Industry Study Report

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Industry Study

Final Report
Transportation Industry

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Transportation Industry

ABSTRACT: The United States' (U.S.) historical economic success was predicated on its investment in its transportation system. The country's governmental and industry leaders understood the economic potential the U.S. possessed due to its massive supply of natural resources and vast coastal access and worked with vision to invest in and develop an instrument to exploit this potential. This mechanism was an unprecedented modern transportation system that grew and evolved as technology allowed and afforded the U.S. an unparalleled asymmetric advantage over its foreign competitors. Today this nation puts its proverbial finger in the dike to keep this aged system afloat as opposed to investing strategically in an integrated and synchronized network capable of preparing the nation for the economy of the future. Funding streams have deteriorated, planning is disjointed and all the while the foreign competition has followed a chapter out of the U.S.'s history books and made the strategic infrastructure investments necessary to compete globally. This paper provides a strategic assessment of the U.S.'s contemporary freight transportation infrastructure by mode, discusses the impacts of the shortsighted abandonment of both government and industry to maintain this critically enabling system, and offers a number of recommendations to empower this nation to reclaim its economic greatness founded on transportation infrastructure.

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PLACES VISITED

Domestic:

American Association of Railroads and Short Line Railroads (Washington, DC)
American Trucking Associations (Arlington, VA)
APM Terminals (New York, NY)
Area Maritime Security Committee (New York, NY)
Delegation of the European Union to the United States of America (Washington, DC)
FAA Air Traffic Control System Command Center (Warrenton, VA)
Federal Highway Administration (Washington, DC)
Federal Railroad Administration (Washington, DC)
Hampton Roads Transit (Norfolk, VA)
J.B. Hunt Transport, Enterprise Solutions & Government Services (Washington, DC)
Maritime Administration (Washington, DC)
Maersk Line Limited (Norfolk, VA)
MITRE Aviation Idea Laboratory (McLean, VA)
National Highway Traffic Safety Administration (Washington, DC)
National Transportation Safety Board Training Center (Ashburn, VA)
New York Harbor (New York, NY)
New York Maritime Association (New York, NY)
Norfolk Southern Railroad (Norfolk, VA)
Norfolk Southern, Croxton Yard (New York, NY)
Norfolk International Terminals, Inc., Port of Virginia (Norfolk, VA)
One World Trade Center (New York, NY)
Pipeline & Hazardous Material Safety Administration (Washington, DC)
Research & Innovation Technology Administration (Washington, DC)
Shell Pipeline Company LC (New Orleans, LA)
Transportation Research Board (Washington, DC)
United Parcel Service Freight Headquarters (Richmond, VA)
U.S. Army Corps of Engineers, New Orleans District (New Orleans, LA)
U.S. Coast Guard Sector New York (Staten Island, NY)
U.S. Department of Transportation (Washington, DC)
U.S. Merchant Marine Academy (Great Neck, NY)
USNS *Gordon* (T-AKR-296) (Baltimore, MD)
The Vane Brothers Company (Baltimore, MD)
Wells Fargo-Wachovia Securities (New York, NY)

International:

European Container Terminals (Rotterdam, The Netherlands)
FEDEX Distribution Facility (Cologne, Germany)
Flower Auction Flora Holland (Rotterdam, The Netherlands)
Maersk (Rotterdam, The Netherlands)
Netherlands Board of Inland Waterways (Rotterdam, The Netherlands)
Port of Duisberg (Cologne, Germany)
Rotterdam Port Authority (Rotterdam, The Netherlands)
Van der Vlist Special Trucking (Rotterdam, The Netherlands)
598th Transportation Brigade, SDDC (Rotterdam, The Netherlands)

INTRODUCTION

Since its discovery by resource-strapped Europeans, the land that would become the United States has offered an impressive economic advantage, first to the Europeans, then the young upstart colonists who elected to form a new nation. The U.S. possessed an impressive array of natural resources, but more importantly it provided a natural ease of accessibility to these resources. This new land had deep-water coastal access, navigable rivers, and vast territory that had been traversed by the natives who inhabited it. This accessibility afforded the young country the opportunity to quickly harvest resources and transport them for refinement, development or shipment to foreign ports where they could be traded for needed currency. The U.S. parlayed these advantages to swiftly grow its raw economy in the rapidly globalizing world; however, it was massive investment in modern transportation systems that transformed the country into the economic powerhouse that sets the pace for the rest of the world today.

In 1817, the Erie Canal was constructed, connecting ports on the Atlantic Ocean to markets in the Midwest via the Great Lakes. For a $7 million investment, the cost of transporting a ton of goods from Buffalo to New York City was reduced from $100 to $10 thereby increasing demand on local farmers' produce due to improved access to metropolitan markets.[1]

In 1827, the first U.S. railroad, the Baltimore and Ohio, was formed in an effort to provide the City of Baltimore rapid access to the frontier.[2] This new invention increased the speed and endurance of the transportation system, further growing the U.S. economy by getting goods and people to markets in a more timely and reliable fashion.[3] This investment has evolved over the years from a 9,000-mile rail system in 1850[4] to the 140,000-mile juggernaut it is today; and while costly ($24.5 billion invested annually),[5] it contributed $265 billion in annual economic activity and supported 1.2 million jobs in 2012 alone.[6]

The Federal Aviation Act of 1946 was the first legislation to specifically deal with civil airport investment. The Federal government provided $500 million[7] to help "local governments build the necessary infrastructure to accommodate the growth and demand of the aviation industry."[8] This investment took a diffuse, fledgling civil aviation capacity and strengthened it into a nationally organized and structured aviation industry, helping develop a nascent tourism industry and modernize the nation's ability to swiftly transport post and cargo across the nation.

In 1955, President Eisenhower wrote Congress regarding his intent to transform the Union from "a mere alliance of many separate parts" into a highly networked nation via a national highway system that would "connect by routes, as direct as practicable, the principal metropolitan areas, cities and industrial centers, serve the national defense, and connect with routes of continental importance in Canada and Mexico."[9] This visionary maneuver proved to be one of the greatest catalysts of economic success this nation has ever enjoyed and has provided a rate of return to the U.S. economy of $6 for every $1 invested.[10]

The sum of these remarkable investments empowered U.S. manufacturers and farmers with a strategic advantage by getting goods to market faster, safer and more reliably than foreign competitors. However, this advantage has eroded as U.S. strategic investment in infrastructure has dwindled over the last several decades resulting in transportation choke points and economic burden. The American Society of Civil Engineers' (ASCE) 2013 Infrastructure Report Card[i] highlighted the reality of this disrepair and graded the U.S. transportation infrastructure as a D+.[11] The ASCE forewarned that without an investment of $3.6 trillion by 2020, the U.S. transportation capability and capacity would be diminished to the point where it would literally become a drag on the economy as a whole.[12] Similarly, a 2010 World Economic Forum study of U.S. transportation infrastructure places the U.S. in 23rd place, between Spain and Chile.[13] The effects of this reality on the U.S. economy are compounded by the fact that foreign competitors, including the European Union (EU), have made significant investments to improve their

