion of the corridor. With that value, I would have the distance for which I would identify structures which would be an issue to an expansion. I established the width to be that of two tracks and an empty buffer on one side. Only a one-sided buffer is necessary because the existing NEC would be on the opposite side of the tracks. Using Google Earth, I measured the right of ways in Japan and France and found 35 feet are needed, measured from the outer edge of the existing track. This was established as the estimate for the necessary width of space needed to add two tracks to the existing NEC. The track centers required by the Federal Railroad Administration (FRA) rules verify this estimation. Class 6 railroad track or higher at which high speed trains would operate requires 14 feet of separation of track centers. For two tracks and the width of a barrier and buffer, the 35 foot estimate is reasonable.

I inspected the track visually through the satellite imagery. Impediments to expansion and items that would need rehab were tagged, as long as they were within the 35 feet. These included:

- Bridges
- Rail yards
- Parallel railroad track
- Structures
- Junctions
- Parallel roads
- Stations
- Tunnels
- Parallel waterways

100 feet was used for waterways because of the higher sensitivity to building near waterways. To the extent possible, additional information was attributed to each tagged item. All bridges were labeled for what feature they crossed, as well as whether it passed over or under. Larger stations were identified by name as well, and whether they were on both sides of the track or just a single side. For structures and parallel items, the distance from the track's edge was specified.

Additionally, stretches of railroad track passing through residential or commercial properties were identified as such.

The corridor was broken up into one-mile segments, which were labeled north from Washington D.C.'s Union Station to Boston's South Station. Various features were attributed to each segment, so each part of the corridor could be summarized by the issues facing it.

In order to report the data in the same manner as in The NEC Infrastructure Master Plan, the one-mile segments were grouped into that report’s corridor parts. These seven parts are: Boston, MA to Westerly, RI (BOS-WLY), Westerly, RI to New Haven, CT (WLY-NHV), New Haven, CT to New Rochelle, NY (NHV-NRO), New Rochelle, NY to New York, NY (NRO-NYP), New York, NY to Trenton, NJ (NYP-TRE) Trenton, NJ to Newark, DE (TRE-NRK) and Newark, DE to Washington, DC (NRK-WAS).

Interviewing NEC Stakeholders

To help inform the study, I conducted interviews with a variety of stakeholders on the NEC. Their opinions and thoughts on the current conditions, future plans, and barriers to improvement were crucial to understanding the NEC. The issues are of course multi-faceted, and many stakeholders had differing opinions on many topics. Included in the interview list were officials at Amtrak and commuter rail agencies, economic development professionals from the various cities on the corridor, and transportation consultants who work consistently with rail and the NEC. A list of the interviewed stakeholders is in Appendix 1.

Criteria for Evaluation

To evaluate the different options for HSR, I focused on certain criteria that I felt were most important. On the top of the list was the alternative’s ability to induce a mode shift. When looking at the alternatives, I thought about which would be the most efficient and effective way to attract riders to rail. Included in this was always a mind on cost, which although is important, should not be the only driver in making these choices. I wanted to make sure the significant value of a more expensive project is not brushed aside only because of its price tag. Additionally, from my conversations with stakeholders, I made sure to not glorify speed, and recognize the value of frequency and reliability when evaluating alternatives.

RESULTS

Physical Impediments

Analysis of satellite photography revealed many aspects of the NEC that would inhibit expanding it for HSR. The northern end of the corridor has more physical impediments to expansion than the Southern end, with almost three times as many structures and 20 percent more bridges, although much of this can be contributed to the dense territory in New York and southwestern Connecticut (the portion of the railroad owned by Metro North.)

Using the one-mile segments of the NEC as the building blocks of the analysis, the magnitude of the issues facing expansion to the corridor become apparent. The corridor has many obstacles to expansion: over two bridges and one structure within 35 feet per mile, with a station placed on average every five miles. A summary table of the physical impediments can be found in Table 1:

Table 1: Summary of Physical Impediments

	Bridges	Structures	At-grade Crossings	Stations
<u>Entire NEC</u>				

Total	1091	588	11	100
Average per segment	2.39	1.29	0.02	0.22
Segments with/	387	184	8	94
% Segments	84.7%	40.3%	1.8%	20.6%
<u>Southern End Summary</u>				
Total	495	152	0	48
Average per segment	2.20	0.68	0.00	0.21
Segments with/	178	57	0	46
% Segments	79.1%	25.3%	0.0%	20.4%
<u>Northern End Summary</u>				
Total	596	436	11	52
Average per segment	2.57	1.88	0.05	0.22
Segments with/	209	127	8	48
% Segments	90.1%	54.7%	3.4%	20.7%

The above information is summarized in Table 2 by the NEC Infrastructure Plan segments:

Table 2: Physical Impediments Summary by NEC Infrastructure Plan Segments

	BOS- WLY	WLY- NHV	NHV- NRO	NRO- NYP	NYP- TRE	TRE- NRK	NRK- WAS	Grand Total
Bridges	189	153	161	93	124	210	161	1091
Structures	138	64	138	96	54	82	16	588
At-grade	0	11	0	0	0	0	0	11
Stations	20	9	23	0	14	19	14	99

Bridges

Bridges are the most common issue facing any expansion on the corridor. 1091 bridges cross the NEC, with a slightly higher rate on the northern end. Eighty percent of all the one-mile segments had a bridge. There is a close to even split between those that cross over the tracks to those carrying the tracks over another road or waterway, as seen in Table 3. Of the latter, 20 percent, or 106, are water crossings.

Table 3: Bridge Summary

Type	Frequency	Percentage
Bridge over tracks	561	51.2%
Bridge carrying tracks [<i>over water</i>]	533 [<i>106</i>]	48.7% [<i>19.8%</i>]

Although it was not possible to tell through satellite imagery, it is reasonable to assume that most of these bridges will need to be rehabbed. This assumption is based on the satellite imagery, where almost all bridges carrying the tracks over roads and water lacked space for another track. The bridges were built to serve the needed track capacity when they were erected, and are not ready for immediate expansion. Bridges crossing over the tracks may have available space between the current tracks and the retaining walls, but each would need to be checked for standards of clearance. Almost all of these though, using the reasoning above, are expected to need rehab. Any abandoned spans could be used if they are reported to be structurally sound to

support a train traveling at high speeds. State DOTs are responsible for bridges over the railroad and must be worked with for rehab of their structures.

There are several stretches with a high number of bridges. The route from northern Delaware into Bucks County Pennsylvania is particularly dense, with more segments with four or more bridges than any other part of the NEC. Northern New Jersey and the Metro North territory from New York City to Bridgeport also have a dense frequency of crossings. The remainder of the northern end has a higher rate of crossings than the non-dense portions of the southern end.

Figure 2: Bridge Distribution on Southern End of NEC

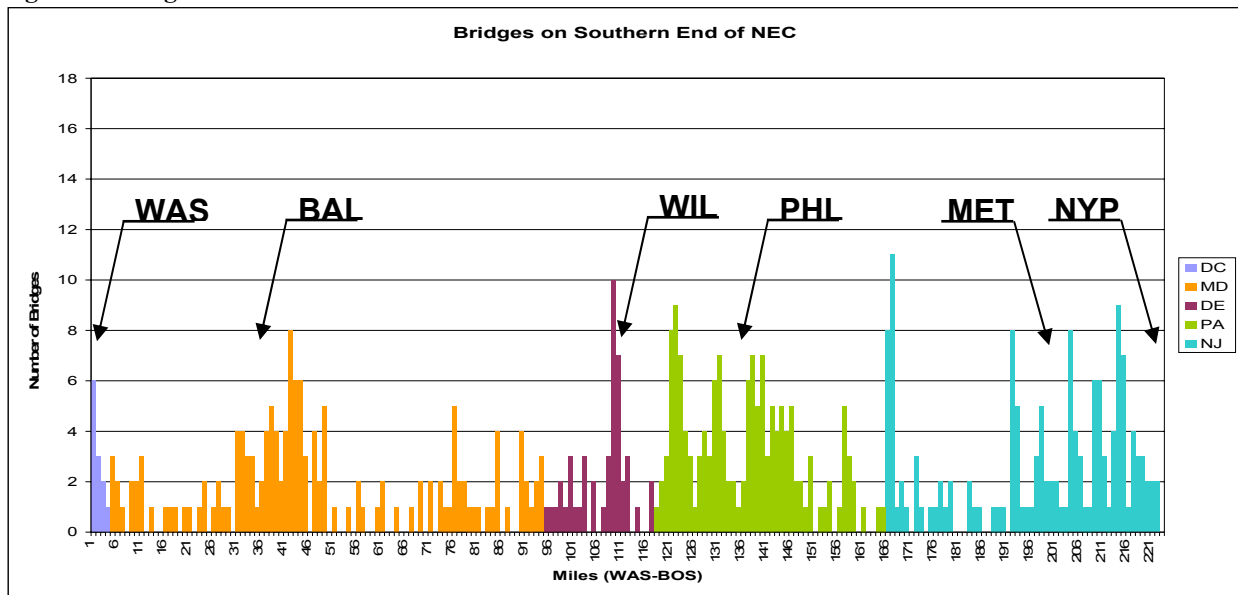
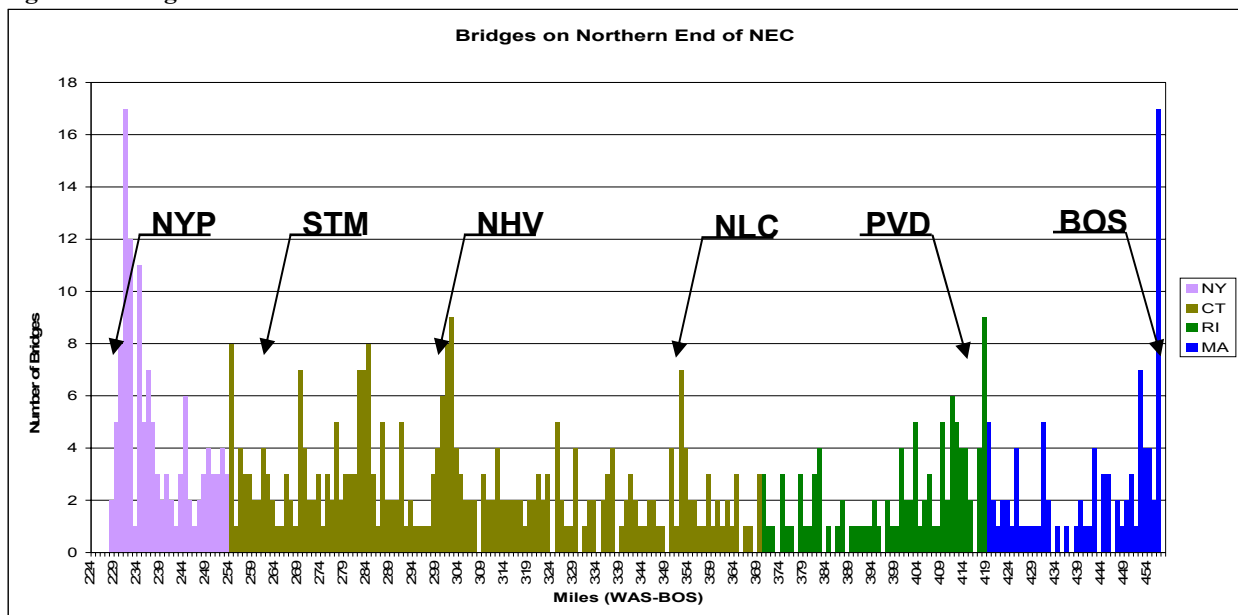


