Appendix A
The Steel Interstate System
A 21st Century Railroad Network for the United States

Executive Summary

The Steel Interstate System (SIS) is proposed as a modernized, privately-owned American core freight rail network. The SIS would employ currently available rail technology to allow the U.S to build capacity more than sufficient to fulfill future national freight requirements, operate more efficiently and reliably, utilize 100% domestically generated motive power, and achieve point to point speeds from 60 to 110 mph for various classes of freight and passenger trains.

As envisioned the national SIS would involve about 40,000 miles of high capacity, multi-line track built on present rights-of-way that parallel the existing highway interstate, as well as selective use of new track lines. Total cost, to be principally borne by the private sector is estimated to be $500-1,000 billion.

Higher efficiency and capacity of the national SIS can be accomplished by using the following technologies:

- *Electrified rail*, to permit interstate freight shipments powered by domestically-produced, and more efficient electric motive power, rather by liquid fuels derived from imported oil or natural gas.
- *Grade separation* similar to the U.S. Interstate System and the Washington Metro Line - the system would be designed to have no junctions with automotive roads, thereby

allowing higher speeds and improved energy efficiency.
- *Improved rail alignment* and other modern engineering features.
- *Regional intermodal terminals* at periodic intervals to increase access of smaller truck and shorter distance operators to the benefits of the system.

Benefits would be a 50% reduction in the liquid fuels consumed by the SIS compared to transportation of the same freight volume by trucks, representing a 6% decline in total national oil consumption, with proportional reduction of pollution and green house gases. Fatalities for the 40,000 miles will decrease by 30% because of grade separation and reduction of truck traffic volume. The cost to American taxpayers and businesses will be as much as 60% less by providing increased rail capacity rather than increased highway capacity for trucks. Other benefits would include improved national defense security, energy security, and balance of payments, as well as increased productivity

1. INTRODUCTION

The freight rail system of the United States is in need of a broad range of improvements to bring it up to standards that will allow the system to contribute significantly to meeting the transportation needs of the future. RAIL Solution proposes that the U.S Government lead a set of policies and enact legislation as required to enable a public-private effort to modernize the American freight rail system, creating the Steel Interstate System.

The American freight rail system is mostly privately owned. We do not advocate any change of ownership. We are recommending that significant incentives be given to encourage the accelerated improvement of the freight rail system to enable it to offer very competitive services for all classes of freight, especially to enable rail to realize the new market potential for intermodal and passenger service. Failure to attract additional capital to greatly increase the bare bones construction capital that U.S. railroad companies are capable of generating will result in erosion of freight market share from the rail mode, placing far higher and untenable burdens in the long run upon taxpayers, businesses, highway users, and the entire national economy. The Steel Interstate will be developed using a combination of sustainable technologies that do not require major innovations or scientific breakthroughs - just the willingness to make the investment and use American engineering and labor to get it done.

2. STEEL INTERSTATE CONCEPT

The Steel Interstate[1] should be developed by the railroad companies undertaking phased improvement of the existing freight railroad infrastructure, starting with the location of best opportunity for improved efficiency and increased market potential for transportation services. The Steel Interstate System would utilize mostly existing rail lines that parallel existing interstate roadways, mostly choosing those paired road and rail systems that already have heavy freight traffic. The system would consist of approximately 40,000 route miles of railroad, containing a multiple-tracked high capacity system. See Figure 1 for the flow of truck and intermodal rail freight in the U.S. in 2013[2]. (Average daily intermodal service is the annual tonnage moved by container-on-flatcar and trailer-on-flatcar service divided by 365 days per year and 16 tons per average truck payload. Only rail routes with very high intermodal traffic are depicted in Figure 1.) The rail intermodal service is service on rail lines parallel to highway interstate routes. The system would, of course, need to be derived from analysis of the actual freight volumes anticipated in the future.

The Steel Interstate System (SIS) concept is a core national network of high capacity, grade separated, electrified railroad mainlines. The system would realize for railroads what the

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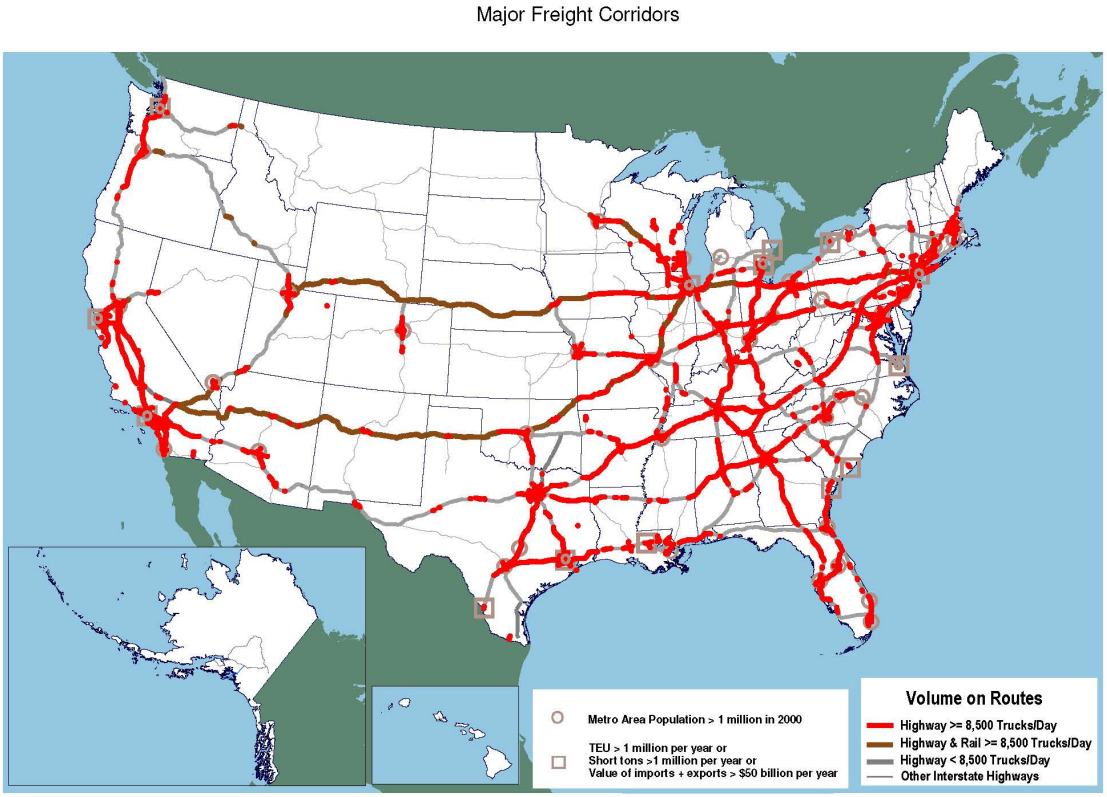
[1] The Steel Interstate System concept is described on this website: http://steelinterstate.org

[2] U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, 2013.

Eisenhower Interstate Highway System achieved for roads, and would become the backbone for movement of both goods and people in the 21st Century. Many more trains of all kinds would be accommodated, and these could move much faster, providing truck-competitive speeds for movement of freight, and auto-competitive speeds for movement of passengers. This section describes what such a rail system would look like, how the SIS would transport all kinds of goods as well as people, and how the concept fits into the evolution of rail transportation in America.



Note: Highway & Rail is additional highway mileage with daily truck payload equivalents based on annual average daily truck traffic (2011) plus average daily intermodal service on parallel railroads. Average daily intermodal service is the annual tonnage moved by container-on-flatcar and trailer-on-flatcar service divided by 365 days per year and 16 tons per average truck payload.
Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, 2013

Figure 1. Major freight corridors including both truck and rail

The many benefits of the SIS include benefits in such areas as energy conservation, national security, health and safety, pollution reduction, greenhouse gas emission abatement, economic competitiveness, energy independence, infrastructure investment, and preparing the nation to cope with diminishing oil reserves in the future.

2.1. Description of the SIS

The SIS would be high capacity, electrified, and grade separated, resulting in speed, reliability, and safe operation. These design features are depicted in Figure 2.

Figure 2. Steel Interstate Design Features

2.1.1. High Capacity.

The SIS would be high-capacity, meaning that these main lines would have at least two through tracks, so that trains can be handled in both directions without having to stop to meet oncoming trains. Because the nation's rail system has stagnated and declined over the five decades that the Interstate Highway System has been built out, many places where rail lines once featured multiple tracks today have only one, although the rights-of-way, in many cases remain, such as the one depicted near Knoxville, TN in Figure 3.

Norfolk Southern RR, former 2-track bridge over Holston River, Strawberry Plains, TN

Figure 3. Two track bridge on the Norfolk Southern north of Knoxville, TN

Modern signaling systems permit trains to operate in both directions on a single track with periodic passing sidings, but this drastically reduces capacity and fluidity of movement because trains inevitably have to stop and wait at the sidings for oncoming trains to pass. The Steel Interstate will require the capacity and speed afforded by multiple tracks. In some places a second track can be added rather easily on rights-of-way that once had two or more tracks. In other places the added track capacity will be more difficult to install, requiring new grading, bridges, and relocation of equipment.

A view of what the multi-tracked system might look like in Virginia's Shenandoah Valley is shown in Figure 4.

Figure 4. Pictorial representation of Steel Interstate System in Virginia Countryside

2.1.2. Electrified System.

Electrified means that the SIS network will be powered by electricity, provided to electric locomotives from a system of overhead wires called catenaries. A spring-tensioned device on top of the locomotive, called a pantograph, presses against the catenary wire making a solid contact for the electric current to flow. Today in North America, only Amtrak's Northeast Corridor passenger operation uses such an electrified system. Trains in the rest of the country are powered by diesel locomotives, where fuel is burned on board to generate electricity to power the locomotive's traction motors. Electrified rail operations are not technically new or

complex. Railroads throughout much of the world are powered this way today. Many rail systems in the U.S. were electrified up until the middle of the last century. Electric operation is a key part of the SIS because of certain efficiencies offered versus diesel-powered trains. But most importantly because domestically generated electric power can be substituted for foreign oil. This produces enormous economic benefits that accrue year after year and can help pay for the Steel Interstate System. Of course the system can be operated with diesel power while phasing in electrical motive power.