[i] The ASCE Report is referenced throughout this paper. A summary of the Report Card is included at Appendix A.

infrastructure in an effort to harmonize the diverse capacities of their member nations[14] while increasing their access to emerging markets.[15]

The U.S. has rested on its transportation laurels for far too long. The fault lines in the infrastructure are beginning to show in countless ways. From the Howard Street train tunnel fire in Baltimore, MD in 2001,[16] to the collapse of the I-35 Bridge in Minneapolis, MN in 2007[17] to the I-5 Bridge collapse in Skagit, WA in 2013[18] the economic impact caused by transportation interruptions is being felt across the nation. Furthermore, U.S. investment in transportation infrastructure has fallen steadily from over 5.0 percent of GDP in the 1960s to 2.4 percent today.[19] Meanwhile, EU competitors have increased their investment to 5.0 percent of GDP,[20] allowing further erosion of the U.S.'s asymmetric transportation advantage. As the U.S. slowly climbs out of the recession and political attention turns to this topic, the logical time to push for reinvestment is now. The U.S. must address the critical transportation infrastructure issues that threaten its economic prosperity and national security. While the military mobility aspects of transportation are important (the Department of Defense relies heavily on the commercial sector during both peace and wartime), the detrimental impact of congestion and degraded infrastructure on the economy is the far greater threat to national security. This paper begins with a basic overview of the current state of the U.S. transportation infrastructure across air, rail, maritime, and trucking modes. Next, several essays delve deeper into key issues and initiatives affecting the transportation industry: critical inter-modal choke points; transportation technology initiatives; and public-private partnerships (PPP). The paper concludes with recommendations for action.

PART I: MODAL ANALYSIS

Industry Defined

The transportation industry in the U.S. is a large and complex area for study. It includes industries providing transportation of passengers and cargo, from municipal bus and subway systems to massive container vessels and cargo aircraft circling the globe. Spending across the U.S. transportation and logistics industry in 2011 totaled $1.3 trillion and made up 8.5 percent of annual GDP.[21] This paper focuses on the key subsectors that make up this enormous industry – air, rail, maritime, and trucking – and emphasizes the freight aspects and intermodal linkages in those areas.

There are clear connections between the subsectors, as trucks and rail transport passengers and freight to air and maritime terminals for forward movement (and vice versa), but there are also industry-unique issues in each mode. Part I of this paper begins with a look at the four subsectors individually. It includes a brief overview of the mode, an industry analysis based on Michael Porter's "five forces model,"[22] and concludes with industry challenges and an outlook for each mode. Key to understanding the four modes and their shortfalls is analyzing the roles and responsibilities of the U.S. Government. From the modal analyses to the conclusions and recommendations, the burdens, benefits, and obligations of federal, state and local organizations are covered in depth. Given the state of U.S. transportation infrastructure, the government must collaborate closely with the private sector to build consensus and forge a unified way forward from a policy and resourcing perspective in order to return the industry to the economic and security bulwark it once was.

Air Mode

Overview – Air Mode

The U.S. air transportation industry consists of 19,786 pubic and private airports.[23] In 2013, the domestic aviation transportation industry flew approximately 646 million passengers and 20 billion

pounds of freight/mail, generating $138.3 billion in revenue.[24] Mr. Michael Huerta, Federal Aviation Administration (FAA) Administrator, provided an even more powerful point when he testified before the House Transportation and Infrastructure Committee in May 2013, appealing to the committee to not lose focus on the needs of the nation's aviation infrastructure and, "…protect the great contribution that civil aviation makes to our economy of $1.3 trillion and 10 million jobs."[25] Although the airline industry was deregulated in 1978, there are numerous government agencies, such as the FAA and Environmental Protection Agency, who impose safety and environment regulations on the industry.

Industry Analysis – Air Mode

Table 1 provides a high-level look at the aviation industry, which primarily includes air cargo and passenger services. The analysis highlights the importance of suppliers. There are two main aircraft manufacturers in the world, Boeing and Airbus, which limits the airline industry's options for purchasing new aircraft. Additionally, manpower supply through unions (mostly pilots) is also important. Labor negotiations can significantly affect operations. Perhaps the key major supply force, and its related operating expense impact, is fuel cost. For example, Delta Airlines is clearly looking to affect supplier power and cut variable costs through its recent purchase of a refinery[26] – the business results of which remain to be seen. The power of suppliers is high, and it's the most important force to manage for air mode firms in a challenging industry.

Table 1: Porter Five Forces Analysis – Air Mode

Threat of New Entrants	Supplier Power	Customer Power	Threat of Substitutes	Competitive Rivalry
LOW	**HIGH**	**MEDIUM**	**MEDIUM**	**HIGH**
*Large capital required to enter the industry - barrier to entry	*Unions, fuel suppliers apply pressure *Boeing v Airbus compete Large Aircraft market	*Limited ability to affect price *Do have choice, however	*Train, bus, rail *Cost is high to switch due to time *Affected by economic conditions	*Few domestic competitors due to cabotage *Control of variable costs is key to succes

Challenges and Outlook – Air Mode

The air transportation industry is facing several major issues that will carry into the future without government and industry action. First, the FAA recently concluded that the current airport infrastructure would not meet capacity requirements in the coming years. A 2007 report, conducted by the FAA and the MITRE Corporation, determined "many of our hub airports and their associated metropolitan areas could be expected to experience capacity constraints (i.e. unacceptable delays), even if the planned improvements and upgrades were completed on time."[27] Not surprisingly, the report also found that many of the nation's largest and fastest growing metropolitan areas would need to boost future capacity.[28] The FAA projected that by 2025, 14 airports and 8 metropolitan areas will need additional capacity and infrastructure[29] beyond what is already planned.

The economic impact of this congestion in the aviation industry is enormous. This chokepoint cost passengers and businesses approximately $24 billion in 2012, with nearly one-third of that attributable directly to cargo business.[30] Annual impacts from congestion are forecasted to rise continually to almost $34 billion by 2040, with similar passenger and cargo ratios.[31] Additional impacts from the failure to increase investment levels in airport infrastructure can be measured in terms of lost GDP, jobs, business sales, and exports. Overall, the loss in GDP is estimated at a $47 billion loss per year by 2020 and nearly a $70 billion loss per year by 2040.[32] This translates into approximately 350,000 lost

jobs and $11 billion in lost exports, with that number rising to $60 billion per year by 2040.[33] Capturing the net effect: $313 billion in lost GDP by 2020 increasing to a sobering loss of $1.5 trillion in lost GDP by 2040.[34] Again, when measured against the capital investment needs, the benefits of infrastructure investment far outweigh the cost.