Figure 3: Bridge Distribution on Northern End of NEC



Structures

On the corridor, there are nearly 600 structures that could obstruct a new expanded NEC for HSR. As noted before, 35 feet was used as the basis for whether a structure is an impediment. The northern end of the corridor is much more affected than the southern end. Over half of the mile-long segments north of New York City have structures that would be affected, compared to only a quarter on the southern end. This is a good indicator of how dense the development is to the tracks, regardless of how dense the general area the tracks are passing through. For example, although generally more dense, Wilmington and the non-tunneled portions of Baltimore have very few buildings within 35 feet of the tracks, but many small cities in Connecticut and Rhode Island are built closer to the corridor. Figures 4 and 5 show the distribution of structures on the southern and northern ends of the NEC.

The densest areas of structures again are in northern Delaware into Bucks County, PA, northern New Jersey, and Metro North territory, but also in northern Rhode Island. The New York City area is especially dense because of the raised rail structures running above dense development.

Figure 4: Structure Distribution on Southern End of NEC

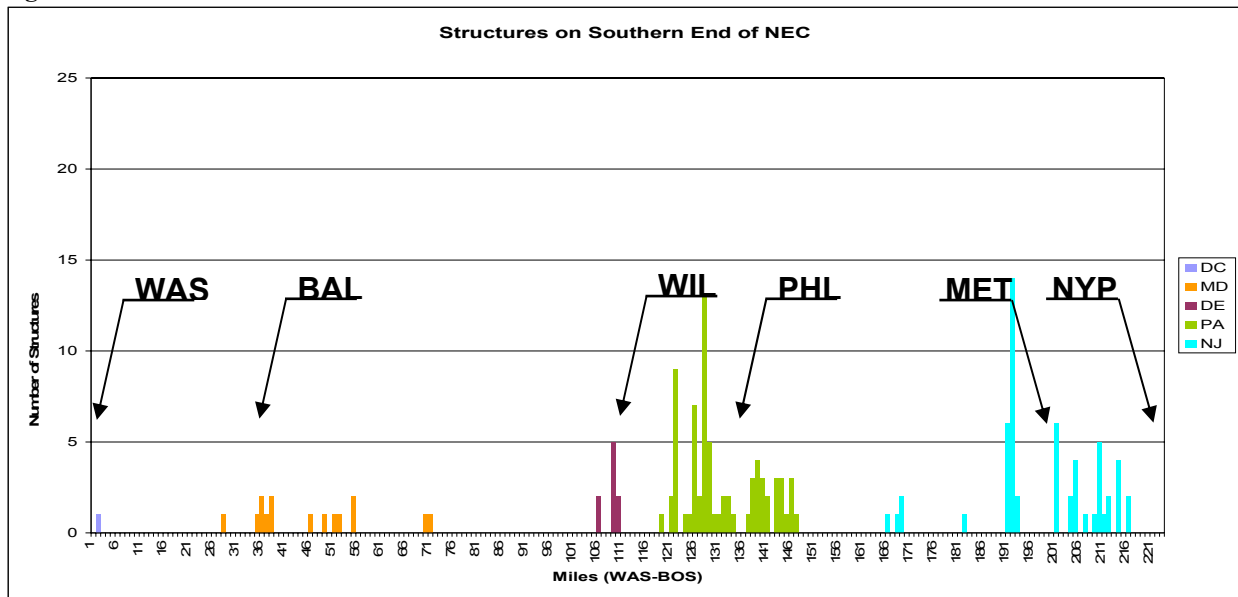
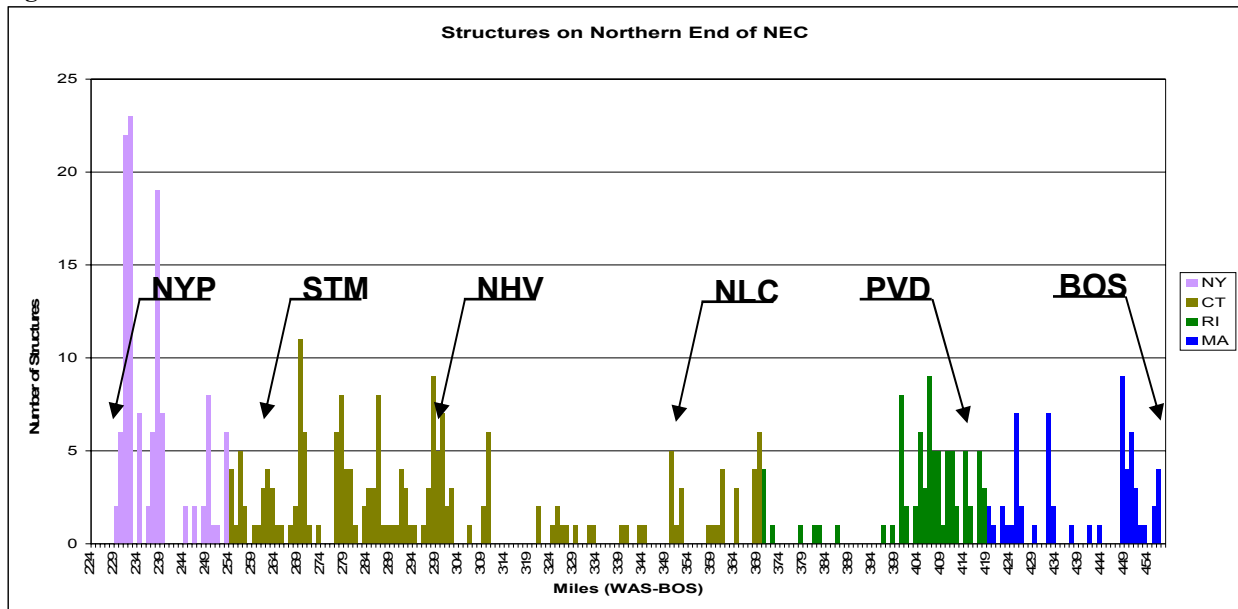


Figure 5: Structure Distribution on Northern End of NEC



At-grade Crossing

There are only eleven at-grade crossings along the NEC, all located between New London, CT and Westerly, RI. Their current impact on the top speed the trains can travel through this corridor is relatively minimal, as seven are located near the water crossings of the Thames River and Mystic River where the train is already required to reduce speeds. Any future expansion to the corridor to allow for true HSR though should have included plans to separate the crossings which are reducing the speed for no other reason except the at-grade crossing itself. Otherwise, implement all necessary technologies to ensure train high operating speeds such as quad gates and advance warning systems.

Stations

Both ends of the NEC have a significant number of stations that will require reconstruction if the corridor was expanded. The majority of these stations are solely for commuter rail, and twenty-nine also are used by Amtrak. There are a few exceptions located between New London, CT and Providence, RI that are solely used by Amtrak.

On average, there is a station every five miles on the NEC. This is far from the real situation, however, as there are many long stretches that are sparsely stationed. southwestern Rhode Island and northeastern Maryland are two such cases, and in fact so is New York City with only New York Penn Station between Newark and New Rochelle.

The stations range in size from the one-sided platforms in eastern Connecticut to the double digit tracked stations in Washington, New York, and Boston which also serve commuter and rapid transit rail lines. Each has corresponding parking, many time with structures, along with station buildings, pedestrian bridges, ticketing systems, and many other amenities.

Tunnels

Only a few tunnels exist on the corridor, but they are the most constraining pieces of infrastructure on the corridor. The most notable are the Baltimore and Potomac (B&P) Tunnel and the Union Tunnel west and east of Baltimore's Penn Station respectively, and the North River Tunnels and the East River Tunnels west and east of New York's Penn Station respectively. Additionally there are tunneled segments in Boston and Providence that are below grade but covered by structures.