2.1.3. Grade Separation.

Grade-separated means that rail lines of the Steel Interstate will not cross roads and highways at grade, but will pass over or under using bridges or underpasses. This is analogous to the design advancement brought about in Interstate Highways. Rail operations will be substantially expedited by having all major grade crossings eliminated. Increased train frequencies and speeds will not adversely affect the driving public, and safety will be greatly improved by removing a major cause of vehicle/train collisions. Figure 5 shows a railroad trench used for grade crossings for roadways and also for noise abatement.

Figure 5. Railway trench to avoid grade crossings by vehicles

2.1.4. Alignment of the Steel Interstate.

Core network means that there will be a backbone of SIS-caliber railroad main lines, just as there is today a backbone structure of Interstate Highways. In both cases the core network of main routes supports and feeds traffic to and from a larger network of secondary routes. The rail system alignment would need to be improved to allow the speeds and capacity necessary; that is, curves restricting speed would need to be eliminated, and super-elevation of alignments changed to accommodate higher speeds. In addition, because of the volume of rail traffic in many towns and cities, where the old routes run parallel to the main street, rerouting on new rights-of-way may be required, just as interstate highways often bypass urban centers.

To illustrate what would need to be done, the pictures of Figures 6 and 7 show the "before" and "after" alignment.

Figure 6. Single track alignment with passing sidings before double tracking.

Figure 7. Alignment after double tracking and changing curvature

2.1.5. Speed of the SIS.

The Steel Interstate System would be designed to be capable of point-to-point average speeds of

- Freight 60 mph
- Intermodal 70 mph
- Passenger 90 mph - passenger service for high travel density
- Passenger top speed - ~115 mph

Speed is greatly improved because there is room on the SIS for through trains in both directions to run without having to stop for trains traveling in the opposite direction. Extra tracks would be constructed where needed for faster trains to pass slower ones, or to permit separate passenger train operations. Furthermore, trains can move on the core network over long distances, avoiding the congestion of yards and terminals. Trains would exit from the SIS network, just as we exit from the Interstate Highways today, to interface with local rail operations such as yards, terminals, and local industrial switching.

The SIS is not a "high speed" rail system for passenger trains; rather it is a vastly upgraded network of key rail corridors that can serve both freight and passenger trains on shared infrastructure, operating in a range of speeds up to 115 mph on shared right-of-way, with a typical low speed target of 60 mph. The Steel Interstate range of speeds is sometimes called "high*er* speed" rail, high performance rail, or highway competitive rail. (The term High Speed Rail (HSR) describes passenger trains operating on HSR-dedicated tracks at speeds of 125 mph and above. The SIS is distinguished from HSR by serving as system

for both freight and passenger trains.)

2.1.6. Reliability of the SIS.

Reliability is very important to rail operations, both passenger and freight. Today, the nation's rail system is characterized by much lower capacity compared to recent decades, and rapidly rising traffic. This combination preordains congestion, and congestion kills system reliability. The Steel Interstate will provide adequate capacity so that all trains, both passenger and freight, can move fluidly over the network without getting in each other's way or having to stop and wait. This will enable freight to be more truck competitive and move much better on just-in-time schedules that shippers want. Passenger trains will be able to maintain published schedules and not be delayed frequently by freight trains blocking the lines.

2.1.7. Capacity of the SIS.

Capacity of the key SIS corridors would be much greater than today's existing lines, primarily due to the use of multiple tracks. Trains of all kinds could be accommodated – conventional freight, unit trains, double-stack container trains, open-intermodal trains such as rolling highway (truck ferry), mail and express, perishable cargoes, and passenger trains. Railroads would not have to turn away business desiring to shift to rail because of highway congestion, driver shortages, or skyrocketing fuel costs. This is an important benefit to the nation, because from an energy security, an economic productivity, a health and safety, or an environmental standpoint, it should be national policy to maximize freight movement by rail. The SIS makes this possible. Rail traffic will have room to grow again. And every ton or passenger switched from the highway to electrified rail will lessen our chronic dependence on oil to power the transportation sector of our economy.

In a study of capacity Cambridge Systematics analyzed the maximum capacity of multi-tracked systems[3]. Their conclusions follow:

Table 1. Capacity of systems with centralized traffic control

Capacity of System with CTC	trains/day
2 track multi-type trains	75
3 track multi-type trains	133
Average Trains per day on system	104

Single-tracked systems without centralized traffic control, but with automatic block signals, have a capacity of 18 multi-type trains per day.

2.1.8. Open intermodal features.

Open intermodal system design should be considered as an option so that regional, smaller terminals can make intermodal rail more accessible and increase significantly freight that can be diverted to rail. If a large number of trains were leaving major end terminals, which will be the case in high density freight corridors, some could be made up to allow stops at intermediate locations. For example, shipments in containers of goods from China destined for a distribution center 400 miles distant

[3] 1- Table 6-1, National Rail Freight Infrastructure Capacity and Investment Study, Cambridge Systematics, Sept. 07

could be assembled into a regional train that would be stopping to unload at small intermodal terminals located at approximate 200 mile intervals along its route, which in total might be 1000 miles or more in length. The attractiveness of this system is that small trucking operators, even those operating a single truck, can easily use such a system, thus providing small operators and businesses entry into the intermodal market while still maintaining control over their loads.

There are several open modal systems that can be used. All of them feature small footprints for the terminals and load without requiring cranes. Some allow the tractor to go with the trailer. The Modalohr system used in Europe (Figure 8), or similar system, works for quick loading without cranes. While the Modalohr has the down side of having to carry an articulated platform, it has the advantage of being able to accommodate multiple loading and unloading all at the same time. This is just an example of a new type of system that should be considered.

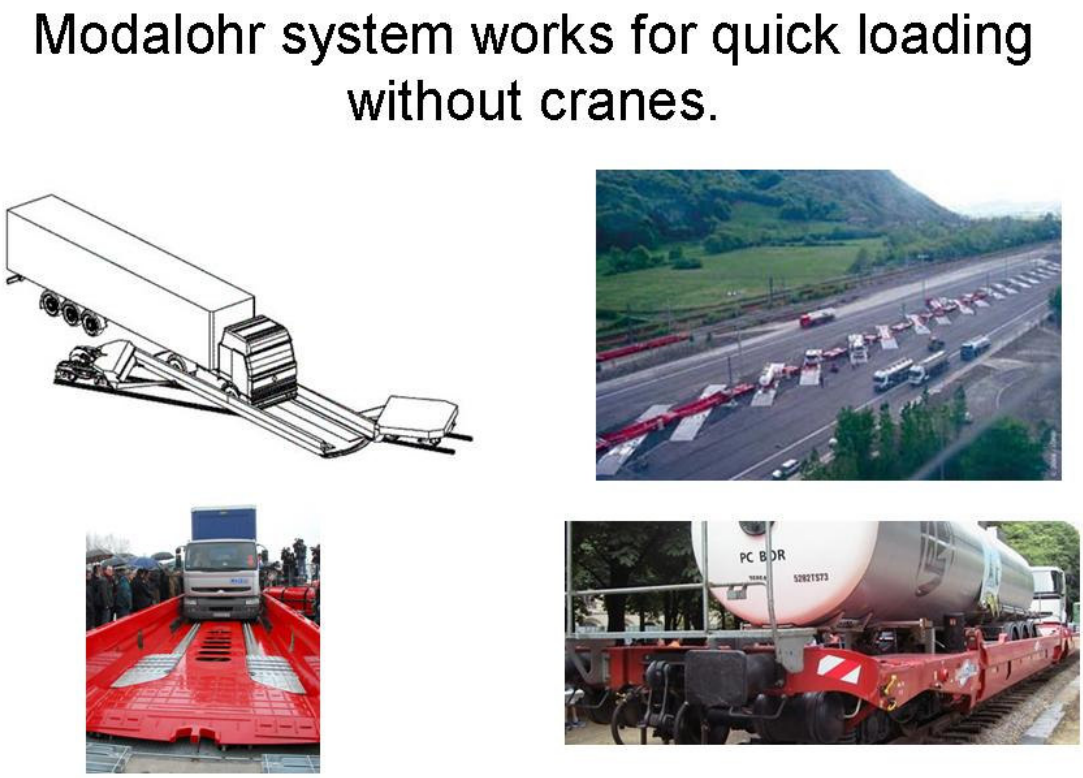


Figure 8. Modalohr System used in Europe is an example of a quick loading open modal system

Many other intermodal services have been and are being offered through open modal systems, including RoadRailer and roll-on-roll-off or rolling highway, which do not require lifting cranes and accommodate the whole tractor-trailer rig. Historically and even now, the trailer on flat car (TOFC) concept is being used, but this requires a crane for loading the trailer, thereby making loading a significant number of train cars time-consuming.

2.1.9. Rationale for the SIS.

Why do we need a national rail system for the Twenty-first Century with more speed, reliability, and capacity?

The railroad industry's capacity had been in steady decline, but capacity has increased in recent years because of selected track and signal improvements and increased capacity of railroad car and engines. Historically, however, the interstate highway network diverted large amounts of freight, especially time-sensitive and high-value products, away from the railroads and onto the highway. That method of transport is more expensive because of the capital and maintenance costs of roads relative to rail and because of the higher truck operational costs compared to rail over intermediate to long haul distances. Because of the competition from and public financing of the interstate highways, railroads have responded by abandoning many miles of light density lines, taking up double-track on many routes, removing sidings, scrapping freight cars, and otherwise making difficult downward capacity adjustments. In addition to declining business, the steady impact of paying property taxes on every mile of track and piece of rolling stock and equipment provided a further catalyst to downsize wherever possible. These events have created a system that is far from optimized to provide modern, high speed, reliable fast rail service. The SIS concept reverses these trends.