One investment the FAA and industry have been making since 2004 is its Next Generation Air Transportation System or NextGen – an upgraded Air Traffic Control (ATC) system that allows aircraft to fly more efficiently via spacing, direct routes, and satellite technology.[35] Having spent approximately $1 billion annually on the project,[36] expectations are high that it will deliver not only the capacity to absorb projected growth, but also deliver 12 percent reduction in greenhouse gas emissions by 2025 as projected by the U.S. Government Accountability Office (GAO).[37] With aircraft equipped to operate using the NextGen system, UPS is showing as much as a 34 percent reduction in emissions.[38] However, it's expected the FAA will need to spend $32 billion for full implementation by 2025[39] - an obvious challenge in tight budgets.

Funding for projects such as NextGen is a key concern in the air transportation industry, as it is in all modes. Federal dollars currently allocated to modernize and improve airport infrastructure are insufficient to meet the growing demand. The U.S. Airport and Airway Trust Fund (AATF), funded by revenues from ticket taxes, ticket fees, international arrival and departure fees, and fuel taxes, is the primary source of funding for the FAA's capital programs, as well as its operations.[40] The Airport Improvement Program (AIP), funded through the AATF, provides grants to both public and private agencies for "development of public-use airports that are included in the National Plan of Integrated Airport Systems (NPIAS)." However, grants typically cover only 75-95 percent of eligible costs.[41] Passenger facilities charges, currently capped at $4.50 per segment or $18.00 per round trip, are passed through the airlines to the airports "to preserve or enhance safety, capacity, or security of the NAS (National Airspace System); reduce noise; and enhance competition among carriers."[42] While a disappointing 14 percent of these charges have actually been used for funding airfield safety and expansion projects, they represent an underutilized and potentially useful tool in meeting aviation infrastructure needs in the future.[43] As discussed in a later essay, PPP initiatives may be the better model for addressing these concerns. Their government-industry sharing arrangement may allow the dollars to flow more readily to where they are needed most.

The air transportation industry has proven to be a resilient institution.[44] According to Boeing's *Current Market Outlook,* 2013–2032, "commercial aviation has weathered many downturns in the past."[45] "Recovery has followed quickly, as the industry reliably returned to its long-term growth rate of approximately 5 percent per year."[46] Boeing estimates this expansion trend will continue over the next 20 years, with world passenger and cargo traffic growing 5 percent annually.[47] Cargo traffic growth will be the strongest in the Middle East and Africa due to projected rapid economic expansion.[48] While positive for the industry, this demonstrates the necessity to fund infrastructure improvements in the U.S. and to ensure that airports have the capital to meet the growing domestic and global demand. However, the resources and funding currently committed to sustain and improve the nation's airports are insufficient, and in some cases, are being ineffectively utilized. Without changing course, it seems the airline industry will be unable to meet the growing demand for air travel, resulting in reduced efficiency across the industry and detrimental impacts to our nation's economy and security.

Rail Mode

Overview – Rail Mode

The $50 billion-per-year[49] U.S. freight rail industry is a cornerstone of American economic power. Railroads transport 43 percent of the nation's intercity freight and approximately 30 percent of

U.S. exports. The nation's rail network includes nearly 140,000 miles of track, which is shared by all operators moving freight and passengers. U.S. freight railroads are broken into three classes, to include: Seven Class I freight railroad systems; 21 Class II Regional railroads; and 537 Class III Short Line railroads. Amtrak, a single intercity passenger rail provider, and 27 Regional commuter rail lines provide passenger rail service.[50] In addition to its economic impact, rail operations play a critical role in supporting national security. The U.S. Army Surface Deployment and Distribution Command works with industry and municipal governments to maintain over 36,000 miles of critical rail, linking more than 130 defense installations.[51]

Industry Analysis – Rail Mode

The U.S. rail freight industry can be characterized as an environment with healthy competition and upward growth linked to overall economic prosperity. Table 2 breaks down the forces affecting the industry. Buyers' bargaining power is relatively high, with low switching costs and little differentiation between major rail firms, however, there is little choice between the seven Class I railroads, especially those which dominate regionally (e.g., Union Pacific in the southwest). But the most compelling dynamic in the industry is the unique relationship between competing firms, who are each other's customers as well as rivals. The firms share rolling stock, routes, and interline train cars for maximum efficiency. After the major consolidations of the 1990s, the landscape seems to have stabilized between the Class I firms, with any further major consolidation likely to provoke anti-trust action.

Table 2: Porter Five Forces Analysis – Rail Mode

Threat of New Entrants	Supplier Power	Customer Power	Threat of Substitutes	Competitive Rivalry
LOW	**MEDIUM**	**HIGH**	**LOW**	**MEDIUM**
*Rolling stock cost, workforce training, track "right-of-way"are barriers to entry	*Rail less susceptible than other modes in terms of fuel prices *Labor is specialized and stable	*Low switching cost *Little differentiation between rail firms *Limited Class I choice in certain regions	*Unique capability (tons per mile) is hard to replicate *Companies providing intermodal svcs	*Competing firms are also customers *Firms share rolling stock, routes, and some train cars for efficiency

Challenges and Outlook – Rail Mode

From an infrastructure perspective, the rail industry fares comparatively well to other transportation modes. The unique way rail industry firms own and manage their own track creates an infrastructure management model that differs from other modes, and is one reason why rail infrastructure was one of the better rated areas in the 2013 ASCE report.[52] Since the 1980s, the freight railroads have spent approximately $500 billion to modernize their network by adding new tracks, or updating existing ones, and expanding tunnels to accommodate trains with double-stack intermodal containers.[53] Still, the industry faces a number of challenges. A later essay covers the rail linkages to the nations ports, but issues discussed here are the implementation of the new Positive Train Control (PTC) initiative, and capacity and safety issues related to shipping petroleum from the Bakken oil fields in North Dakota and Montana.

The U.S. Government has mandated that major railroads implement PTC, a comprehensive automated command and control system, by 2015.[54] The PTC law imposes a major financial burden and technical challenge for the railroads. Implementation will entail: mapping 60,000 miles of track right-of-way and over 470,000 trackside equipment items; installing hardware on over 22,000 locomotives; replacing over 12,000 switches; installing over 36,000 new "wayside interface units" to transmit

commands to trains.[55] Railroads will implement PTC either as an overlay system or through Communications-Based Train Control (CBTC).[56] In an overlay system, PTC components are placed over existing infrastructure so that, for example, a legacy switch is actuated with new Supervisory Control and Data Acquisition (SCADA) technology. More complicated and expensive CBTC systems have greater automation and communications connectivity, providing real-time position updates transmitted from the trains themselves, and advanced in-cab controls for receiving and acknowledging electronic commands from dispatchers.