Although in length they make up a very small portion of the corridor, the four main underground tunnels are choke points that cause large delays. The B&P Tunnel has operating speeds of 30 mph because of its geometry, and is the top item up for replacement on the NEC. In order to help congestion in New York, the North River Tunnels will soon have the Access to the Region's Core tunnel to help, and the East River Tunnels will have the East Side Access tunnel.

Surrounding Character

The Northeast Megaregion is already noted for its dense development patterns, and the NEC is no different. The rail lines pass through mostly suburban and urban land uses, with only minimal amount of areas that could be classified as rural. There is a mix of commercial and residential development along the corridor, as well as many stretches of water that parallel the tracks. There is no one typical corridor stretch that can summarize the entire NEC.

Density

The NEC is predominantly bordered by urban and suburban development. This classification was calculated from the maximum density of the surrounding development within 350 feet to each side of the one-mile segments of track. The distribution of the classified mile-segments is in Table 4 with the distribution for each NEC Infrastructure Master Plan segment in Table 5:

Table 4: Density Summary

	Population Density (pop/sq mi)	Total	Percentage
Urban	>10001	113	24.7%
Inner Ring Suburban	2501-10000	155	33.9%
Suburban	501-2500	144	31.5%
Rural	0-500	45	9.8%

Table 5: Density Summary by NEC Infrastructure Plan Segments

Segment	Urban	Inner Ring Suburban	Suburban	Rural
Boston, MA - Westerly, RI	19%	27%	34%	19%
Westerly, RI - New Haven, CT	1%	29%	54%	16%
New Haven, CT - New Rochelle, NY	38%	45%	16%	0%
New Rochelle, NY - Penn Station NY	79%	5%	11%	5%

Penn Station NY - Trenton, NJ	29%	31%	38%	2%
Trenton, NJ - Newark, DE	44%	44%	10%	1%
Newark, DE - Washington, DC	11%	37%	37%	14%

Only 10 percent of the land is classified as rural, and the majority of it exists in eastern Connecticut and western Rhode Island, with small parts in northeastern Maryland. The suburban densities are much more widespread, but still are heavily concentrated in the aforementioned spots, and in addition, central New Jersey and southern Massachusetts. Just because there are low densities surrounding the track though, does not mean they are not important places for rail ridership; 17 of the 100 stations on the NEC are in the segments considered rural and suburban. This also includes stations served by Amtrak at Route 128, Kingston, Old Saybrook, Prince Junction, Newark, DE, and BWI Airport. So although immediately next to the tracks it may be less dense, farther away the land still has the potential to provide ridership.

The remaining places are of much higher densities, and accordingly have the large majority of the stations currently located there. These spots are more likely to have structures near the tracks as well.

Water

All waterways were identified if they were within 100 feet of the railroad tracks. In total, about 17 miles of water is near to the tracks, and this excludes water crossing by bridges or tunnels. 14 percent of the one-mile segments on the corridor are affected at some point by the nearby waterways. Including the 106 bridges and two tunnels over and under rivers, there is a substantial amount of track which is affected by water. The northern end is much more affected by water than the southern end, with significantly more bridges over waterways and three times as many mile-segments that are within 100 feet of water.

Development Type

Using Google Earth’s satellite imagery it was possible to create an approximation of the types of development adjacent to the NEC. Evaluating the sizes of buildings, parking, and street patterns, in addition to Google’s Streetview where necessary and possible, the land type was recorded as either residential or commercial. In the case where a stretch of track was bordered on one side by residential development and the other side by commercial, the classification preference was given to residential. Where little or nothing existed, the land was left classified as undeveloped. The distribution for each of the NEC Infrastructure Master Plan segments can be seen in Table 6.

Table 6: Development by NEC Infrastructure Plan Segments

Segment	Type	Miles	Percentage
BOS-WLY	Undeveloped	33.8	38%
	Commercial	29.3	33%
	Residential	24.9	28%
WLY-NHV	Undeveloped	31.4	45%
	Commercial	18.9	27%
	Residential	19.7	28%
NHV-NRO	Undeveloped	7.9	14%

The split between the three types is relatively even, although because of the preference given to residential over commercial when they were on opposite sides of the track, commercial development would likely be a bit higher than seen now. In addition, the undeveloped land portion also includes areas over or under water, and as well the stretches underneath New York City. So although one-third of the corridor can be said to be undeveloped, it does not necessarily mean that nothing is there. Some of this land is also parkland and wetlands, and might even be harder to construct on the developed land.

	Commercial	31.5	57%
	Residential	15.7	28%
NRO-NYP	Undeveloped	5.5	29%
	Commercial	9.1	48%
	Residential	4.5	24%
NYP-TRE	Undeveloped	22.8	39%
	Commercial	20.2	35%
	Residential	15.0	26%
TRE-NRK	Undeveloped	15.8	23%
	Commercial	30.6	44%
	Residential	23.6	34%
NRK-WAS	Undeveloped	32.8	34%
	Commercial	30.8	32%
	Residential	33.4	34%
	Total Undeveloped	150.0	33%
	Total Commercial	170.4	37%
	Total Residential	136.8	30%

Commercial development being more often adjacent to the corridor than residential should not be surprising. Many businesses and industrial areas are located near the tracks in order to have access to the NEC for freight rail, even if only historically so. Many sidings on the corridor are in place to facilitate that. This can be seen strongly in the older industrial portions of the corridor, such as from Trenton, NJ to Newark, DE and north of New York City towards New Rochelle.

Adjacent ROWs

The expansion of the NEC would also mean that several ROWs of other operating railroads and roadways will be infringed upon. From Google Earth satellite imagery, all roads and railroads within 35 feet of the NEC's railroad tracks was identified. Along the corridor, cumulatively 35 miles of roads and at least 22 miles of railroad lines are within those 35 feet. The road figure is accurate, however the distance of rail line might be higher due to difficulties in identifying NEC and non-NEC rail in dense urban areas where many tracks were close together. In total, there are 107 one-mile segments with a parallel roadway, 36 for railroads. The average length of each in those segments is 1750 and 3250 feet respectively.

The highest concentration of parallel roads and railroads is in northern New Jersey and the Metro North territory. There are also concentrated locations in Washington, Providence, and Boston.

The presence of parallel ROWs can be read as either a positive or a negative. It is hoped that it would be easier to expand into a ROW of another railroad or a state DOT owning a roadway, as opposed to private property. However, this might be easier said than done, and may not be possible in many locations. None of these parallel ROWs are very long, and would only be a fraction of any expansion requiring land taking.

Tracks

Table 7: Track Summary

2 tracks	37.4%
3 tracks	20.8%
4 tracks	37.9%
5 tracks	2.6%
6 tracks	1.3%

The large majority of the corridor is between two and four tracks. Most of the two-tracked portion is between New Haven, CT and the Route 128 station in Massachusetts, with shorter portions scattered throughout the remainder of the NEC. The most heavily traveled parts of the corridor is where it is consistently built with four tracks, through most of Pennsylvania, New Jersey, New York, and western Connecticut. The smaller proportion of three-tracked parts of the corridor are mostly in Maryland and Delaware. The distribution by route mile of the number of tracks is in Table 7, and graphically depicted in Figure 6 and Figure 7:

Figure 6: Tracks on Southern End of NEC

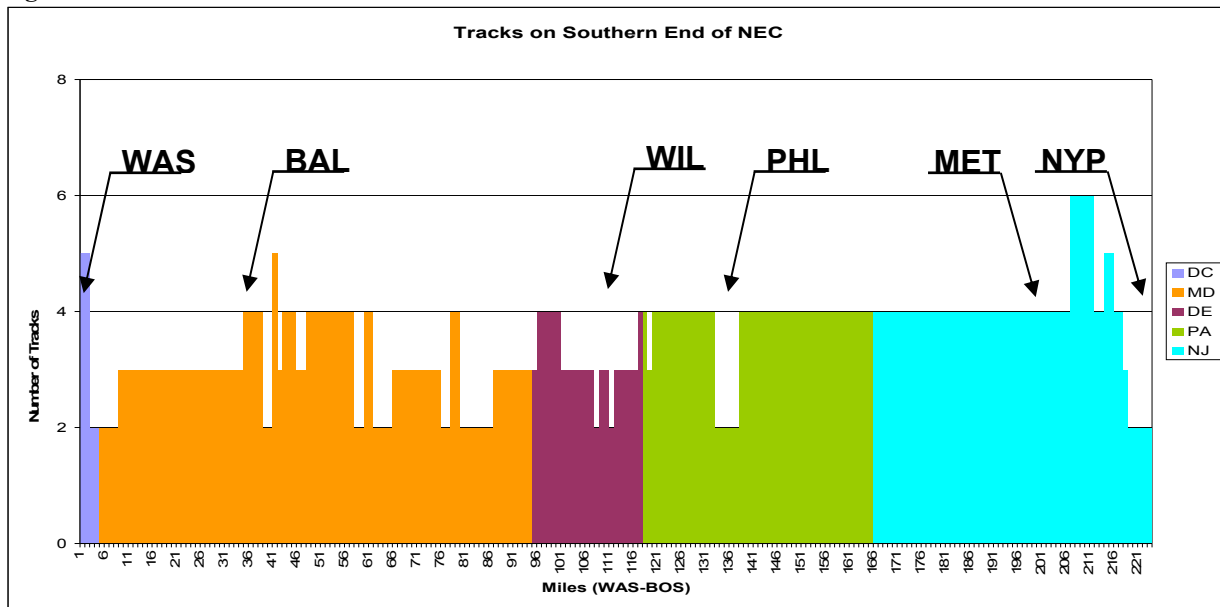
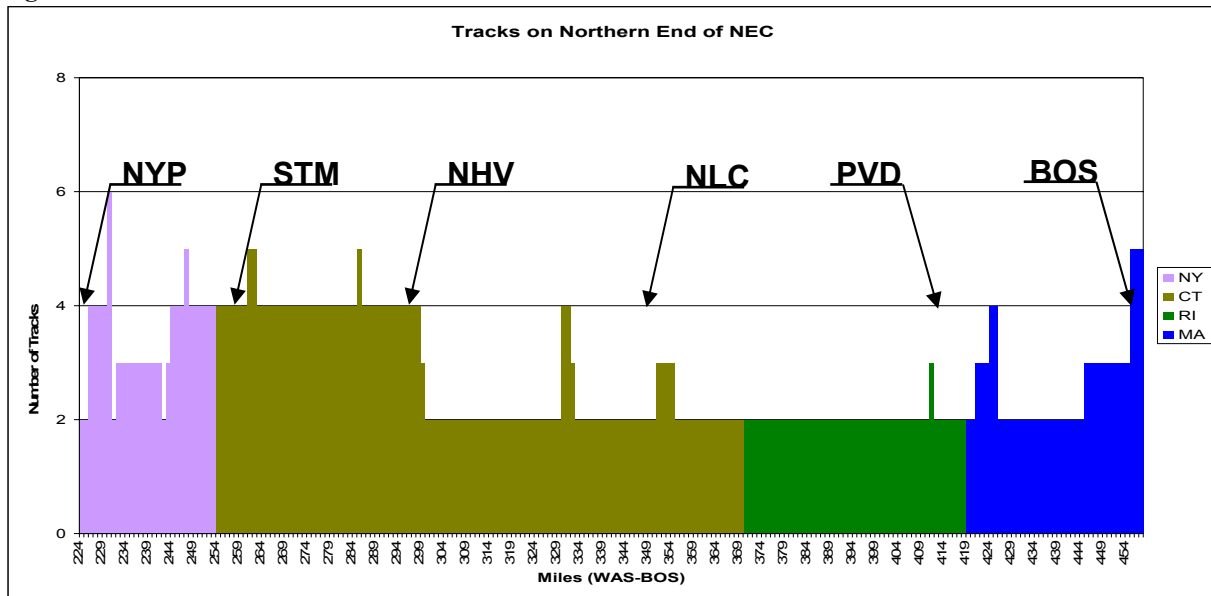