2.1.10. State of the Technology for the Steel Interstate System

The Steel Interstate System is not an invention. It is a description of how transportation policies can be crafted to take advantage of existing rail technologies—specifically along corridors of national significance. This rail technology is in place and being used elsewhere in the world. It should be in place and used here. One of the first to suggest the steel interstate idea was Gil Carmichael, who at the time was head of the Federal Railroad Administration. In 2011, he said that "Interstate 2.0, a rail-based North American transportation network, represents the new transportation paradigm for the 21st century"[4].

Technologically, rail is capable of economically moving the world's citizens and essential goods without oil, using renewable energy sources.

Electrified streetcars, light rail, subways; and commuter, intercity and high speed rail trains can transport us:

- Around city centers
- Between neighborhoods
- Across metropolitan areas
- From bedroom communities to regional work centers
- From small towns to cities
- Between midsize cities
- Across and between mega-regions
- To long-distance flights

Electrified rail can also transport *our goods*:

- In bulk shipments on unit trains

[4] http://www.inboundlogistics.com/cms/article/embracing-interstate-2-0-a-rail-based-transportation-vision/

- From domestic manufacturers to urban markets via high volume merchandise carload trains
  - From seaports to regional distribution centers on double-stack "land barge" intermodal trains
  - In long distance domestic-market lanes on double/single-stack intermodal trains
  - Between mid-range domestic markets on higher-speed, open-technology (iterations of "piggyback") intermodal trains
  - At the head end of conventional intercity and true high speed passenger trains, in airline cargo containers or other modern equivalents of Railway Express and Railway Post Office.

The Steel Interstate System is the common thread that weaves these rail services into a seamless, multi-modal, transcontinental transportation system. It would consist of a core network of high-capacity, electrified, grade separated railroad lines capable of providing all of the services above except high speed trains.

2.2. Railroads build the infrastructure

The new infrastructure would be built by the railroad companies using present system infrastructure for the major part of the eventual national route system. It will be necessary to obtain new rights-of-way in locations where existing ROW is not wide enough or does not have adequate configuration, where the system needs to be rerouted, such as away from the center of towns in many cases, or to shorten routes substantially. In some cases, inadequate bridges and tunnels restrict traffic. Some main line rail routes cross each other at grade level. These parts of the infrastructure need significant work. Figure 9 depicts the manner in which bridges restrict speed and therefore, capacity of the system.

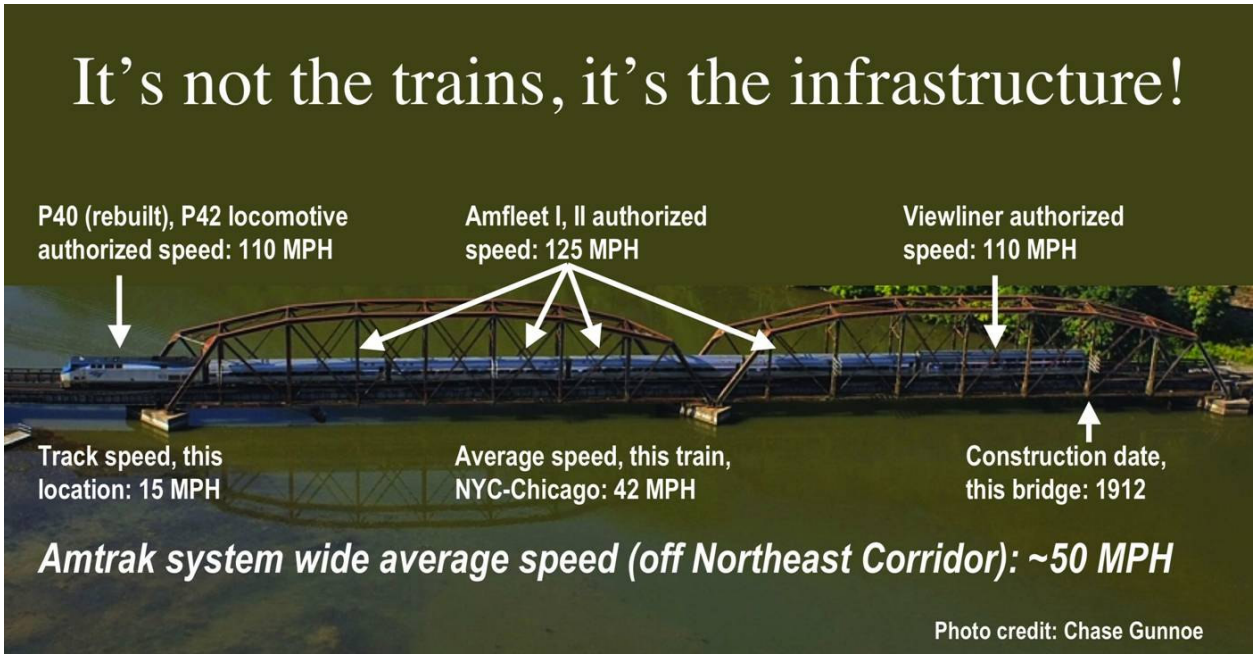


Figure 9. Such speed reduction infrastructure as depicted by this bridge would need to be replaced.

2.3. Service provisions of the Steel Interstate System

To summarize the service provisions, the ideal Steel Interstate System provides high capacity for all classes of traffic except High Speed Rail (greater than 125 mph which must be built on systems dedicated to passenger rail). The system would maintain the ability to transport bulk freight - only faster - and would offer very competitive speed and reliability for intermodal freight and passenger rail.

Examples of these trains are bulk freight (coal train) in Figure 10, intermodal freight in Figure 11, and passenger service in Figure 12.

Figure 10. BNSF Coal Train - Steel Interstate design speed- 60 mph (Photo courtesy of Doug Wertman)

Figure 11. Intermodal Freight Train - Steel Interstate design speed point-to-point - 70 mph (Photo courtesy of Doug Wertman)

Figure 12. Passenger Train- Steel Interstate design speed- 90 mph point-to-point (Photo courtesy of Peter Vanden Bossche)

2.4. Steel Interstate System should parallel key highway routes

To facilitate the optimum use of the U.S. highway and the railroad systems, the railroad must be brought up to Steel Interstate standards along high density rail lines that parallel similarly dense Interstate highway corridors, so that the two become a paired corridor. Examples of this are: 1) the Norfolk Southern paralleling I-75, I-40, and I-81 between the Mid-south region and the Northeast, 2) the CSX from Florida to Chicago paralleling I-75, I-24, and I-65, 3) the CSX paralleling I-95 from Florida to the Northeast, 4) several railroad lines (Union Pacific, CSX, and Ohio Central) in series which taken together parallel I-70 from Denver to Pennsylvania and Maryland, and 5) I-40 and BNSF from Los Angeles to Memphis.**2.5.**

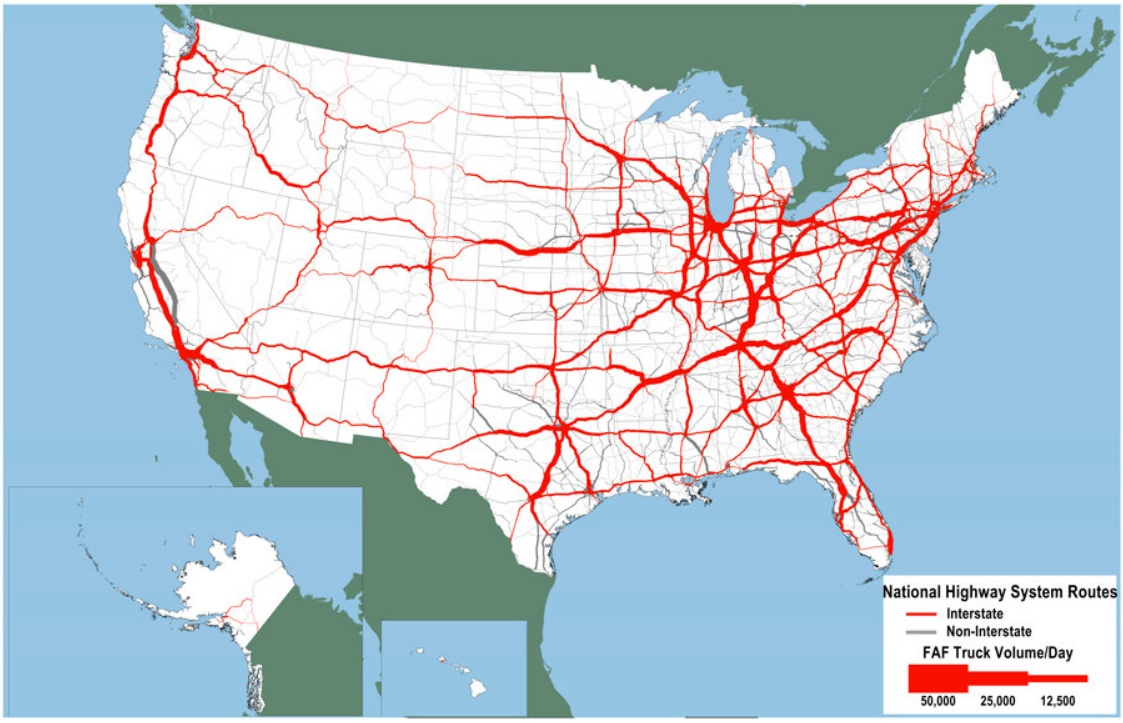
2.5. New Vision Multimodal Freight Map

A new future map should be developed that depicts the optimized use of various modes of transportation in freight corridors. What most of the planning seems to do at the present time is extrapolate what presently exists. That means, in the home region of Rail Solution (East Tennessee and Western Virginia) that the Interstate highways of the future will be carrying 20,000 to 30,000 long-haul trucks per day and the parallel rail route the equivalent of perhaps 2000 trucks in 8 trains a day. That is unsatisfactory and is going to be the expensive course for the future. But, that is where the planning is going. A new approach to a future system to be the target and objective of development should be the goal of the Federal Government and ever state and locality. **A new map optimizing the use of various modes of freight transportation in the future must be developed.**

2.6. Phased implementation

The Steel Interstate System would be phased in over a period of 25 years to obtain the complete 40,000 mile system. The phasing would give priority to high density freight corridors. (See Figures 13 and 14 for graphic depiction of long-haul truck freight volume in 2007 and 2040.) In addition to phasing the upgrading of track infrastructure, various features can also be phased, such as electrification of high density corridor to replace diesel (or gas) and passenger service, both of which are capital intensive.