PTC, however, faces many problems. According to Steven Ditmeyer, a former Federal Railroad Administration (FRA) Associate Administrator and noted PTC expert, PTC implementation suffers from a lack of coordination and standardization, and demands a "network-centric approach to operations, which is already used successfully by the military and aviation industry."[57] Another key concern of the PTC system is the potential threat of hackers. As the intent of PTC is to connect and control railroad operations in an enterprise fashion, an attack on the entire enterprise could have serious economic and safety implications, or be nested into a larger coherent attack on American critical infrastructure. In addition to targeting operational control and monitoring systems, an attacker may choose to target administrative data systems to manipulate schedules, freight manifests, or critical economic information.

The second major infrastructure challenge facing the rail industry is its ability to support the burgeoning domestic energy exploration market. The U.S. is currently in the midst of an energy boom, due in large part to recent technological advances in the extraction of crude oil and natural gas deposits from Bakken shale rock formations in North Dakota and Montana. By utilizing hydraulic fracturing and horizontally drilling technology,[58] crude flows have grown to exceed the capacity of the nation's 95,000 mile pipeline network infrastructure, creating a surge in demand for railroad tanker cars to transport crude. Roughly 60 percent of North Dakota's daily oil production (640,000 barrels) leaves the state by rail, according to estimates by the North Dakota Pipeline Authority.[59] Moreover, according to the Association of American Railroads, "In 2008, U.S. Class I railroads originated 9,500 carloads of crude oil. In 2012, they originated nearly 234,000 carloads and will likely originate around 400,000 carloads in 2013."[60]

Furthermore, the growth in oil shipments by rail continues to significantly impact other segments of the U.S. economy that rely on rail transportation. Specifically, power plant operators, farmers, and other big cargo shippers have criticized the railroads for favoring lucrative crude oil shipments over traditional freight shipments such as coal, grain, and chemicals. Equally important are concerns over tanker car safety and security that have captured the attention of State and Federal lawmakers, as well as numerous civic organizations, in light of several recent high profile tanker car derailments.

Safety concerns notwithstanding, most economic forecasts predict that energy companies will continue to turn to railroad industry operators to transport their oil as pipeline networks struggle to keep up with production. Consequently, the rail transportation sector faces a significant challenge in managing existing infrastructure and investment to meet this anticipated demand. All combined, according to the U.S. Department of Transportation (DoT), freight rail transportation is projected to increase 92 percent between 2002 and 2035.[61] Therefore, railroad operators, business and civic leaders, and regulators at every level must consider a comprehensive strategy that balances economic growth, establishes improved railcar safety standards, and enacts cost-wise regulation. It is imperative that this strategy does not inadvertently impact the rail industry's combination of cost effectiveness, fuel efficiency, and mobility, all of which make rail an attractive, safe mode of transportation, linking communities and businesses and powering the U.S. economy from coast to coast.

Maritime Mode

Overview – Maritime Mode

The U.S. maritime transportation system consists of over 95,000 miles of coastline and 25,000 miles of waterways, and includes: 360 ports; 1400 intermodal connections; and 3700 facilities that allow for the transportation of goods and people vital to economic sustainability and national security.[62] The maritime transportation network comprises both inland water transportation that covers the movement of cargo and passengers on lakes, rivers and intracoastal waterways, and port/harbor operations that enable the movement of cargo within the domestic and international maritime transportation network. With over 95 percent of U.S. foreign trade arriving at a port, and approximately 51 million truck trip equivalents of cargo moving throughout the inland waterways system, maintaining maritime transportation capacity to meet expanding economic growth is vital to U.S. interests and our national security.[63]

Industry Analysis – Maritime Mode

Industry growth is considered mature, and there is a high degree of rivalry within the market with fuel costs driving profit margins. Diversity of rivals is low, with capacity and efficiency driving standardized profit margin targets across the industry. As captured in Table 3, barriers to entry are medium in the inland waterways industry with fuel being the major expense for industry operators. Competition is primarily based on commodity shipping rates. A company can enter the market with relatively little capital investment (procurement of a single vessel), although they may not have a competitive advantage over other companies with more assets and greater scheduling flexibility and capacity. Harbor and port operations face high barriers to entry due to the constraints of geography, with few new locations for container ports available. In addition, extensive capital investment is required to build port infrastructure, including major equipment for loading/unloading goods, as well as the intermodal connections (rail and road) needed for further movement of cargo. Companies must also go through extensive public approval processes for new port development projects. Heavy regulation creates additional barriers to entry. Regulation of the maritime industry is overseen by a number of federal entities including the U.S. Coast Guard and other elements within the Department of Homeland Security (DHS), the Maritime Administration (MARAD), U.S. Army Corps of Engineers, and Department of Transportation (DoT). Of particular regulatory significance is the Jones Act, a cabotage law that places restrictions on the operation of foreign vessels within U.S. domestic trade routes, and the foreign ownership of inland water transportation operations. The law protects the U.S. maritime industry from foreign competition by limiting suppliers of the industry to U.S. entrants. The "poor state of inland waterway infrastructure will make industry operators less competitive with other modes of transportation."[64] Still, mileage costs per tonnage transported remains lower in the maritime industry, making the threat of substitutes for port/harbor operations low.

Table 3: Porter Five Forces Analysis – Maritime Mode

Threat of New Entrants	Supplier Power	Customer Power	Threat of Substitutes	Competitive Rivalry
LOW	**HIGH**	**MEDIUM**	**LOW**	**HIGH**
*Inland waterways (med) - vessel acquisition relative ease *Ports (low) - large capital investment, regulatory / environmental restrictions	*# of suppliers low *Product differential low *Tied to fuel costs	*Limited operators drive freight prices *As economy improves may open freight sectors	*Port operations limited substitutes *Aging lock/dam system shifting cargo to other modes	*Mature industry *Profits margins driven by fuel costs *Low differential - all seek capacity / efficiency

Challenges and Outlook – Maritime Mode

Capacity and capability as a result of aging infrastructure and lack of capital improvements are the primary challenges within the maritime industry. The size of vessels entering U.S. ports/harbors and their capacity to carry more goods has resulted in an increase in port congestion and placed additional stress on aging infrastructure. With the expansion of the Panama Canal, ports must be able to effectively and efficiently move larger volumes of cargo through the intermodal system while accommodating larger vessels. This includes ensuring enough berthing capacity, adequate loading/offloading equipment, deeper waterways, and higher bridges to accommodate the larger vessels. Similar challenges face the U.S. inland waterway lock and dam system, which requires major funding and investment to accommodate increased inland vessel traffic and prevent delays and congestion especially in major choke points – all covered in more detail in a later essay.