Figure 7: Tracks on Northern End of NEC



Summary

In general, the northern end of the NEC has a much more restricted the right of way. There are many more structures within 35 feet of the track than in the southern end and generally has higher population densities. The only seemingly emptier portion from New Haven to Westerly is still much more affected by structures than the majority of the entire southern end. The many parallel roads, stretches of water, and other railroads in the northern end nearby the tracks add to the difficulty of any northern section expansion.

DISCUSSION OF ALTERNATIVES

HSR's Place in the NEC

The three alternatives for faster rail service that should be considered in the Northeast Megaregion were presented to a group of stakeholders. Despite the clamor read in newspapers and heard from politicians about HSR, those familiar with the issues and tied to the NEC were often not proponents of bringing such service to the megaregion. Their reasoning originated in the density of development in the corridor, and the immense costs involved in acquiring the space to build any significant HSR project. The current corridor's infrastructure state is in poor condition and can discourage a major project. There are those that see the chance of HSR happening though. Dr. Allison L.C. de Cerreño in her report *The Future of Transportation in the Northeast Corridor* describes what will need to be done to see true HSR as a reality:

“To address these deficiencies and bring the Northeast [rail] Corridor (NEC) to a level of service which not only entices passengers from automobile and air, but also is recognized by our global competitors as true high-speed rail, several things need to happen. First, at the very least the corridor needs to be brought up to a state of good repair. Second, policy decisions (and corresponding funding to support them) need to be

made that would allow for a true high-speed intercity rail system that is both closely linked with the aviation industry, and is supported by transit networks in the cities it connects.”

Despite this, because the Northeast already has decent service with the Acela train, the stakeholders repeatedly described that major investment in new dedicated HSR infrastructure was not responsible and time gains not significant enough to warrant it. Instead, what can be gained more cheaply through upgrades on the existing corridor is significant, and should be the priority for the megaregion.

One of the key questions behind HSR development, as described by one of the interviewed stakeholders, is what type of service it will provide to the megaregion. The overarching question is if we want to service a few people really fast, or a larger number of people slightly slower. This question underlines all decision points of a potential route: station selection, alignment, and frequency of service. Although one would hope that higher speeds translate to more riders, pulling them away from the air market and automobiles, it also comes with sacrifices. To operate at the higher speeds and gain the time savings the train would skip stations, losing riders at those points. Straighter segments of track are needed as well, requiring land acquisition, causing tension with the communities of potential riders, increasing cost. Lastly, the cost of investing in speed could rather be used as an investment in frequency. This would translate into additions to the fleet and improved signaling. With capacity improvements, the new trains could run on the tracks more often. That increase in frequency creates a different system with a different priority, but is superior in some eyes.

Although one could price fares accordingly for higher speeds, noting that riders will be lost due to fewer stations and perhaps sparser service, is speed the goal? The motivation for HSR is not just to move people faster, but also to get people off of short haul flights, out of their cars, and providing an option which is cleaner for the environment. If more riders benefit from more stops, but at the expense of speed, what should the choice be? A premier world-class HSR system can make the Northeast Megaregion’s image stand out internationally, but is it feasible?

A New HSR Corridor

Building a dedicated separate corridor for HSR faces several large issues. It is believed by most of those knowledgeable on the topic that this will not ever be feasible in the Northeast Megaregion. The strongest points to consider is the immense amount of land acquisition which would need to occur in the densest of all megaregions, the likely scenario of having to locate stations outside downtowns, and the extreme costs involved. Several times stakeholders referenced how Representative John Mica’s support of HSR systems across the nation is great and worthwhile, but will likely never apply to the Northeast, but is perfect for other megaregions such as in California, Texas, and Florida. Lastly, because the Northeast already has decent service, the call for HSR is not as loud, as the need is not as perceived by the population. Lastly, there was no hope from any stakeholder that such a corridor would ever pass the environmental process.

Acquiring the land to build a dedicated corridor is an immense task, and it alone is prohibitive to the idea’s development. According to those knowledgeable on the subject, other countries managed to achieve such projects in much less dense areas, and had larger swaths of land

available to lay down straight stretches of track. Some of the stakeholders speculated this is not the case in the Northeast, with development at a much higher density. To acquire such a large amount of land would be opposed by hundreds of communities and delay any work for many years, perhaps indefinitely.

Connecting this new corridor into current system has its challenges as well. Because of the land acquisition issues, bringing this new corridor into downtowns becomes even more difficult. It is desirable to run a new HSR corridor as long and as straight as possible, with a limited amount of stops to have the fastest travel times. But to join back with the new corridor into the current NEC, it would more than likely have to be done well outside the city limits to reduce the amount of property taking. The train would then have to travel on conventional rail systems, meaning it would need to have compatible technology. Lastly, the slower speeds on the NEC would increase trip times significantly.

If speed was the biggest priority, the downtown stations would be avoided entirely. The slow speeds needed on the inner-city approaches would not help in achieving the goal of attaining the fastest travel times. Instead, stations on the fringe of cities would be necessary. Considering this though is fruitless, because the strength of the rail system is its ability to link central business districts. New stations also would need to be linked to the established network or commuter rail and rapid transit systems, and by avoiding downtowns for speed reasons, the new rail line would be unlinked, and not serve its purpose. Thus, any HSR corridor must slow down to enter cities on current rail corridors, for both the purpose of linking downtowns and integrating into the current rail network. In fact most international systems operate this way, tying into slower rail lines as they approach cities.

The cost of acquiring land, which takes up the majority of funds to build a new rail corridor, adds considerably to the total project cost. A new corridor would have aspects to it that would not exist for an expansion of the current NEC. First and foremost, a new line would have a more arduous grading process, as the land chosen would most likely not be level enough for HSR. A new line would require a complete fitting of signals, catenary, and power systems above and beyond the effort required for an expansion. This would lengthen the planning process, and push the project completion date back.

If there is any bright light though, it is that building a dedicated corridor would likely be faster than building in the current corridor. There would be no restriction on when contractors could be working, and no disruption to rail service on the existing corridor. Due to this reason, actual construction time could end up being shorter, and was believed by a stakeholder experienced with construction that it has a chance of being cheaper.

One way to add HSR is to use abandoned or freight ROWs. For example, a nearby CSX freight line exists west of the NEC from Washington to Philadelphia. It comes fairly close to the NEC as it approaches the cities urban centers, so perhaps it could be possible to create links to the NEC to serve the downtown stations. There are however problems, the freight corridor does not necessarily pass through less dense areas, nor is it without its own issues of expansion. The corridor is also less straight than the NEC and would need realignment for higher speeds. It is less direct as well, arcing over a longer distance.

The chances of operating on nearby freight lines are slim beyond their share of infrastructure and geometric issues. Union Pacific dictated to the California High-Speed Rail Authority in 2008 that they would not want their operating ROW be considered in the route determination or interfere with Union Pacific operations at all. This is in some part influenced by the lawsuit against CSX for negligence when a commuter train collided with by one of their cars. The freight railroads are not interested in risking such collisions.