Average Daily Long-Haul Freight Truck Traffic on the National Highway System: 2007



Note: Long-haul freight trucks typically serve locations at least 50 miles apart, excluding trucks that are used in movements by multiple modes and mail.
Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 3.4, 2012.

Figure 13. Average daily long haul truck traffic in 2007. (FHWA)

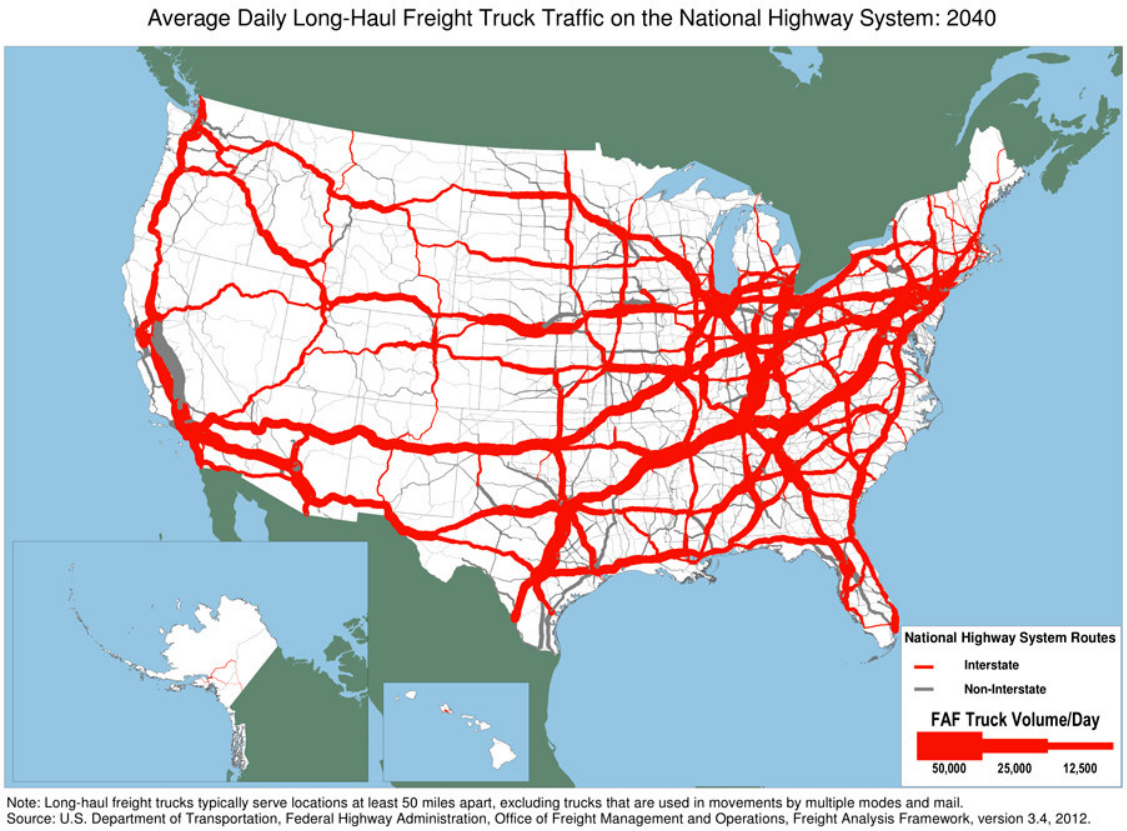
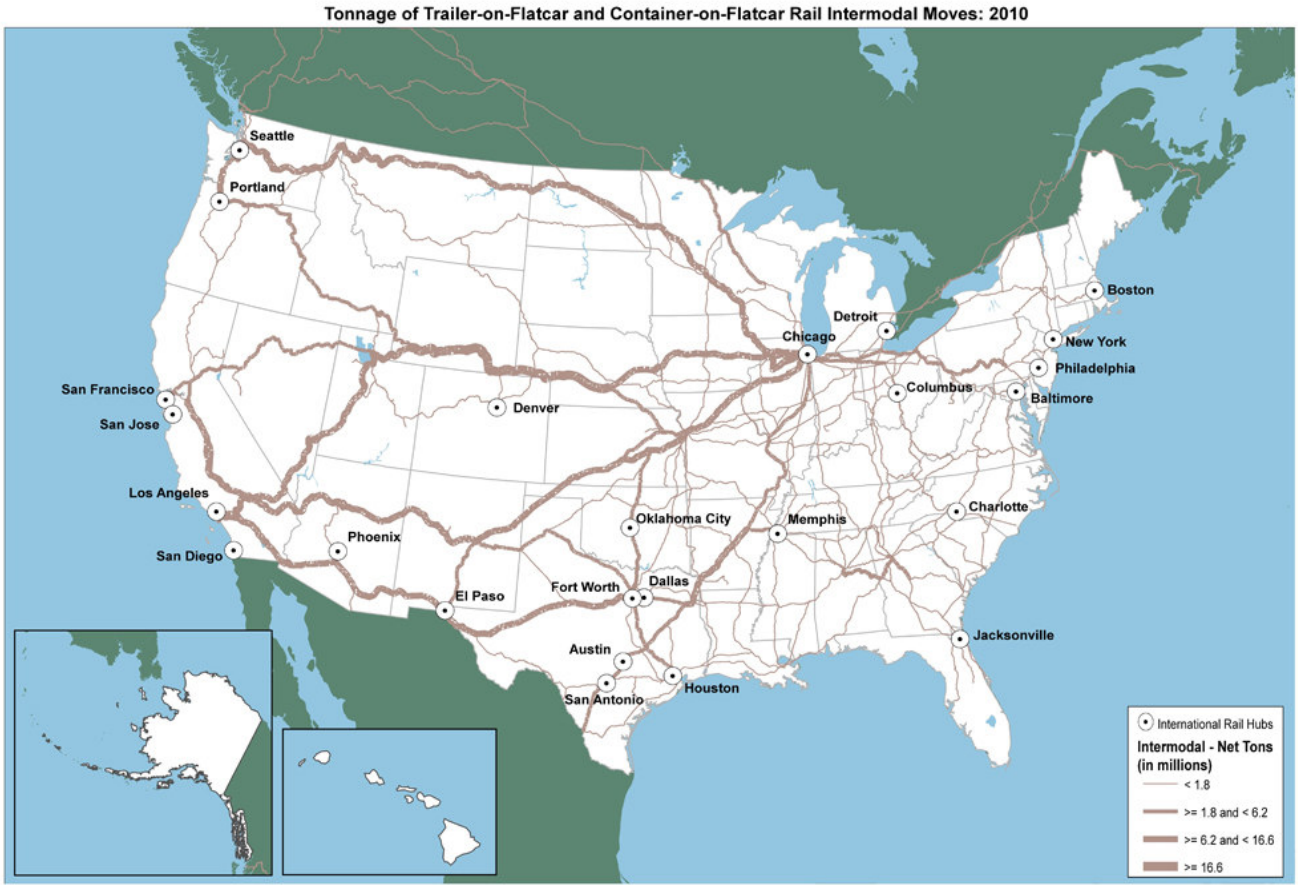


Figure 14. Average daily long haul truck traffic in 2040. (FHWA)

The task of deciding where the emphasis should be placed in phasing improvements requires an assessment of the present state of the rail system, and comparing it with the truck freight statistics, and making assessments of freight that could be switched from truck to rail, if the rail system were adequate in all corridors. However, the rail system cannot compete in many geographic areas of the country because of capacity and speed limitations. The following discussion illustrates these points about inadequate railroads in large parts of the country, where trucking is the default option. And, apparently, going by the maps of the future, the assumption of planner is that there will be no actions taken to make rail competitive for time-sensitive freight in most of the country.

The map of the Federal Railroad Administration for tons of intermodal freight (Figure 15) shows that intermodal rail east of the Mississippi River is not such a large amount[5]. This is thought to be due to short hauls, but that is not necessarily the case. Much of the lack of competition by rail is because it is not competitive in terms of capacity, reliability, and speed. Much of the eastern systems were laid out in the 1800s, when the excavation was done by animal and manual labor. For rail to be competitive and compete in intermodal transportation, the system must be

improved. Priority will need to be given to the eastern systems, where heavy dependence is now on highways.



Source: U.S. Department of Transportation, Federal Railroad Administration, special tabulation, September 2012.

Figure 15. Tonnage of intermodal rail moves in 2010 (FRA)

Some Projections for freight rail volume are given in Figures 16, 17, and 18. In Figure 16, the same data are reflected by the AAR showing again the weak flows for rail in the truck-dominated eastern United States. Furthermore, apparently there is little expectation for growth in the same region as shown in Figure 17, which shows very anemic growth of rail which the truck volume is increasing by huge quantities. Apparently, railroads do not expect to capture much of the truck freight. Why?