As with all intermodal systems, the competition for limited resources during a period of fiscal constriction and large U.S. debt is a major challenge. While recent economic activity has spurned an increase in imports and exports and resulted in a positive outlook for the health of the industry, additional capital investment is needed. The lack of coordinated effort between multiple federal, state, local and private funding sources is also problematic, and has resulted in potential for overlapping and competing demands, with some funding decisions driven by political pressures. With numerous stakeholders all vying for limited resources, it is imperative that overarching funding coordination and project prioritization be optimized to meet aging infrastructure sustainment and improvement project deficits.

Despite these challenges, the outlook for the industry is good. Port and harbor operations revenue is expected to increase at an average annual rate of 1.5 percent to $1.7 billion as a result of rising freight volumes and demand for port services, while inland waterways industry revenue growth is forecast to rise at an annualized rate of 2.9 percent to $6.7 billion, in part, as a result of chemical manufacturing that relies heavily on barge transport.[65] In order to capitalize on this continued growth, which is vital to the U.S. economy, infrastructure investments will need to be made to the inland waterways lock and dam system, as well harbor and port facilities to accommodate increased foreign trade volume and increased size of new vessels entering the maritime transportation market. As trade volumes are expected to grow and account for 60 percent of U.S. GDP by 2030, infrastructure must be planned and managed effectively to sustain future growth past 2030.[66]

Trucking Mode

Overview – Trucking Mode

The trucking industry is critically linked to and integrated within the fabric of the American economy. American trucks play a vital role in the transportation of raw materials to manufacturers and partially to fully finished products to the consumer, both over the short and long haul. The complex system of national, state, and local highways these products traverse are so critical to the U.S. economy that they have been valued at $2.8 trillion.[67] According to the Federal Highway Administration (FHWA), of the more than 50 million tons of freight handled by the freight movement system each day in the U.S., over two-thirds is carried by trucks. The trucking sector handles 87 percent of high-value, time-sensitive goods, and 71 percent of lower-value bulk tonnage, such as agricultural products from farms, local distribution of gasoline, and pickup of municipal solid waste. Over the next 30 years, the weight of shipments carried by trucks is projected to increase by 1.3 percent per year, rising from 12.5 billion tons in 2010, to 18.5 billion tons in 2040.[68]

Industry Analysis – Trucking Mode

In 1980, Congress passed the Motor Carrier Act (MCA), freeing trucking companies from a federal regulatory structure. Results were swift and extensive. The post-deregulation re-emergence of for-hire carriers was but one indication that competition in the industry had been lagging. Furthermore, the rapid changes in industry structure, the mass of new entrants and bankruptcies, and the declining unit costs and profits were all highly suggestive of impedance of competition in a heavily regulated environment. Lastly, the stagnation in unit revenues and unit costs was consistent with the hypothesis that a low-competition environment is not supportive of value creation.[69] Table 4 covers the current state of the industry that resulted from the MCA. Deregulation helped to increase competition by creating lower barriers to entry and increasing customer bargaining power, as well as supplier power. The health of the trucking industry is good, and will only continue to rise as the U.S. economy recovers.

Table 4: Porter Five Forces Analysis – Trucking Mode

Threat of New Entrants	Supplier Power	Customer Power	Threat of Substitutes	Competitive Rivalry
HIGH	**HIGH**	**HIGH**	**MEDIUM**	**HIGH**
*Deregulation reduced barriers to entry *Price of a big rig	*Supplier power is high - fuel, deregulation *Driver shortages increasing labor power	*Deregulation increased buyer power *Numerous options for customers	*Rail improving and moving to provide intermodal services	*Many players in the industry competing on efficiency - fueling technology advancement

Challenges and Outlook – Trucking Mode

The biggest issue with the nation's road network today is a complex combination of: gradually crumbling infrastructure; increasing usage; diminishing federal, state and local resources dedicated to repair of that infrastructure; and, a complicated, non-standard approach to application of those resources. Within the U.S. there are approximately four million, centerline miles of public roads. Of the nearly one million miles of road designated as eligible for federal aid, the FHWA found that approximately 187,000 miles (19 percent) were in poor or mediocre condition and needed repaving or substantive repairs. In urban areas, roads were in a state of greater disrepair, with nearly 30 percent of highways needing repairs.[70] The situation on U.S. highways is so bad that the ASCE gave America's roads an overall grade of D, with nearly one-third of major roads categorized in poor or mediocre condition.[71]

The current state of the nation's ground infrastructure will only grow worse as increased population and urban growth stress ever decreasing capacity. According to a recent study, poor surface infrastructure leads to millions of lost hours in transit due to congestion. More importantly, poor infrastructure causes increases in: operating costs of vehicles, including trucks; costs due to vehicle damage and repairs; and environmental and safety costs. This is in addition to lost jobs and productivity. The situation is so precarious, that, "By 2020, America's projected surface transportation deficiencies are expected to cost the national economy cumulatively, almost $900 billion in GDP, rising to $2.7 trillion through 2040."[72]

The nation's bridges are in a similar state of disrepair with one in every nine bridges being rated as structurally deficient. Most bridges are built with an approximate 50-year life span, and the average age of bridges across the U.S. is currently over 43 years.[73] The 11 percent of bridges that have been rated as deficient, average 65 years of age. The FHWA estimates that to eliminate the nation's bridge-deficient backlog by 2028, the U.S. would need to invest $20.5 billion annually, while only $12.8 billion is currently being spent.[74]

Funding for highway infrastructure primarily comes from the public sector, with around 75 percent of expenditures coming from state and local governments, and the rest coming from the federal government.[75] A significant portion of these funds is raised through an excise tax on fuels. The 18.4 cent

per gallon federal gas tax has not been adjusted since 1993, and is actually only worth 11.5 cents today. Had the fuel tax been indexed to inflation back in 1993, gas and diesel taxes would be 29 cents and 38 cents per gallon today, and billions of dollars would have been added to the highway trust fund.[76] Appendix B shows a recent projection of the highway trust fund account from *The Wall Street Journal*. If things continue status quo, the Congressional Budget Office (CBO) projects a deficit of $120 billion in just 10 years.

The situation for highways is serious, as the HTF will be depleted by late August. A funding crisis, for example, would affect the nearly 600 major projects in California at a cost of more than $11 billion.[77] Relief, however, may be in sight. On April 29, 2014, the Obama administration submitted a four-year, $302 billion transportation funding bill to Congress that would replace the current authorization law for transportation, called Moving Ahead for Progress in the 21st Century (MAP-21), set to expire at the end of September. The new proposal, called the Grow America Act, would, "shore up the [HTF] with new revenue from reforms to business taxation and provide an additional $87 billion to improve deficient bridges and transit systems. It would provide for improvements to freight rail, highways and ports; streamline the process for project approval and permits; and relax a current federal prohibition on imposing tolls on interstate highways." Additionally, the bill, "calls for a 37 percent overall annual spending increase on transportation programs, including 21 percent for highways and 69 percent for transit. Funding for passenger rail service would be increased 71 percent."[78]

PART II: ESSAYS ON KEY ISSUES

Essay 1: Transportation Choke Points

As the individual modal analyses indicate, all U.S. transportation modes, but particularly air and maritime, are facing significant infrastructure choke point challenges. There is an associated cost to the U.S. economy and national security today, which will only increase in the future as transportation demand grows and infrastructure investment continues to lag. This essay will study those concerns from several specific perspectives.