Perhaps the largest potential for untapped markets, and a possible option for a new true HSR corridor, is to head north instead of east from New Haven. Running HSR through Hartford and Worcester on the way to Boston, instead of east through Providence, is an option that should be considered. Although it would face a political battle from eastern Connecticut and Rhode Island, this alternative route to the current NEC has the benefit of not being constrained by the dense development along the shoreline. Hartford though, is described by a couple of stakeholders as having both closer economical and social ties to New York rather than to Boston, and could benefit greatly from such a rail link. The connection between New Haven and Hartford would be parallel to the current ROW. Heading northeast from Hartford, the rail line would travel near the I-84 ROW, as it is straight and passes through mostly undeveloped areas. From Worcester, the train would likely travel east to Boston along the current rail ROW. Springfield, although initially part of this study's proposal as a potential part of the route, would unlikely receive support for a rail line, according to those familiar with the region.

Unless a dedicated HSR corridor is constructed, it would be unlikely that trains would be routed away from the current NEC. The Hartford-Worcester option only applies if there is commitment to building a separate corridor for true HSR. Otherwise, it would be unwise to attempt a corridor here if speeds will only be equal to those already possible on the NEC. The shoreline route that the NEC trains currently travel is acceptable, and it although has barriers to expansion, still has the community's support.

Tunneling is an attractive option to bypass congested areas that need more capacity. If the ROW is highly constrained, a tunnel underneath the current tracks is an option. Stacking the tracks in this fashion is expensive though, and a tough operation to carry out. Some stakeholders interviewed blew this off as a preposterous idea because of how expensive it is, despite the excitement it creates, and noted that even in Europe these tunnels have made up immense portions of a system's cost. Putting tracks underground still does not remove the need to have access to the surface, as tunnels require vents. It was emphasized that tunnels are already in place where they are necessary, and any more should be avoided.

The proposition of using a highway ROW for rail is also frequently mentioned. If the median has space, or there is room on the sides of the highway, using this space for a rail line seems to make sense. As long as the ROW has few and smooth vertical curves, rail would not have a problem being constructed here, especially rapid transit and light rail systems. HSR is more difficult to construct in these situations though because of the vertical curvature. In order to reduce highway travel speeds for automobiles the road is typically given many more horizontal curves. HSR needs long straight sections of track to operate, and because of the curves on a highway, it would rarely be able to achieve maximum operating speeds.

Even those not in favor of the project agree that if the money was available, and an environmental statement could manage to get approval (a concern so strong that many stakeholders felt would never happen,) constructing a dedicated corridor has its benefits. Straighter sections of track without any commuter trains to operate side by side with means less delays and unforeseen issues. In order to maximize the benefit though, it would need to stop in the downtowns of the current cities Acela serves, albeit likely only the most critical metros.

HSR Operating Adjacent to the NEC

Constructing a new HSR corridor may be more feasible if it followed the current NEC. The ROW is already established, integrating into the current network is simpler, and station options are straightforward. The current NEC though pierces through several long stretches of dense development. Adding two additional tracks dedicated to HSR service may prove to be prohibitively difficult. As well, construction may take very long because it would have to occur around current operations.

An expansion to the current NEC for true HSR should not be overlooked. It passes through all the metropolitan central business districts, and already has in place an established network. The various transportation modes set up to service stations along the route are established, and a shift in behavior by passengers would not be required. Commuter rail networks are established at the current station, making it easy to be fed by these systems. Stations will likely require additional platform capacity to allow a new system to operate out of there, but barring a restriction of the ROW, new stations would not be necessary, so the ticketing and service facilities will be established. Lastly, trains can be scheduled accordingly to ensure the HSR trains are fed by the commuter services. Careful planning can ensure that transfers between networks are short and convenient for passengers.

In terms of infrastructure, building parallel tracks may be no easier than a separate corridor. Most aspects of the corridor would need to be rebuilt, expanded, or need new infrastructure all together. Many stations along the corridor will need new platforms and perhaps be completely redone if new HSR tracks were placed. The faster speed trains will need to be separated by a barrier under FRA regulations. This could severely impact the location of each station, mostly those not served by HSR, because of the space needed for such barriers and how new tracks could pass through or around the station. Nearly all bridges will need to be widened for the new tracks, regardless of whether the rails are passing over or under. All the catenary will need to be added onto, in many cases requiring new supports, and additional power stations will be necessary. Interlockings and signals will require refitting and expansion. Altogether, the efforts to add additional tracks are just as intensive as a brand new corridor.

The technology of new train sets would need to be fully compatible with the current NEC. Although for the majority of the corridor it would operate on its own set of tracks, when it reaches metropolitan areas, it would likely have to operate on the current rails because of severe space constraints. The hope is that the HSR tracks would be for those trains' sole use, but it is not unimaginable that to gain additional funding and support, commuter trains might get access when necessary.

The fleet itself would need to be designed carefully to operate safely both on and off the dedicated rails. The current Acela trains are heavier than those seen on the TGV lines in France, a factor in its lower top speed. However, this weight, even though less than that of the Amtrak Regional cars most seen on the NEC, is high because the trains are operating on shared tracks with freight rail. FRA rules require that passenger rail cars operating on the same tracks as freight rail must be able to sustain a collision with a freight train. Combine all this with the poor state of the infrastructure on the NEC, causing the Acela trains to need repeated maintenance, a new HSR fleet would have to be carefully designed within these bounds of FRA rules, high speed desire, and need for robustness. Ultimately, if the trains are going to share the ROW with freight trains, they will need to be heavier. This results in more energy usage and lower operating speeds. It was expressed by one stakeholder that investment in technology specifically adaptable to the conditions in the United States needs to be improved to ever safely and efficiently operate.

Constructing this corridor would be quite difficult. Not only are there are constraints for space, there is the constraint that current operations put on construction. Already there are over 2,500 trains operating on the NEC each day. In order to build the tracks work would have to happen at night, and only for limited periods. This lengthens the timeline to build-out, delays the trains current operating, and requires lengthy staging procedures adding to the cost of the project.

In order to get the full benefit of the HSR trains, there would be a need to realign the tracks at points. The geometry of the current corridor, especially on the northern end, is speed restrictive. Added tracks would need to reduce curvature allowing them to maintain their high operating speeds. Amtrak has several small locations where they have targeted realignment, and these could be the first places where parallel HSR tracks could deviate for a segment.

Several portions of the corridor are better positioned for major HSR upgrades. Portions of Maryland, central New Jersey, and the Connecticut shoreline between New Haven and Westerly have the lowest population densities. Accordingly, these areas also have low numbers of bridges and structures impeding the ROW. Because of the low population density, it would be more likely in these areas to construct a brand new ROW. The fact, however, that the current corridor is clearer in these spots means these spots would also be suited for the expansion of two new tracks immediately parallel.

Incremental Improvements to Speed and Frequency

The final alternative under consideration is bringing up speeds through incremental infrastructural improvements to the existing corridor in order to hit time goals. This is where Amtrak's current plan fits in. Instead of trying to hit speeds that are yet to be seen on American soil, track segments would be improved to have faster operations. Updating a 110 mph segment to 135 mph or a 30 mph segment to 60 mph are both important, and the aim is to capture as many of these as possible in shaving time. None of these indicate a world class true HSR system, but for a much lower cost, the operational improvements can still be significant.

To be clear, these improvements will be made whether or not a new true HSR system is built. The NEC is in desperate need of updates for safety reasons, beyond just performance. So even if

HSR is built on a separate or parallel corridor, improvements still need to be made to bring the corridor up to a State of Good Repair. This benefits both commuter and intercity trains, allowing higher speeds and more frequency. Part of the State of Good Repair is also to update the technologies on the corridor which will not only improve performance, but are critical for safety reasons as well.

One of the most important technologies to be added to the NEC is positive train control (PTC), already installed on tracks between New Haven and Boston, a 24 mile stretch in New Jersey, and 27 miles through Maryland and Delaware. Amtrak plans to install PTC on the remainder of the corridor using ALSTOM'S Advanced Civil Speed Enforcement System at a cost of \$100,000 per track mile. The system brings important safety features to the NEC and is critical in allowing speeds of 150 mph. The system is based both on-board and on along the tracks, and uses passive transponders to enforce positive train stops. Train speeds are ensured not to exceed the allowable speeds on a stretch of the corridor, and prevent conductor error. Through speed limit enforcement preventing overspeed incidents, train separation is maintained and collisions avoided. It also helps to ensure temporary speed enforcements, such as for construction reasons.

Beyond PTC, critical infrastructure improvements are updates of the catenary, signal systems, and interlockings that allow for denser movements. Constant tension catenary will play a large role in allowing train speeds to be increased. Only short sections of the corridor currently have this technology, but the entire corridor should be fitted. This not only benefits intercity trains, but also the commuter trains sharing the corridor, as the wires allow for faster accelerations, an issue more important when starting and stopping frequently. The upgraded signal systems will help to reduce headways and operate the trains more frequently.

With major bridge and tunnel replacements, PTC, and catenary upgrades the NEC can achieve significant time reductions of 15 minutes. Amtrak estimates these upgrades to a State of Good Repair can happen by 2018. The next 15 minutes are then possible through additional targeted infrastructure improvements, including realignments of curves that would allow the train sets to maintain higher speeds for longer stretches. Amtrak officials referenced the realignment of tracks in Bowie, Maryland to allow for higher speeds as an example. Here two of the tracks now pass straight through a cut in the terrain while one track from the original alignment curves around, allowing higher speeds on the new tracks. This type of improvement, where a short segment with a high degree of curvature gets straightened is part of Amtrak's priority to significantly bring down travel times. Major infrastructural improvements on the corridor are flagged by Amtrak in their NEC Infrastructure Master Plan. This document thoroughly outlines the major projects necessary to prepare the corridor for a doubling of ridership by 2030. This report considers those projects timely and necessary, and are critical for completion whether or not new high speed service is introduced.