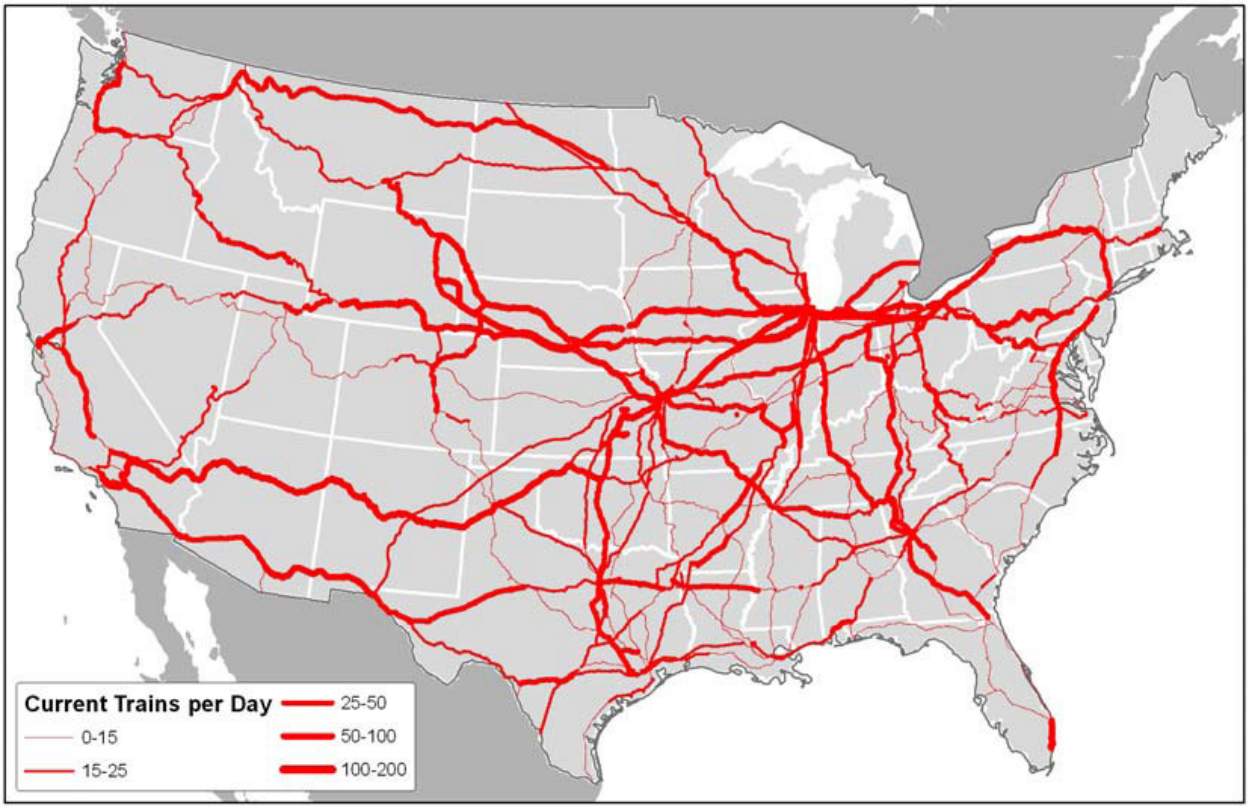


Figure 16. Figure of AAR Study showing low volumes of freight and passenger, prior to the Recession, in the Southeast (between Southwest and Northeast) by rail (Reference: National Rail Freight Infrastructure Capacity and Investment Study, AAR by Cambridge Systematics, 2007)

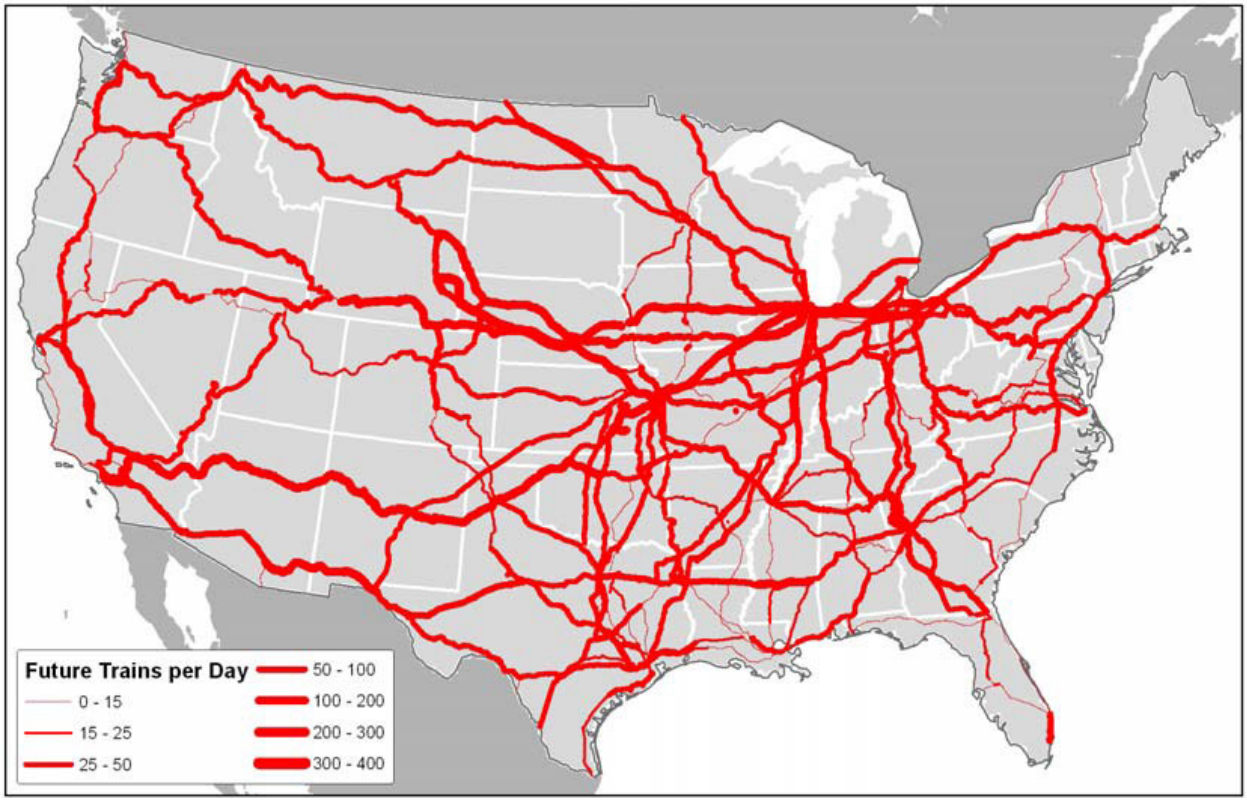
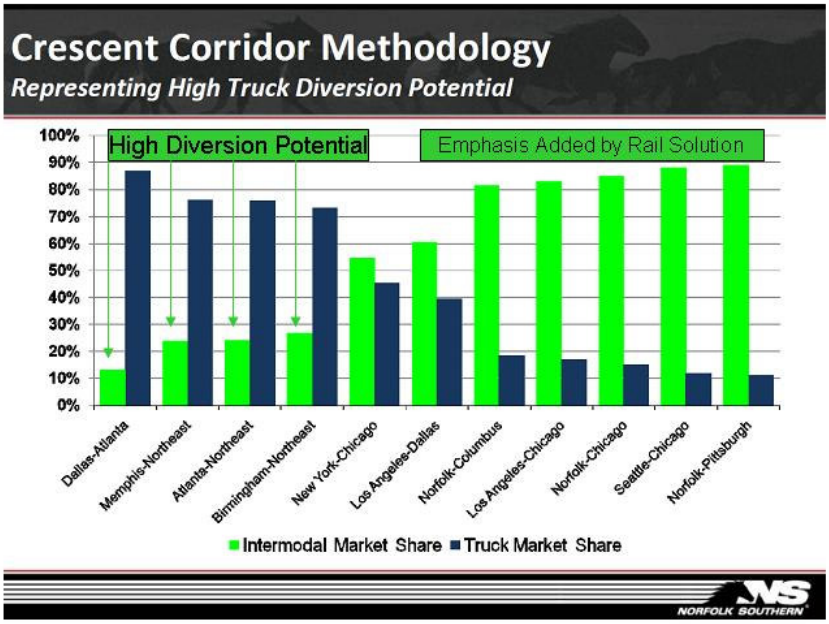


Figure 17. Graphic of AAR Study showing low volumes of freight growth on rail in the Southeast by 2035. (Reference: National Rail Freight Infrastructure Capacity and Investment Study, AAR by Cambridge Systematics, 2007)

In Figure 18, Norfolk Southern compiled figures to show freight-hauling market share between various city pairs. The comparison shows that in corridors between southeastern (and southwestern) cities and northeastern city pairs, rail averaged about 20% market share and truck almost 80%, while in the New York City-Chicago corridor rail market share is over 50%. In the Norfolk-Chicago or Los Angeles-Chicago corridors rail market share exceeds 80%. Much of this successful rail volume is containerized international port traffic. That rail infrastructure and its interface with port cargo handling facilities had to be upgraded to support that intermodal success story. Similar upgrades are vital to the success of domestic rail intermodal.

Figure 18 reinforces the fact that the penetration by rail intermodal service between the southeastern U.S and the Northeast is weak. Clearly, some areas have good competition, but others not so much. When examined in detail, what the data show are trucks occupying routes that have adequate, direct interstate highways vastly out-compete parallel archaic, slow rail corridors. For example, there is almost no predicted future traffic on the rail lines paralleling I-95 in the Southeast. Why is this? This type of data needs much more detailed examination to determine where incentives should be developed for more and better rail service. Compilations based on simple extrapolation of present truck and rail patterns, which is often practiced in studies, are not adequate analyses on which to base policy for future decades.

This graph of Norfolk Southern shows higher use of rail for intermodal freight outside SE to NE corridor*.



*Graph from Norfolk Southern-overlay for emphasis by RAIL Solution

Figure 18. Intermodal and truck proportions of packaged freight.

3. BENEFITS

Modernizing the U.S. freight railroad system to meet the standard of the Steel Interstate System will provide many benefits to American life. The Steel Interstate System will bring with it significant benefits to the economy, to the environment, to the health of the American people, and to national security. The SIS will provide the infrastructure for the addition of passenger rail throughout the country. The improvements will reduce the overall cost to transport goods and people, will reduce the cost of transportation infrastructure, and will reduce the amount of taxes that must be raised to accommodate growth of transportation requirements.