Larger Ships in Port

The world has become a global marketplace and the heartbeat is the world's transportation network. The main arteries of this network meet at the world's ports; the U.S. is no exception. The U.S. relies on ports as the gateway for international trade. As both ship size and international trade grow, ports will face an expanding intermodal demand as more containers and goods require transition to and from road, rail and intercoastal networks near the ports. The U.S. will need to focus on short and long-term solutions that will ease the congestion caused by shortfalls in infrastructure, from the dockside to the rest of the national freight system.

With the continuing evolution of merchant vessels with deeper drafts and larger cargo capacities, it is important for the U.S. to evolve from its current antiquated state to accommodate these larger vessels by dredging those ports that can support the expanded cargo throughput across the U.S. Appendix C includes a graphic depicting the ever-growing size of the ships in service today. All the major container ports on the West Coast already have the port infrastructure to support post panamax plus vessels (8000 twenty-foot equivalent units (TEUs)). While most U.S. ports on the East Coast have dredged or have begun dredging to the required 50 foot depth to support post panamax plus vessels, some ports have yet to commit to making the necessary upgrades – some due to cost, and others due to environmental concerns. The U.S. can expect to see an influx of post panamax class vessels calling at ports along the East Coast with the completion of the Panama Canal.

Ports not dredged to 50 feet or more will likely see a drop in cargo throughput, which would be detrimental to the U.S. economy. Today, Conley Terminal, in Boston Harbor, is debating whether to undergo what would be a $300 million dollar renovation to dredge their port facility and terminal in order to support the post panamax vessels.[79] The reasons for Boston's delay focus primarily on the cost benefit analysis and potential environmental concerns. It's difficult to calculate how long it would take to return the investment, but estimates indicate the improvements could bring in $100 million annually.[80] Boston has already updated its port facility capacity with state of the art gantry cranes to support the post panamax vessels and has also made intermodal strides by developing a freight corridor to provide a more efficient way of moving the containers.[81] Boston is just one example, but the need for dredging and infrastructure investment at other U.S. ports is paramount in order to meet the needs of the larger ships.

The Intermodal Factor

The intermodal complexity in U.S. ports brings a number of challenges to the transportation industry. The point where containers are loaded and unloaded from vessels to trucks, rail, or inland waterways is difficult to manage because of complex regulations, as well as movement coordination among mode-specific networks. Past transportation planning did not view ports as part of the intermodal system. In addition, most U.S. ports are in urban settings designed to support the local economy and did not address the intermodal model of freight movement used today. Several key challenges in these areas will be covered in this section.

The Jones Act, mentioned previously, requires the use of U.S. flagged vessels for domestic port-to-port cargo movement. This law greatly affects the use of the intercoastal marine highways because the regulatory imposition (and lack of an open, competitive market) drives up costs. Due to higher costs associated with shipping via inland waterways, more companies choose to move freight via rail and trucking. This adds to the intermodal congestion in those modes even though substantial capacity exists in our local waterways. From a pure economic standpoint, this law is exceptionally inefficient, though the intended benefits have kept it alive in spite of some past reforms.

The U.S. national marine highway is underutilized. In addition to the Jones Act, a key deficiency is simple port planning. As stated in the introduction, intermodal considerations have not been built well into U.S. ports. Increasing the use of the marine highway, for example, would reduce port road traffic and fuel usage. By lightering cargo from larger ships to smaller coastal ships or barges, ports would be able to move more cargo along the coasts and inland waterways, increasing utilization of smaller ports. This would require investment in dockside handling equipment and U.S. flagged vessels, which would have a positive impact on the U.S. fleet (one of the goals of the Jones Act). This increased use of these vessels for commercial cargo would allow the government to reduce subsidies and ensure that the nation has a viable U.S. flagged fleet that can support our national security needs.

There are intermodal aspects of the Bakken energy boom, in addition to the rail capacity challenges mentioned above. The development of shale gas and potential export of liquefied natural gas (LNG) is an opportunity as much as a challenge. Proper intermodal infrastructure would play a big part in the U.S.'s drive towards energy independence. Cheniere Energy is among a small group of American companies constructing facilities to export LNG out of Southwest Louisiana.[82] With approval from both the Department of Energy and the Federal Energy Regulatory Commission (FERC), Cheniere is well on its way to exporting by late 2015. With continued demand for LNG as an energy source in Puerto Rico and Hawaii, this boom also avails itself as an opportunity to boost the U.S. Merchant Marine through the Jones Act. The potential LNG production and transportation benefits abound both in terms of national security and economic growth for the U.S. Approval and investment to build the capacity is essential.

Inland intermodal hubs are another concept that could reduce congestion in and around ports. In this case, rail would be the best method of getting cargo out of the port and to the hub site. By converting

dockside area to rail yard operations and away from trucking, more cargo could be moved, while simultaneously reducing fuel usage and impacts to the environment. Truck movements within the port could be significantly limited. This would also reduce road congestion and the cost associated with maintaining the road network that feeds the port. The intermodal hubs could be located outside urban areas and include easier access to rail and highway networks. From a security perspective, they could be made to more easily support screening and cargo inspections.

Even the simplest things like moving truck operations to evening off peak hours would reduce the traffic entering the port locations and reduce their interaction with normal intercity congestion. But there are regulatory and organizational roadblocks to even this. The intermodal challenges are perhaps as difficult as any in the transportation industry due to mixed industry and government interests. However, the solutions to many of them are relatively simple and could have an immediate impact on port operations, creating efficiencies and reducing environmental issues. The creation of a National Transportation and Freight Strategy that brings together the range of government agencies and industries that operate at the ports could be the start of a cohesive way forward. A key aspect of this strategy would be to identify intermodal solutions and projects with the biggest return on investment. With industry assistance and active involvement, a National Freight Strategy should be developed and implemented with a funding plan to match.

Congestion in the Skies

The airline industry is also feeling the pressure of infrastructure limitations. Passenger and cargo transport services are vital to both U.S. national security and economic interests. The overall health of this segment depends heavily on sufficient, modern infrastructure that not only supports today's demand, but has the ability to accommodate forecasted growth. The FAA reports that the "U.S. civil aviation manufacturing industry continues to be the top U.S. net exporter…providing a positive trade balance of over $75 billion in 2009".[83] Any investment that improves the overall health of this market or the ability of the supporting infrastructure to support continued growth is hugely beneficial.