Although it would be nice to operate true HSR on the current tracks, upwards of speeds of 180 mph, this is feasible but expensive. The railroad tracks are not constructed to a high level as to allow such speeds, and would need upgrades to rail ties and the rails themselves. Such high speeds also do not integrate well into the current array of commuter and other intercity services. A train operating so quickly would need long lengths of track open ahead of it for it operate as it

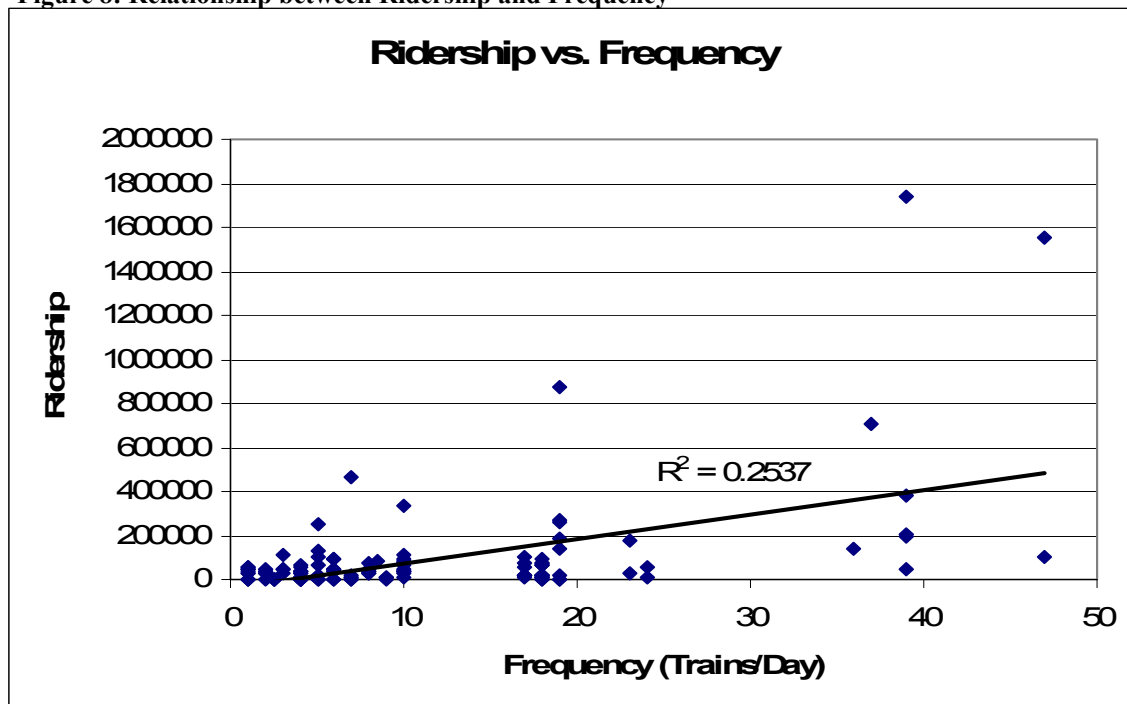
needed, limited operations of other trains on the corridor. In effect, each time a high speed train traveled through, an entire track must be dedicated for it for tens of miles.

What was described by several stakeholders as the smartest approach to targeting spots for improvement is not to achieve higher speeds on the stretches already with trains operating near top allowable speeds (125 mph or more) but rather bring up the slowest segments as much as possible. A simple example verifies this. For a 30 mph speed improvement on five miles of 60 mph track, bringing it to 90 mph, the equivalent upgrade bringing 120 mph track to 150 mph would require almost three and half times more distance, around 17 miles. This illustrates the importance of upgrading the slowest segments first, as a small investment in them pays off in large time savings.

In the absence of a big jump in top speeds through true HSR to induce ridership, most stakeholders felt that investment can be wisely made in frequency. Providing service with shorter headways, the intercity trains on the NEC will be perceived as more convenient and more reliable. There will be more options for a traveler to complete their itinerary, and this will attract potential passengers who previously worried about having to sit for long periods of time in stations or cut their day short for a train. Speed may be attractive to a rider because they can arrive quicker, but frequency allows them to get on the train in the first place.

The case for frequency as an inducer of ridership is not solely anecdotal. Figure 8 compares ridership and frequency of service between U.S. cities connected by rail service. The city pairs having at least 100,000 residents and are no more than 500 miles apart. The relationship between the two variables is positive. Although one should be cautious believing there is a causation relationship, it does indicate a correlation between the two. The question is whether the frequency of service is there only because the ridership between two cities is high, or whether the frequency itself is helping to increase the ridership. On a case by case basis, one or both of those reasons could be in effect.

Figure 8: Relationship between Ridership and Frequency



A separate study examining this correlation would be beneficial, but is out of the scope of this study. There are numerous worldwide examples of corridors that have increased the number of trains operating and subsequently saw proportional increases in ridership. One focus of such a study should be looking at cities with many trains per day which have high ridership, but with a relatively low population. In that case, does the city's population have an affinity for intercity travel, or people choosing to ride mainly because the service exists. On the opposite end, does a highly populated city with low frequency and low ridership exhibit this solely because of the number of trains available?

The main reason to undergo incremental infrastructure improvements instead of true HSR is cost. For the reasons of price, it is the more feasible option. There are many barriers that could prevent true HSR ever being built, as mentioned in the previous sections. Because this third option is less affected by the problems of property acquisition and the physical impediments to expansion, it could be completed in a shorter period of time and affect current operations less. Although the impact on travel times may not be as large, or create a new system that would be a premier system in the world, it could produce the needed results quicker. By not abandoning what the Northeast currently has, money can be saved and connectivity and growth goals can still be achieved.

It comes down to how much benefit we are going to get from the investments that are made. If billions are invested in a true HSR system, and ridership only grows a small percentage, is it worth it just to have a premier high speed system? Instead, could an almost equal increase in ridership occur only with infrastructure improvements that reduce travel time and increase frequency? Although it is unknown what the exact ridership gains could be seen from different levels of investment, it was widely believed by stakeholders that the optimal point on such a curve would be lower rather than higher. Inducing this mode shift is important, and is attainable without incredible investment.

Branch Corridors

The NEC has three branch corridors that are seeing various degrees of success. Each has the potential for growth, and even potentially see increased travel speeds in the coming decades. It is essential for all to be integrated well with the commuter networks that also operate, or will operate, on parts of these corridors. As well, with the continued mention of blended services in the Northeast, these corridors will increasingly have strong roles in the NEC's growth.

The Keystone Corridor from Philadelphia to Harrisburg is already one of the greatest success stories of the Amtrak system. It is one of the most frequently ridden routes along with California's Pacific Surfliner and Capitol services, behind the NEC. The Keystone Corridor from Philadelphia to Harrisburg has seen immense success since upgrades were made to the corridor over the past decade. The potential for HSR in this corridor is still perceived as high, existing continually on the list of federally designated high speed corridors. Since it already has high

ridership levels, it is known that there is a viable market for HSR service. Whether this means true HSR as opposed to service similar to Acela remains to be seen.

The Empire Corridor from New York Penn Station to Albany is also seeing its fair share of success. Compared to the Keystone Corridor, the Empire Corridor is not as heavily ridden intra-corridor, but riderships are generally high to Albany and New York.

The Springfield Corridor running north from New Haven to Springfield has the least service of the NEC's three branches. The potential for HSR in this corridor was included in the discussion of a new HSR corridor, by creating an alignment through Hartford and then northeast to Worcester.

Stations

Determining the stations of a new HSR system is critical for determining when deviation from alignment can happen, and what level of ridership will be aimed for. Endpoint to endpoint, a New York to Washington direct train could operate in 2 hours 15 minutes on the current tracks with infrastructure improvements, but it is both practical and necessary to stop at intermediate stations. At minimum, Philadelphia should be connected, due to its ridership potential. Baltimore and Wilmington as well are necessary to serving the populations of both their states. This would create a five-stop service on the southern end of the corridor with all station contributing to ridership. Further evidence to service these stations is the track geometry around each. They all are along stretches of track which have slow travel speeds, thus coming into those stations, even if skipped, requires decelerating. If a train is already dropping its speed to navigate curves, stopping to pick up additional passengers is not detrimental; it would be unwise to simply pass through the station.

The sixth city, and the first off the list of stops, is Newark, New Jersey. Nearby to New York and with northern New Jersey having decent transit connections into the city, some stakeholders argued that this station be skipped to gain time on the route. Others disagreed, describing how an intercity train must pass through the station while traveling on the NEC, and at slow speeds as well. Thus stopping to gather additional riders does not mean losing significant time. If a sixth stop was to be considered, Newark is the prime candidate, allowing easier access to intercity trains for northern New Jersey residents.

On the northern end of the corridor, it appeared the consensus from stakeholders was to have a five-stop service between New York and Boston South Station servicing Stamford, New Haven, and Providence. Likely, because of the slow operating speeds in the area, Boston Back Bay would also be served.