3.1. Cost of Transportation

The cost of transportation would be reduced by the implementation of the Steel Interstate System. Primarily this would be due to the avoided capital costs for additional highway lanes and replacement of worn out lanes and maintenance costs required to accommodate increased truck volume. The addition of truck climbing lanes and lanes to reduce congestion are very expensive. In addition, much of the rail infrastructure is

financed and maintained by the railroad companies, thus reducing taxes that would be paid by the American people.

The construction cost from improving 40,000 miles of interstate roads to standards that meet those of truck thruways, such as the one proposed by Star Solutions for Virginia, would be on the order of $2 trillion. Assuming that such capital costs are not needed in more than half of the U.S., the cost would be about $1 trillion (2013 dollars). The cost for engineering and constructing the national Steel Interstate System, not including rolling stock and engines, may be in the range of $500 billion. Even assuming that the $500 billion estimate is low, and that construction cost for the Steel Interstate will be $1 Trillion, still the cost to the American tax payers will be less than $150 billion, because 85% of the capital cost comes from private sources. Thus, the capital cost for accommodating future freight load is probably much less with rail; significant cost is borne by private companies; and high capital costs and additional maintenance cost is avoided by the public.

The diversion of trucks to rail will enable the avoidance of additional costs for maintenance of the roads. A study done for the Commonwealth of Virginia showed that in Virginia, heavy trucks on I-81 are being subsidized by the public at a rate of by $.086 per mile for maintenance alone.[6] Based on traffic volumes, additional truck-induced maintenance cost, not paid by trucking, in Virginia on I-81 would be approximately $50 million annually. At projected 2035 truck traffic volumes and assuming no rail improvements, the subsidy to the trucking industry for maintenance on I-81 in Virginia increases to $70 million annually. For national trucking, the maintenance costs, not paid by the trucking industry, will be a much larger figure, perhaps on the order of $5 billion. Depreciation costs for truck contribution to total replacement of worn-out highway infrastructure are additional to this cost.

For medium to higher density rail passenger routes less than 500 miles, passenger rail should be cheaper than automobile travel or plane.

3.2. Economic Benefits and Impact

Economic benefits accrue to the railroads, the trucking industry, the logistics industry, the users of transportation (all businesses and people), and the economy in general.

3.2.1. Railroads

The railroads are limited in business sectors that assure growth. Some sectors may decrease, such as coal volume. Where growth in rail business volume can be increased is in intermodal transportation of consumer goods and packaged freight and in passenger rail. However, to realize the potential, the railroads much become more competitive in speed, reliability, and overall performance, including cost. For example, Norfolk Southern has the potential for up to 30 intermodal trains per day on the western part of their Crescent Corridor (paralleling I-40, I-75, and I-81), if the company can get 60% or more of the longer distance trucks diverted to their system. This number would grow to 60 by 2035. Right now, in 2013, the NS is

[6] When environmental and health and safety costs were included, Virginians are subsidizing every truck on I-81 at the whopping rate of more than $.33 per truck mile traveled. All figures in 2010 dollars. "The Virginia Statewide Multimodal Freight Study," Cambridge Systematics, Final Report 2010, Page 34 Table 1.6, Selected Monetized Transportation Benefits.

operating one train each way on this same section of their Crescent Corridor. These larger numbers cannot be attained now because the Crescent Corridor is slow and capacity limited--- in need of reconstruction to Steel Interstate standards. But, apparently the expectations of Norfolk Southern for this part of their systems are low. The line from Knoxville to Northern Virginia (all East Tennessee and Western Virginia) are not even identified in the referenced Cambridge Systematics AAR Study as a primary future rail routes, although the route is the shortest route from Birmingham or Memphis to Harrisburg. (Note that railroad companies designated their primary systems utilized in the Cambridge Systematics report.)

With the Steel Interstate System, passenger rail can be offered for operation on a system that is fast, reliable, safe, and comfortable. The speeds of passenger trains will be fast enough to be very desirable for short to intermediate distances. The Steel Interstate will make passenger rail a reasonable alternative for most small to large cites throughout the United States. The fact that trains can be operated profitably and provide revenue for freight railways has been proven recently in Virginia with the success of trains operated by Virginia Rail under contract with Norfolk Southern and Amtrak. The Steel Interstate will provide an alternative to short flights, such as from Knoxville to Atlanta, or to driving round trip. Wick Moorman, President of Norfolk Southern, says that, if you want passenger rail, cover the operating costs, the liabilities, and the extra capital[7]. We would add also a reasonable profit.

3.2.2. Trucking industry

The trucking industry will be enhanced with the Steel Interstate System. The rail system will never replace the use of trucks for short distance and for delivery to and from the doors of businesses and homes. What it will do is change the mode of operation for the drivers. Most long distance moves of trailers, trucks, or containers would be by rail to local intermodal terminals. The drivers for trucks to and from these terminals would be able to complete their round trips in a day or much less. This would help the trucking industry for lowering transport cost and making driving profession more attractive, addressing the national driver turn-over rate and shortage. However, the Steel Interstate System must be implemented in such a way to assure that it is as fast as highways, as reliable in terms of on-time delivery, and is not obstructed by interface problems between rail lines and roadways.

3.2.3. Logistics industry

The logistics industry is now coping with a very complicated network of roads and rail lines with widely varying efficiencies and performance. The Steel Interstate will help bring order and higher level capacity and performance to the freight transportation network, reducing inventories and supporting just-in-time delivery goals.

3.2.4. Transportation users

Users of transportation services will see better service overall from various elements of the system. Because of enhanced efficiency, transportation costs would be less than they would be without implementation of the SIS. Elderly and disabled citizens

[7] Paraphrase of public comments of Wick Moorman in a speech to the Joint Rail Conference, Knoxville, TN, April 17, 2013

and mid-distance business travelers will especially benefit from an extended, affordable passenger rail service alternative to auto and air travel.

3.2.5. The Economy of the United States

Electrified, the Steel Interstate will be more efficient and will significantly reduce consumption of oil[8]. As oil consumption for moving freight declines, so do national oil import requirements, allowing more money to remain in the U.S. growing our economy and improving our balance of payments. Rail service options will increase transportation productivity, and since transportation is a significant component of every American product, transportation productivity increases will improve productivity across the national economy. The rail rights of way will also be used to carry electricity by high efficiency technology, connecting regional grids all along the Steel Interstate and transmitting energy generated by remotely sited wind, solar, hydro, and sustainable biomass to market. Where an individual wind turbine or solar panel farm's output is variable, the more arrays that get connected over a larger area, the more reliable/predictable the overall power production becomes. This is how sustainable power technologies can be harnessed to produce a system capable of meeting the base and peak demands we currently have. And, what about high speed, high capacity data networks too? We need more bandwidth and higher speeds, and the Steel Interstate would enable access all over the country.[9]

3.2.6. Business and regional development

The SIS should help stimulate business along it routes, rebuilding the economies of older "fly-over" cities and attracting businesses internationally. Why? Any business within a distance of 100 miles or even more of a Steel Interstate rail line will have access to the world through a modern, fast transportation system. Business imperatives such as fulfilling production input materials and components and shipping products will be fast, extremely reliable, and reasonably priced.

Development will be possible around regional terminals located at distances of perhaps 150 to 200 miles apart. This is a different idea from what exists on American railroads today, where terminals may be as much as 500 to 1000 miles or more apart. Businesses will tend to locate as close to comprehensive rail and highway transportation as possible.

3.2.7. Rural development implications

The Steel Interstate System will bring excellent rail service to America through reasonably close access to freight terminals and, when provided, close access to passenger rail. For example, in Knoxville, the closest intermodal rail terminal on the Norfolk Southern is in Atlanta or in Birmingham. The closest intercity passenger rail is in Atlanta, Cincinnati, Greenville, SC, Charleston, WV, or Memphis. Access to freight and passenger service by rural Americans depends on the development of small, open access terminals and passenger service where volume is sufficient.

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[8] Alan Drake, "A 10% reduction in America's oil use in 10-12 years", http://www2.energybulletin.net/node/16682

[9] Bruce McFadden Blog, http://www.dailykos.com/story/2012/09/02/1127109/-Sunday-Train-Powering-the-Steel-Interstate

To illustrate this point, Figure 19 shows an overlay of the part of the Crescent Corridor of the Norfolk Southern over the legislated service area of the Appalachian Regional Commission. The Valley Route parallels the backbone I-40, the I-75, and I-81 highways, all of which have important feeder Interstate highways, such as I-59, I-26, and I-77. With terminals properly located, most of this region could be served by both intermodal and passenger rail from this part of the Crescent Corridor (the Valley Route).

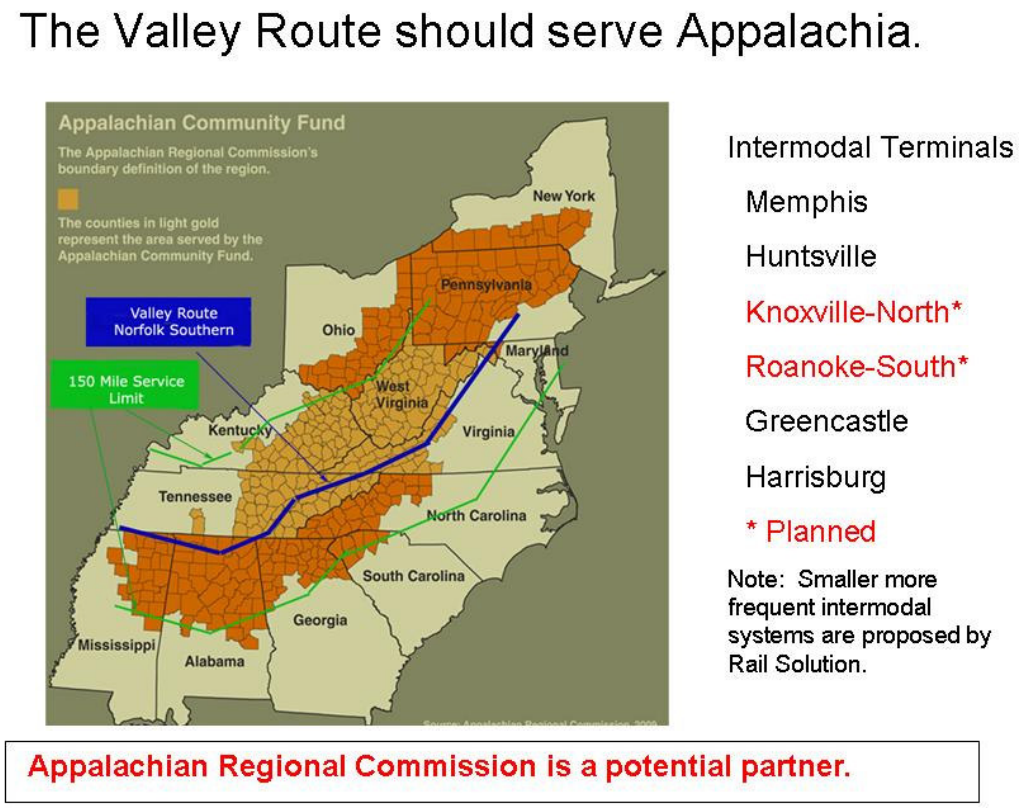

Figure 19. Appalachian service region for the Valley Route of the Norfolk Southern Railroad

3.3. Social Benefits

Social benefits of the Steel Interstate System included increased transportation safety, improved heath, more transportation choices, and less crowded highways.