The FAA's Aerospace Forecast for 2013-2033 indicates consistent year-over-year increases in passenger traffic and air cargo demand. While a positive indicator from an economic perspective, these forecasts paint a stark picture for this nation's airport infrastructure, which is already operating above capacity at several major hubs. Over the next 20 years, the report forecasts average domestic passenger growth between 2 percent and 3 percent, and growth of international passenger traffic at an even higher 4 percent.[84] These estimates result in a net increase of over 400 million enplanements by 2033, which represents a 57 percent increase over the approximate 700 million enplanements in 2013.[85]

The Eno Center for Transportation, a non-partisan think tank, points out that airline consolidation has resulted in fewer hub airports, leading to more passenger enplanements at the larger hubs.[86] This consolidation to fewer hubs creates a strain on current capacity. The FAA's report *Capacity Needs in the National Airspace System* forecasts continued significant capacity shortfalls at this handful of major economic hubs, even if planned projects are funded and executed as planned. The FAA's analysis identified four remaining metropolitan areas, six airports in total, which will require capacity improvements beyond those planned.[87] Results of this analysis indicated that New York, Los Angeles, Philadelphia, and San Francisco all require additional capacity (the six airports identified are all located within these metro areas, including Newark).

Additionally, the ASCE's 2013 report card gave Aviation a grade of "D", indicating the current condition of the U.S. national airport infrastructure to be in "…poor to fair condition and mostly below standard, with many elements approaching end of their service life…condition and capacity are significant concern with strong risk of failure".[88] The ASCE reports an investment gap of approximately $2 billion per year through 2020, with the gap narrowing to approximately $1 billion from 2021-2040.[89]

As mentioned in the modal analysis, the costs of inaction are much higher in terms of lost GDP and jobs – $1.5 trillion in lost GDP and 350,000 jobs by 2040.[90] Measured against the capital investment needs, the benefits of infrastructure investment far outweigh the cost.

Passenger Facility Charges (PFCs), currently capped at $4.50 per segment or $18.00 per round trip, are a simple and transparent source to generate additional capital for the most pressing needs (i.e. those in areas of high congestion and high economic value). Since revenue from this charge falls outside the purview of the Airport and Airway Trust Fund and is more tightly controlled by the individual airports, a much higher percentage of the funds would go directly to infrastructure expansion. Allowing a select number of publicly-owned airports to raise this charge according to demand could raise significant capital to help cover costs of infrastructure shortfalls. Raising the PFC by $5 per segment for every passenger regardless of location would generate approximately $3.5 billion per year or $35 billion over ten years, which completely covers the investment gap identified by ASCE's study.[91] An important secondary effect would be that Airport Improvement Program grants could be better aggregated to the infrastructure needs of remaining airports located within significant, albeit lesser areas of economic activity. These grants are currently disbursed to a wide constituency throughout the U.S., which, while they serve important needs, can sometimes have muted effects. Another potential funding methodology is through PPPs, detailed in a later essay.

Conclusion – A European Solution

When considering the range of capacity challenges facing the U.S. transportation industry, it's valuable to look outside of the country for possible improvements. The Port of Rotterdam, Netherlands, is a model for the U.S. Nearly every concern listed above is addressed by a city that's been dedicated to shipping for centuries – aging infrastructure and reinvestment is clearly a strategic consideration. All U.S. ports combined handle 32 million twenty-foot equivalent units (TEUs) annually. Los Angeles is the largest port at just over 8 million TEUs. Rotterdam, the largest container port in Europe, processes 12 million TEUs annually. Additionally, the world's largest class of container vessels, the Maersk EEE (Energy Efficiency, Environmental Performance, and Economies of Scale), which entered the market in 2013 with an 18000 TEU capacity, calls at APM Terminals in Rotterdam. The majority of U.S. ports today can barely support the post panamax plus vessels. Additionally, the intermodal efficiencies are optimized through an organized terminal that uses separate sectors for containers, crude oil, and transfer to inland waterways – a capability leveraged in order to balance congestion on the roads and rails. The U.S. can learn more than just port management from the Dutch – it can also take note of their reverence for their historic transportation roots.

From an aviation perspective, the EU faces similar challenges as the United States. Their ability to manage hub traffic is as complicated as in the U.S. and they're working together to manage Air Traffic Control upgrades. They are ahead in managing aviation environmental concerns, implementing a cap and trade system well ahead of action by the rest of the world.

The clear advantage the U.S. has over Europe is the union itself. Many in the EU would note that theirs is a union in name only. Trucking companies, for example, highlight the challenges of moving oversized cargo from one EU nation to the other due to regulatory differences. The Europeans and Americans are allies and they must learn and assist each other. For the U.S., the takeaways are remarkably aligned with the challenges above: develop intermodal-centric ports; expand the use of inland waterways; and build the capability to accept and distribute cargo from the larger vessels in service. Allowing EEE vessels into port may be in the distant future for the U.S., but it isn't simply a status symbol and the benefits aren't short term – it's about strategic investments to make the U.S. economy more efficient and therefore the nation more secure.

--Mr. Daniel Loechner, Dept of Navy
--Colonel Eric Fleming, U.S. Army
--Captain Jayson Mitchell, U.S. Navy

Essay 2: The Potential of Technology to Improve Infrastructure Performance

Addressing the congestion and other myriad problems impeding the nation's transportation network has been, and continues to be, accomplished mostly through multi-billion dollar, brick-and-mortar type funding for highways, ports and bridges and other capital-intensive projects to repair, upgrade or replace aging infrastructure. Unfortunately, cost estimates to improve transportation, water and energy infrastructure range as high as $2.4 trillion, [92] an amount that is politically unappetizing considering high budget deficits at federal and state levels. Infrastructure improvements, however, must not necessarily be limited to overwhelmingly costly public works projects involving legions of civil engineers and backhoes. For some economic and national strategic objectives, investments in technology, even modest ones, can have a significant impact in enhancing various aspects of the transportation network. The following provides examples of how advanced technologies, both in place or in development, are reshaping and revolutionizing transportation to enhance efficiencies, and achieve greater economic and social benefits.

Maritime Technology Initiatives

The Automated Identification System (AIS) was originally designed as a navigation and collision avoidance tool for commercial maritime shipping. For safety reasons, the United Nation's International Maritime Organization (IMO) mandated that AIS transponders be placed on all vessels over 300 gross tonnage. However, as AIS transmits basic ship information – ship name, ownership, registration, crew and cargo data, international call sign, IMO number, last and next port of call, tonnage, speed, heading, positional data and other useful information – governments and industry have identified, over the last decade, additional value in AIS-generated data, outside its original safety role, to track and manage shipping. Specifically, the U.S. and other governments around the globe have found that AIS's unclassified data plays an important role in support of their homeland security efforts through increased awareness of the cargo and personnel entering their respective waters and ports.