Airports

Having intermodal connections at airports is of course beneficial to a city's transit system, and allows the air traveler going and coming from the airport to make the trip without a car. Currently along the NEC, connections to airports adjacent to the corridor include:

- Baltimore-Washington International Thurgood Marshall Airport (BWI) has a station on the NEC. It is connected to the terminals by a free shuttle bus, which runs on 15 minute headways during peak times. Ten Acela trains in each direction stop at BWI and nine Amtrak Regional trains. Additionally, the airport is served by MARC trains on the Penn Line and the MTA's Baltimore Light Rail.
- Newark Liberty International Airport (EWR) has a station on the NEC, which is the westernmost endpoint on the airport's monorail system AirTrain Newark. The cost of the ride from the rail station to the terminals is \$5.50, and runs on three minute headways during peak times. Ten Amtrak Regional trains in each direction stop at EWR, and it has no Acela service. Additionally, the airport is served more frequently by NJ Transit trains.
- Providence's T. F. Green International Airport (PVD) has a station currently under construction on the NEC at a cost of \$223 M. It will be connected to the terminals by a 1,250 foot elevated walkway. MBTA trains are planned operate from the stop, but Amtrak currently has no plans for either its Acela or Regional trains to service the station because Amtrak's requests on the design of the station were not met. Amtrak officials agree that it is likely that in the future Regional trains will make the stop. From the station, it is about one hour to Boston.
- Philadelphia International Airport (PHL) does not have a station on the NEC, but is two and a half miles from the NEC. SEPTA's regional rail service connects the airport to downtown Philadelphia at 30 minute headways. Having intercity trains service the airport is possible, but has its difficulties. Parking and structures north of the airport prohibit a through rail connection, and would require a flyover to connect service back to the current corridor. South for the airport current communities will likely be opposed to frequent passenger trains passing through the current freight corridor.

Whether airports are necessary to be connected on an HSR line in the NEC depends on what the goals are of such service. If the goal is to replace short haul air travel, having a true HSR rail connection at the airport would be counter-intuitive. If the goal, however, is to broaden access to the airports, then the connection is then perceived as more useful. Whether or not true HSR had an airport stop, Regional trains would still provide service.

Regardless of the goal, some stakeholders on the system do not feel the HSR train sets should be the ones making the connections with the airport, but rather leave that task to the Regional trains and commuter rail. Others, however, do recognize the benefit of an airport connection, but it was the consensus that the goal of the HSR trains should be to continue serving the downtowns. Even BWI, the only airport with Acela service, is not even seen as critical to the system by policy makers in Maryland; that in order to serve the state well, it is only critical to provide high speed service to Baltimore.

What should be done instead is improve the connections at the airports to the commuter systems. Amtrak officials describe Newark Airport as a tough station to serve because of its close proximity to Newark Penn Station, only one and a half miles away. In this case the right idea would be to extend either the PATH Rapid-Transit System from Newark's downtown to the airport, or extend AirTrain Newark into Newark Penn Station. In the case of Philadelphia's

airport, more frequent SEPTA R1 service would better serve those in Philadelphia than an intercity rail stop. The argument that a stop at the airport would serve those in Wilmington is difficult to defend. The Wilmington downtown would be an unlikely spot for northern Delaware air passengers to start their trip only to board an expensive train to the airport. If Amtrak, however, decides that intercity connections at airports are important to their station network, PHL should be heavily considered. One solution would be to convert the Eastwick SEPTA stop to serve intercity trains, and creating a shuttle similar to Newark's monorail the would travel on the current R1 ROW.

The argument could be made that HSR could supplement short haul air travel, but the case is not strong enough to warrant the extra delay trains will have making the stop. Short haul trips for those living in the megaregion could be replaced by having those passengers take the train instead, boarding in their respective downtowns. It would then be unnecessary to serve the airport for them. Domestic air passengers whose final destination is the city in which they've landed would not need an intercity rail connection after arriving, and could rely on frequent commuter service to reach the downtown of the market metro they flew into. It also would be rare that the cost of an air and connecting rail tickets to their final destination would be less than a direct flight, and it is debatable whether taking rail for the second leg would require less time. International arriving passengers who are limited in their choice of gateways to the region might have the highest need for the airport intercity rail connection, but this is believed to be too small a market to warrant an airport HSR connection. In fact the most likely passenger an airport stop would serve is a business traveler who flies one way for their trip, and decides to take the train back, thus needing to get back to the airport where they parked their car.

All considered, airports are best served by Regional service for those who need it, but a high speed train should not be making those stops. Even with a true HSR train operating with a high frequency, making two to three additional stops at airports reduces the effectiveness of the system as a whole. Serving airports with true HSR does have its benefits, and there exists a sizable population of riders who would choose to take rail instead of a short-haul flight when making a connection. There are even international situations that have shown HSR can replace all short-haul travel for the purposes of connections. It was the conclusion of this study, however, that the benefits are outweighed by the disadvantages, and service should be provided by only Regional trains. The time that is saved not serving an airport is important for the HSR train to preserve, and an effective mix of intercity rail services allows for the airport to be bypassed.

RECOMMENDATIONS AND CONCLUSIONS

The NEC has many strengths that have made it the most successful rail corridor in the country, and building upon those would be a wiser than taking giant steps to pursue true HSR. Although without the glamour of a world-class system, travel time improvements of 30 minutes should not be discounted. Although this is not close to the speeds seen in international systems, it should not be seen as a shortfall. The cost to build a dedicated line on which freight would not operate, in order to operate at the higher speeds allow by the FRA, would certainly encourage people to shift modes, but may not be much more effective than incremental infrastructural improvements.

Despite this, it is important for the Northeast Megaregion to plan for its future. A separate corridor may be feasible although expensive, but it may never move past the amount of backlash from communities. Parallel to the existing corridor, although difficult and time consuming, new dedicated tracks should not be dismissed. Although there are points where it may not be possible for new tracks, the barriers to building mostly lie in having to construct around the current system. There are many areas where ROW is available, and this needs to be capitalized on now, when we are starting to take our big steps towards the future.

Base HSR Strategy

Assuming that funding levels remain low, the best option for the NEC is to carry out the plan of incremental infrastructural improvements. The NEC Infrastructure Master Plan written by Amtrak is comprehensive in identifying the key spots on the corridor that need upgrades. With this work, time goals will be able to be met in the coming two decades, and capacity will be increased for both intercity and commuter operations. Air travel is only getting more and more congested, and rail in any form has the opportunity to draw riders from the short haul flights and into the train cars. With the Northeast Megaregion being the most congested in the nation, the window of opportunity is even larger.

The infrastructural improvements described in this report will get the NEC to operating speeds that can continue to attract riders. More important, frequency improvements will attract an even more passengers, and as capacity increases, the headways of intercity trains should be decreased. Efforts need to continue to integrating services on the corridor between commuter and intercity rail.

Limited stop service on the northern and southern end should receive more focus to capitalize on the speed improvements infrastructure will allow. On the northern end this means servicing only New York, Stamford, New Haven, Providence, and the two Boston stations, bypassing Route 128. On the southern end, New York, Philadelphia, Wilmington, Baltimore, and Washington would be service, with Newark as a potential sixth station. Airports should no longer be serviced by the highest speed train sets, but rather have increased connections from the Regional trains, with potential service at T.F. Green Airport in Providence and Philadelphia International.

HSR Strategy with Private Investment

If major funds were ever committed to building true HSR in the Northeast, portions of the NEC could be expanded, but this would not likely be feasible for all lengths. This would be the more feasible option compared to building an entirely new separate corridor. If targeted stretches were expanded for true HSR, these trains would operate on the older tracks for the remaining time. The goal would be to have as many of these stretches as possible, for as long as possible, preferably having single continuous stretches between stations. This itself could be done incrementally, and could allow a progressive roll-out.

It would make sense to target these sections of adjacent tracks for true HSR in the areas where the benefit would be greatest first, but this may not be immediately possible. Instead, the low hanging fruit of the corridor should be expanded first. This should be in Maryland, north of

Philadelphia into central New Jersey, and eastern Connecticut through Rhode Island. Similar to how international systems made use of their most rural areas for new tracks, the NEC should have its least dense portions upgraded initially before denser areas are tackled. Because the recommendation is to do this between HSR stations first, the stretches for initial expansion would be from Baltimore to Wilmington and New Haven to Providence. The central New Jersey part of the corridor has potential for expansion too, but expansion would not be entirely from Philadelphia to Newark. North of New Brunswick, the corridor is incredibly dense and has many impeding structures. It may have to be that parallel expansion is completed in two stages, with the section from Philadelphia to New Brunswick being completed first.

After these initial segments, the next most difficult should be targeted. The Wilmington to Philadelphia portion of the NEC is a relatively short stretch, and although dense, has very few structures near the tracks and less bridges than other parts of the corridor. The biggest constraint would be adding onto the tracks just south of Philadelphia where they are built above grade on a raised structure. Similarly, expansion from Providence to Boston would be the next target on the northern end. The largest constraint here are tracks built below grade as the route nears Boston, north of the Forest Hills MBTA station, and perhaps expansion may have to cease before this. There are a high amount of structures, bridges, and roads on this part of the corridor, but not infeasible.

Lastly, the idea of a new corridor heading through Hartford and Worcester should be studied. It should be evaluated whether investment in this region could have competitive ridership levels. Additionally, coming in from that direction may open up the possibility of terminating at Boston North Station, which could improve connections to the current Downeaster service. This option only makes sense though if true HSR was being invested in, not as an alternative to the coastal route and operating at the same level of service.

A commitment to true HSR would also require a focus on developing HSR technology that is appropriate for America's conditions. One stakeholder described the lack of research and development that has occurred on rail technology supported by the FRA. Specific attention needs to be paid to safety features and locomotive technology, and current investment is not at a level that shows a dedication to HSR.

Comprehensive Planning and Gaining Support

The options for improving speeds on the corridor will not be separate from each other. Mixing and matching methods to improve the corridor will be the ultimate way the NEC progresses through the future. Perhaps one part of the corridor is upgraded significantly and tracks added adjacent to it, while in another portion a true HSR corridor deviates from the current NEC and meets back up with it a hundred miles later. Various arrangements of station servicing can be planned, creating a blend of services ranging from endpoint-only express service to local trains. The fact that the NEC is a shared system though means it is ripe for different service arrangements, stopping patterns, and various levels of improvement.