3.3.1. Safety

Improved safety comes from several features and effects of the SIS. With fewer grade crossings, there will be fewer deaths and injuries and less damage from crossing accidents. With reduced truck volume on the highways, there will be fewer deaths and injuries and less costs from auto-truck collisions. With SIS rail service there will be no economic benefit to increasing the size and weight of interstate trucks which would consequently increase the number and severity of truck

accidents. With the use of passenger rail, there will be a reduction in passenger deaths (0.8 deaths per 100 million passenger-miles vs. 0.03 for rail). Statistics on U.S transportation fatalities are given on the Steel Interstate website[10]

3.3.2. Health

Health of the American people will be improved, especially in areas already challenged by emissions from trucks, trains, and fossil-fueled power plants (e.g. Knoxville, TN). Reduced use of diesel for transportation would lower human exposure to smog-inducing nitrous oxide and to particulate emissions responsible for increased asthma attacks and other respiratory problems. Health benefits are covered in detail at the Steel Interstate website[11].

3.3.3. More transportation choice

People and businesses will have more modal transportation choice, especially for passenger and intermodal service. National productivity will be enhanced through increased transportation competition and lower transportation prices.

3.3.4. Less crowded highways

A not so intangible benefit is reduced highway congestion, a huge social benefit. Many recent studies have sought to quantify the cost to the driving public and businesses of time lost due to congestion delays and failing just-in-time reliability.

3.4. Environmental

3.4.1. Air (Greenhouse gases)

The Steel Interstate will reduce emission of greenhouse gases by substituting: 1) the higher efficiency of rail over trucks for transportation of freight and 2) the higher efficiency of electric locomotive power in place of diesel power. Rail is approximately 10 times more fuel efficient than heavy trucks in transporting freight over mid-long distances. The efficiency of electric power advantage (approximate 2.75 over diesel) comes from regenerative braking and the higher efficiency of the electrical generation for the electrified system. We calculate that the total effect of the implementation of the Steel Interstate on 40,000 miles is estimated conservatively would be a reduction of approximately 50% of greenhouse gases that would be produced by trucks that would be required to move the same freight. That reduction of the impact of exhaust gases is important is substantiated by statistics from the Tennessee Department of Transportation. See Figure 20.

[10] Rail vs. Auto and Truck Safety Record, http://steelinterstate.org/topics/rail-vs-truck-and-auto-safety-record
[11] Air Quality and Public Health, http://steelinterstate.org/topics/air-quality-public-health

TDOT Go.

Tennessee VMT Annual Growth Rates

Vehicle Type	1990-2005	2005-2025
Light-Duty Gasoline Vehicle	1.97%	1.99%
Light-Duty Gasoline Truck	4.64%	1.99%
Heavy-Duty Diesel Vehicle	**2.95%**	**3.19%**
Heavy-Duty Gasoline Vehicle	0.12%	1.22%
Total VMT	**2.80%**	**2.15%**

Figure 20. Annual growth rates in Vehicle Miles Traveled (VMT), actual and estimated, by the Tennessee Department of Transportation.

Vehicle Miles Traveled growth rates of heavy duty diesel vehicles are 50% greater than for all other vehicles. Already many areas of the country (including Knoxville, Chattanooga, Birmingham, the Northeast, and Southern California) exceed the standards for an acceptable atmosphere from the standpoint of particulate matter in the atmosphere, including that from diesel exhaust. See Figure 21.

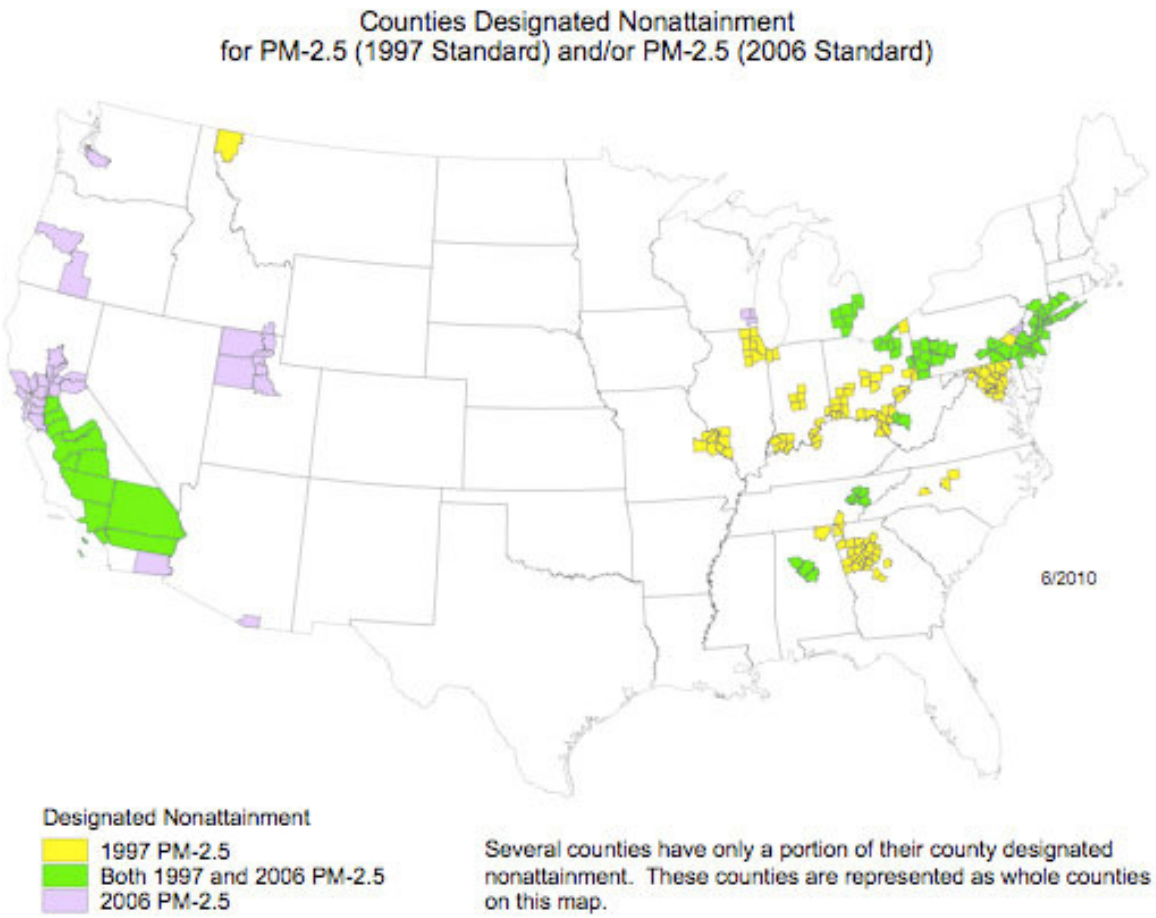

Figure 21. Counties designated non-attainment for particulate matter (PM-2.5)

3.4.2. Land Impact

The footprint of rail is actually considerably smaller than that of highways, so the impact on use of land is less for rail. Thus, providing for more of the transportation by rail will reduce the impact on land use. In many cases a second or third track can be added to existing railroad rights of way with no new land needed. This contrasts sharply with the voracious requirement for real estate where expanded highways are relied on for new freight capacity.

3.4.3. Water

Because trains have a far better safety record hauling toxic substances than trucks, risk to water contamination from crashes and spills drop significantly when those same materials are carried by trains.
Further, there is considerable and increasing damage to underground water resources and surface streams, rivers, lakes and oceans. From headline grabbing crude oil spills--Exxon in Prince Edward Sound, BP in the Gulf--to daily mishaps all along the "stream" of production--drilling, transporting, refining, and to the gas pump and oil change, our precious water supply and its living creatures are at risk.

Water quality damage can be reduced significantly along this supply chain by diverting freight and passenger traffic to the electrified Steel Interstate.

3.5. Government

Besides all of the other advantages realized in various areas, the Steel Interstate provides some benefits that might be classified as benefits to the government, although the benefits are accrued to Americans, as a people.

3.5.1. National Security

The Steel Interstate System will provide a reliable, modern backbone to serve as a backup for any time that a national emergency calls for increased production and transport of very much larger volumes of material and personnel. The Steel Interstate, makes the U.S. much less dependent on oil in times of national emergency. Transportation could still be carried out by rail with only a portion of the oil required by trucks. Reducing dependence of the transport sector on oil reduces the vulnerability of the economy to petroleum price spikes and production disruptions.

3.5.2. Encouragement of competition

The Steel Interstate System will assure more active competition in the transportation arena. Everybody wins with this solution: the railroads, the trucking industry, the logistics industry, businesses, and the people. The government does its job by providing the encouragement and support for public-private partnerships that will enhance productivity and competition across the economy.

3.5.3. Reduction of government infrastructure

The Steel Interstate System will enable the federal and state governments to reduce the amount of highway infrastructure required and thus enable reduced outlays for transportation capital projects and maintenance. Clearly, encouraging the expansion of private, for profit, tax-paying railroads offers a better return on investment than sinking more public funds into highway infrastructure and maintenance to accommodate freight mobility growth. We believe that life-cycle costs for private rail infrastructure are lower than the public's investment in equivalent highway infrastructure required to satisfy future freight transportation demands. Both the interstate highway system and the railroad system are showing limitations that will have to be fixed. Railroads are still using infrastructure largely built decades – and for some routes, even a century – ago. This needs to be recognized when government policies are considered for having railroads shoulder more of the transportation load of the future, especially intermodal freight and passengers.

4. FINANCIAL PLAN

Financing the aggressive improvement called for by the Steel Interstate standards is challenging because it calls for outlays of capital that are considerably beyond what the rail industry currently can muster. In general, some of capital required will need to be financed on a long term basis (25 to 30 years)

4.1. Budgetary Estimate for the National System (40,000 miles)

Rail Solution has prepared a budgetary estimate, or an estimate of the order of magnitude of the cost of the total Steel Interstate- 40,000 miles of multi-tracked, grade-separated, higher speed rail (top speed 115 mph). This estimate is based on factors and costs compiled from various literature sources to estimate the cost of a 1000 mile prototype system (the Valley Corridor), which is discussed later in this document.[12] The cost per mile was then applied to the complete 40,000 mile system. The total estimate on for the National system would be $535 billion.

Table 2. Summary of budgetary estimate for the National Steel Interstate System

	$ Billions
Rail Trackage	275
Added Railroad Right of Way	30
Buildings and Stations	10
Grade Crossings	35
Electrification (Optional)	115
Engineering and Project Management	70
Total for National Steel Interstate System	**$535**

The outlay for the U.S. railroads was approximately $15 billion for capital expenses. However, much of the capital expenditures were for replacement of equipment and infrastructure. The portion that was allocated to improving capacity and speed would be lower - perhaps one-half of the capital outlay (on the order of $7 to $8 billion). If one chooses a 25-year period for completing the Steel Interstate, the outlay must be on the order of $20 to $40 billion per year. So, the deficit in capital that must be made up is in the range of $13 to $33 billion per year.

4.2. Financing

Financing the Steel Interstate System is problematic when the present tax base, practices, and laws apply. Still, the mix of financing instruments that might be used to remedy the financing problem is wide, indeed. Corporate loans, leases, bonds, and equity investment are all of possible use. Government direct subsidy and payment for certain categories of capital expense would seem appropriate. We advise that the government structure the development of the Steel Interstate so the government underwrites the cost of what might be called social benefits- benefits more closely associated with the desires and well being of the public and the business community. Thus, government would pay for elimination of grade crossings at public roads, rights-of-way to relocate rail lines away from urban development and to improve urban street traffic flow, incremental investment devoted to facilitating passenger travel, and for participation in feasibility studies of regional corridors and routes. Private capital underwrites the direct costs of rail rolling stock and infrastructure, such as multiple tracking and alignment changes, bridges, widened rights-of-way, signaling, electrification, and design and engineering costs for those.

[12] RAIL Solution is seeking support for a preliminary engineering study of an SIS prototype in the Valley Corridor. This study will supply firm cost/benefit estimates for implementing SIS infrastructure and technology on the ground across the nation.

We have looked at two cases for financing that represents the extremes of how to finance the improvements required to build the 40,000 mile Steel Interstate. The extremes are: 1) High government support financing and 2) High private investment for financing. Those are discussed subsequently.

4.2.1. Government guaranteed support program alternative

Table 3 shows a split of financing the National Steel Interstate based on a large amount of government support though loan guarantees.

Table 3. Allocation of Cost to Partnership Entities (Government Guaranteed Financing)

	Percent	Total $ Billions	Annual $ Millions
Grants from Federal Government	1.7	9	364
Loans guaranteed by Federal Government	48.6	260	10,400
State Governments (90 percent from Fed. Gov.)	8.1	43	1,733
Local Governments (80 percent from Fed. Gov.)	2.0	11	428
Railroad Company Resources	7.8	42	1,669
Private Capital (bonds)	30.1	161	6,441
Private Capital - direct invest	1.7	9	364
Total for National Steel Interstate System	**100.0**	**$535**	**$21,400**

In this financing arrangement, the private capital pays for 88 percent of the Steel Interstate capitalization. The government, mostly the federal government, pays for 12 percent. Legislation would be required, at a minimum, to increase availability of targeted loan guarantees and for Federal grants primarily for feasibility and preliminary engineering analyses.

4.2.2. Government Corporate tax incentive program for the Steel Interstate System

The second arrangement, which is preferred by Rail Solution, is for the preponderance of capital to be raised privately without government guarantees. The allocation of costs is as given in Table 4.

Table 4. Allocation of Cost to Partnership Entities (Private Financing Incentives)

	Percent	Total $ Billions	Annual $ Millions
Grants from Federal Government	1.7	9	364
State Governments	8.1	43	1,733
Local Governments	2.0	11	428
Railroad Company Resources	7.8	42	1,669
Private Capital - equity investment	80.4	430	17,206
Total for National Steel Interstate System	**100.0**	**$535**	**$21,400**

Government incentives such as those listed below will be required to assist in attracting private capital.

4.2.3. Changes in treatment of profits held in overseas accounts by U.S. corporations. Many estimates put the profits held by U.S. corporations in overseas accounts at levels of $2 Trillion and growing by perhaps $250 Billion per year. So, about $50 Billion per year is being avoided in taxes and $250 Billion per year are available for increased investment. The $2 Trillion is already invested somewhere. If the practice of allowing corporations to defer taxes on profits were ended, then there would be $50 Billion a year in tax revenue that could be invested in transportation infrastructure. If the practice is not ended, then another remedy is to require that, on an annual basis, 50% of the profits held in overseas accounts be invested in U.S. transportation infrastructure projects. That would yield $125 Billion per year invested in transportation infrastructure. This range of capital ($50 B to $125 B approaches the level of the U.S. transportation budget. Of course, neither of these measures deals with the present $2 Trillion in overseas accounts. Companies should be required to, over some reasonable period, invest these profits in U.S. transportation infrastructure or else pay the full tax. Some aspects of this idea are discussed in this reference by independent researcher Alan Drake.[13]

4.2.4. Tariff on imports for transportation infrastructure

The U.S. could impose a tariff on imports if the tariff is used in the economy to decrease the imbalance of in international trade for the U.S. The U.S. is a net importer, so it would qualify under World Trade Organization rules. Increasing the efficiency of the transportation system would make the U.S. more efficient and productive, making American goods more competitive in the world market. Also, the implementation of electrification will directly reduce oil import volume, directly improving the U.S. balance of payments. A number of products could be exempted, such as food products, pharmaceuticals, and medical devices. The imbalance in 2012 was over $700 billion.[14] The imports for 2012 less an allowance for the exempted products ($700 million) would be approximately $2 trillion. If an import tax of one percent were applied to this amount, the tax raised would be $20 billion, a number within the range required annually for financing the Steel Interstate System.

This method of financing is also discussed in more detail by Alan Drake.[15] In the case of implementing the tariff on imports, the U.S. Government on behalf of the citizens would take an equity interest in rail companies. Legislation would be required to set up an authority with the power to invest directly in rail companies, or indirectly through underwriting leases for equipment and facilities. This public interest could be sold off to private railroad shareholders over a period of years.

4.2.5. Tax credits for investment by railroads in speed and capacity increases.

Another way to incentivize the building of the Steel Interstate System is to enact tax credits to railroad companies and other companies for investing in expansion of rail corridor infrastructure to meet Steel Interstate standards. The railroad companies are already investing back into their systems a very high percentage of their

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[13] Alan Drake, http://oilfreetransport.blogspot.com/2012/06/building-oil-free-cross-country.html

[14] All foreign trade statistics from U.S. Census Bureau, http://www.census.gov/foreign-trade/index.html

[15] Alan Drake, http://oilfreetransport.blogspot.com/2012/06/that-fellow-behind-tree.html?view=magazine

earnings. But, tax credits would increase the level of investment, and companies not even involved in the rail industry would be attracted to invest in Steel Interstate corridors with excellent future potential. Improved corridor facilities would be leased back to the railroads.

4.2.3. Other issues on financing and financial management

Other issues that are involved with constructing the Steel Interstate that will need to be examined include:
1) Selection of location and division of finances on grade separation projects,
2) State ownership of rail lines where there is not an entity for developing a Steel Interstate route in a corridor that is designated for rail improvements to Steel Interstate standards. For example, there is an inadequate and incomplete line from Nashville to Knoxville, where there is no railroad existing for part of the route. This route parallels I-40 which has a heavy flow of truck traffic, but no close rail line for diversion of trucks from I-40.
3) Eminent domain issues could arise where authority is not clear.
4) Passenger service guarantees regarding capital costs, operating deficits, and liability for operations will need resolution.

5. ACKNOWLEDGEMENTS

This work is the result of efforts of RAIL Solution, a not-for-profit, 501(c)(3) organization, that studies and advocates modernization of the North American Rail systems, primarily by implementing the concepts of the Steel Interstate System. Individuals contributing to this work are David Foster, Executive Director (Salem, Virginia); Michael Testerman, Vice Chairman (Richmond, VA), and directors of RAIL Solution, Foster Robinson (West Linn, Oregon), Rucker Keister (Lynchburg, VA), A. L. (Pete) Lotts (Knoxville, TN), Ken Marsh (Kingsport, TN), Bob Peckman (Roanoke, VA), Jeff Price (Wycombe, PA), Rees Shearer, Emory, Virginia), Steve Sondheim (Memphis, TN), and Barbara Walsh (Lexington, VA).