In order to understand the effects that can be achieved through various levels of investment, a study should be performed to help inform the decision makers of the NEC. The output of such a

study would be a listing of various levels of investment on the NEC. Starting from a few billion dollars for necessary safety upgrades up to 40 to 50 billion dollars for the price of a separate true HSR corridor, such a table could break down what is possible at each level of investment. The projects that get included in such investment packages must first be put through a cost-benefit analysis. The question remains though, which benefits are chosen to critique each level of investment? Such a table would be an effective product to demonstrate the point at which investments begin to see diminishing returns.

Additional efforts need to be made to raise the visibility of large projects for the NEC. We are current coming out of a difficult eight years of support from the federal government, and into at least four years of a supportive one. The defensive mindset that rail advocates have had to take is still at the surface, and good project ideas that have up to now been dormant need to start surfacing. Innovation for the NEC means believing funds will be there in the future, and proposing projects that deserve such funding. Tunnels, the most expensive single piece of infrastructure likely to get built, are at the front of this conversation. A realigned tunnel in Baltimore, and new station as well, would allow higher speeds and reduced travel times beyond just a rebuild of the current tunnels. A third tunnel under the Hudson and an expanded Penn Station would do the same for New York. Perhaps even a raised structure for some lengths of the Metro North territory. These types of projects, grand in scale but effective in what they'll achieve, will be able to excite decision makers and allow them to support a strong central project. They also will create additional conversation about HSR, and demonstrate commitment to achieving strong connections in the Northeast.

Environmental Argument

HSR is considered an environmentally friendly option versus the automobile and airplane. Most highly touted is the carbon emissions of an HSR train and how much lower it is to other modes. Dr. de Cerreño outlines how rail has significantly lower emissions compared to other modes. She specifically references the differences between car, air, and rail travel, noting how rail releases the least volatile organic compounds and carbon monoxide, and is just behind air travel in its nitrous oxide emissions. Even when changing the variables involved in calculating such emissions, specifically power generation and engine type, rail still outperforms. Additionally, de Cerreño discusses how rail is the most energy efficient of all the modes, especially autos.

But those trying to stop HSR for a variety of reasons, have turned environmental arguments against HSR's supporters. With the California HSR being the hottest issue for the topic in America, it is receiving a lot of criticism from its opponents, and especially feeling the heat for what is claimed to be the environmental benefits. In October 2008, The CATO Institute in Washington, D.C. released a report criticizing efforts nationwide for HSR, and stated:

“high-speed rail lines [are not] particularly environmentally friendly. Planners have predicted that a proposed line in Florida would use more energy and emit more of some pollutants than all of the cars it would take off the road. California planners forecast that high-speed rail would reduce pollution and greenhouse gas emissions by a mere 0.7 to 1.5 percent—but only if ridership reached the high end of projected levels. Lower ridership would nullify energy savings and pollution reductions.”

The report later states that HSR is a spectacularly cost ineffective way to control pollution, particularly criticizing how proponents overstate the benefits when pushing HSR. *A Compendium of Questionable Claims by the High Speed Rail Authority*, a report from Derail, a non-profit group against HSR in California, makes the claim in their report that HSR is no different from automobiles in carbon emissions, using data from a United Kingdom report entitled *Delivering a Sustainable Railway* and showing how the claims in it are tailored to show only that HSR emits less. The primary argument is that trains, unlike automobiles, are always assumed to be full of passengers. The same counterargument about questionable assumptions is used to show that the trains are no less energy efficient.

One additional argument against HSR's environmental benefit which is sometimes ignored is how the operating benefits are offset by its construction. Already expensive and timely to build, the process to build the system is not environmentally friendly. Although the hope is that HSR would operate for decades after its construction, it will need continual repair, so the length of time over which the environmental benefits balance out is a significant proportion of the life of the system.

In the United States the arguments about the environmental benefits of rail have been strong for both sides. Depending on the source, rail gets cast as either environmentally friendly or utterly wasteful.

Comparisons to International Situations

Repeatedly supporters of HSR mock the United State's development of the service by comparing what other countries are developing. They drill home how we are falling farther and farther behind and will be the laughing stock of the rest of the world. They also point out that the United States is not taking any role in developing sustainable transportation modes. Glorifying what Europe and Japan have built and spotlighting what China and other developing economies are pursuing does push American rail funders to move forward. It is, however, unfair to deride American HSR development so strongly, as the situation we face here is institutionally more difficult.

Gathering the opinions from stakeholders on the topic helped to highlight what makes HSR so difficult to move forward in the United States. First and foremost, land acquisition is not simple in this country, and moving through the process takes up the majority of development time. This is perhaps the exact opposite of the Chinese government's control on its HSR projects, able to do as they please in constructing their system. The United States would need a massive shift in policy to achieve the turnaround time in construction from investment that China is capable of. Even comparing the American situation to Europe, the approval process is longer, more strenuous, and does not necessarily guarantee a more robust project. Stakeholders agree that the community backlash heard here is louder and has a higher chance of cancelling projects than any other nation. With a tougher set of barriers to push through, it is not surprising HSR faces such an uphill battle in America.

Some international situations though relate very well to the Northeastern experience because the difficulties lying ahead for the NEC are not entirely unique. The update of the NEC is

remarkably similar to what the United Kingdom undertook to modernize their West Coast Main Line earlier in the decade. Both corridors have around 2000 train movements each day, operate freight and passenger rail on the same tracks (although the WCML has 42% freight traffic), and were lacking in large investment projects to keep the corridor current. The project was only to bring the corridor up to 125 mph, a mark which is below many portions of the NEC, to improve safety and add capacity. Like the NEC it had to do all the work over several years with continuous operations. The project had its fair share of issues in upgrading the infrastructure, and understanding the issues behind it could help in mapping improvements for the NEC. One key item that could be evaluated was the inclusion of private enterprises in the update. Virgin Enterprises played a role in bringing new service, and is an excellent case study for what could happen on the NEC. To lesson from this is that this type of major upgrade can be done in an active corridor. Infrastructural improvements can be achieved and trip times reduced, even in dense urban regions.

Conclusion

The Northeast, because it already has decent service in place, will have a harder case than other parts of the country in convincing stakeholders to back true HSR service. Although there is a certain appeal to dedicated HSR tracks, the return on investment, and the amount of riders gained purely through speed make this difficult to support. Because much is achievable through improving what we already have, the best idea currently is to move forward with these grains from incremental investments. The difference maker is if a sudden influx of funds dedicated to achieving true HSR comes, such as from a private investor, but there is no guarantee that this will happen.

Representative John Mica has stridden ahead and become the country's greatest promoter for HSR networks. Some critics will say he is proposing glamorous schemes that are not in tune with the real issues, adding that the rest of Congress does not understand the difficulty of HSR development. Without his efforts though, the United States would be farther from achieving these systems. Although stakeholders on the NEC agree that it is unlikely that trains traveling at 200 mph and over will ever be seen in this part of the country, they do not discount that there are opportunities elsewhere. In order for America to join the world's elite of high speed train owners, it does not necessarily have to connect its largest city with its capital city (although that would be nice.) With many opportunities coast-to-coast in California, Texas, the Midwest, and Florida to build HSR, America still has the chance to be a leader. Never should the lack of true HSR in the NEC ever be a reason to discount the country, nor the megaregion. Upgraded services still can have flair and be a reason for pride, while meeting the connectivity and environmental goals that are sought after.

The Northeast Megaregion is going to grow extensively in the coming decades. Growth will not only be in the population, but in the economy as well. All of this results in increased mobility needs by the people in the megaregion. The transportation modes must meet this demand, and rail will be playing a significant role in helping build this system. A collective decision on a value of money to invest in the NEC will allow forward progress in proposing what upgrades should and can be made. Always included should be a list of targeted large projects that can make the most significant travel time reductions in the corridor. The blend of services that are

chosen must be ready to serve this growth, and policy makers must be kept forward-thinking in allocating funds.

Gains can be made on the NEC with investments in the infrastructure and service frequency. Although speed will be a welcome addition to incremental changes and upgrades, it is not the driving force behind decision making. Trains on the NEC do not need world-class speeds in order to see success. Already capturing 60 percent of the air-rail market from New York to Washington, rail has the chance to seize even more of this market without building a true HSR system. All of the improvements can come through modernization of the corridor. In order to shift people from other modes onto trains does not have to be a megaproject with an incredible price tag. By working up from its current level of success, the NEC can continue to be the strong backbone of the Northeast.

Appendix 1: Interviewed Stakeholders

Kip Bergstrom
Executive Director
Urban Redevelopment Commission
Stamford , Connecticut
Interview Date: February 4, 2009

John M. Conlow, Jr.
Assistant Director, Strategic Investments Planning, Policy & Business Development
Amtrak
Philadelphia, Pennsylvania
Interview Date: February 6, 2009

Drew Galloway
Director of Transportation Planning
Amtrak
Philadelphia, Pennsylvania
Interview Date: February 6, 2009

Kyle Gradinger
Urban Planner/Designer
Wallace Roberts & Todd, LLC
Philadelphia, Pennsylvania
Discussion Date: February 12, 2009

Robert E. Hellauer, Jr.
Director, Regional Transportation & BRAC, Greater Baltimore Committee
Baltimore, Maryland
Interview Date: January 29, 2009

Michael Marino
AECOM Enterprises.
New York, New York
Interview Date: February 3, 2009

Foster Nichols
Parsons Brinckerhoff-Americas
Baltimore, Maryland
Interview Date: January 27, 2009

Richard Roberts
Chief Planner
New Jersey Transit Corporation
Newark, New Jersey
Interview Date: February 2, 2009

Lyle Wray
Executive Director
Capitol Region Council of Governments
Hartford, Connecticut
Interview Date: January 30, 2009