While the USCG has responsibility for approximately 200 AIS receivers along the U.S. coast under the National AIS (NAIS) program, its current NAIS expansion program has been curtailed, leaving gaps in coastal coverage. Significantly, NAIS never intended to cover the U.S. Arctic coast in Alaska and much of the U.S. The AIS picture north of the Arctic Circle comes from Canadian data and, to a limited extent, from industry-funded AIS receivers. Other than these Arctic shortcomings, most of the significant U.S. harbors are covered through the NAIS program. There is certainly greater potential value for the industry worth considering. [93]

Aviation Technology Initiatives

Perhaps a more mature and better-funded example of the use of technology to achieve greater transportation efficiency is the NextGen system mentioned in the air mode analysis. NextGen is moving U.S. air transportation from a ground-based to a satellite-based system by 2025. Although there are similarities in the use and function of AIS and NextGen in their respective transportation modes, NextGen was designed from the ground up as a command and control traffic management system. Once implemented, NextGen will result in shorter routes and more efficient movement of air traffic. With this improved technology, planes will be able to fly closer together, which will increase the flow of and

number of aircraft through airports without constructing additional runways. NextGen is also designed to conserve fuel and shorten routes with a resulting savings in cost and time. The projected price tag for full implementation is substantial ($32 billion by 2025),[94] but NextGen provides a great example of a technology solution that provides near term benefit via incremental updates, and long-term durability without the community and regulatory challenges of new terminals and runways.

Railroad Technology Initiatives

The rail industry is also in the midst of implementing technological solutions to achieve greater efficiencies. North American railroads continue to use technology advances to segment and specifically identify problem areas long before they manifest into a catastrophic event. In particular, wayside detectors have been successfully tested and installed extensively throughout the nation's 140,000 mile rail network, which are designed to capture images of critical areas of passing locomotives and railcars, images most easily overlooked during routine visual inspections. No matter the speed of the passing train, digital images of critical structural components are immediately captured and transferred back to locomotive and railcar owners for accurate assessment.[95] Likewise, Wayside Detectors operate 24 hours per day, seven days per week providing critical data inputs to all stakeholders. Upon assessment and validation, rolling stock with potential damage can be identified and removed from service long before actual structural or component failure occurs. When considering the negative consequences resulting from a major accident, immediately removing defective wheel sets identified by wayside detectors illustrate the railroad industry's commitment to improving operational safety while leveraging technology advances, thereby protecting the flow of cargo across the nation's rail network.

Positive Train Control (PTC), previously discussed in the rail mode analysis, represents another technological solution intended to improve rail safety and efficiency. Like AIS, PTC was originally designed as a collision avoidance system that allows train operators to know where they can travel safely. In addition to mapping 60,000 miles of track right-of-way and over 470,000 trackside equipment items, PTC entails the installation of hardware to include: digital data links between trains, switches, and command centers; Global Positioning System receivers; digital or analog radios; and brake/throttle interfaces allowing remote braking if the system detects an unsafe indication (overspeed, potential collision, or exceeding the train's authorized limit of travel).[96] Despite the financial and technical hurdles previously covered, PTC has the potential to revolutionize U.S. rail operations by providing a comprehensive, automated command and control system with secondary benefits of added fuel efficiency and detection of mechanical problems with locomotives. Proper implementation, however, is essential.

Highway Technology

A key technology initiative, with the potential to revolutionize highway road usage and vehicle flow, is the development of automated vehicles (AV). The collection of AV technologies enables vehicles of varying shape, size and purpose to travel from point-to-point over the open road without engaging an *active* driver. The rapid development of AV technologies over the last 10 years has brought this capability closer to becoming reality than one might expect.

The potential safety and economic impacts of AV technology are immense. The Eno Center for Transportation recently estimated the potential annual economic benefit of autonomous commercial vehicles to be roughly $211 billion. Of this, $37 billion would come from a 224 million gallon reduction in petroleum-based fuels as AV-related technologies control acceleration and breaking.[97] Second, AV technologies will reduce accident-related expenses and insurance premiums by eliminating driver error. Of the more than five million auto accidents that occur every year, an estimated 93 percent are caused, at least in part, by operator error.[98] Approximately 33,000 people are killed every year in the U.S. in auto

accidents, which computes to a cost of $300 billion to our nation's economy.[99] To highlight the potential impact of AVs, if only half the existing fleet goes driverless, an estimated 10,000 road fatalities caused by distracted drivers could be eliminated, and a 21 percent increase in lane capacity could be realized.[100] If 90 percent of today's fleet is converted, these benefits more than double.

AV technologies are already being implemented and their benefits realized. Many car companies today employ tracking and collision avoidance technologies in their cars to assist drivers. The EU is making one of these associated technologies, the Advanced Emergency Braking System (AEBS), a system which independently acts to avoid or even prevent accidents, mandatory equipment for all new trucks and buses by 2018.[101] In 2012, Volvo Trucks started experimenting with autonomous trucks on public roads to explore the feasibility of a platooning concept, which employs a single driver operating a lead truck equipped with a digital towbar capable of controlling the speed, steering and braking of a series of trucks or cars behind it.[102] This "road train" concept was proven successful in a 100+ km test along a portion of highway in Spain in 2012, and has been repeated in varying degrees in other countries during the past two years. As a final example of a practical application in use today, Maasvlakte Port at Rotterdam currently employs automated vehicles to rapidly transport container boxes, moved from ships, to their designated storage areas.

Conclusion

Since most established transportation modes pre-date modern technology, there is often a reluctance to add technological layers to those modes. That is to say, new technology is not necessary to the operation of a rail line since the rail line existed before the technology was developed. Additionally, the complex risks of cyber crime and terror can bring additional costs to defend against. The efficiencies, safety benefits and cost savings derived from new technologies are not always immediately apparent and must often be highlighted in order to convince government and industry leaders to accept them. The above examples highlight a number of technologic solutions, some of which are costly and some less so. Nevertheless, when compared to the projected costs of massive infrastructure improvements to roads, bridges and other large-scale construction projects, many technological improvements are relatively inexpensive and can substitute for, or compliment, costly brick and mortar investment to meet national transportation requirements and support U.S. strategic objectives.

-- *Commander Graham Jackson, U.S. Navy*
-- *Colonel Thomas Blazek, U.S. Air Force*

Essay 3: Transportation Resourcing and Public Private Partnerships (PPPs)

During a time of constrained resources, innovative solutions are critical to address the nation's most pressing infrastructure requirements. One way to help ease funding shortfalls is through the use of PPPs. PPPs are, "contractual agreements formed between a public sponsor and a private sector entity that allow for greater private sector participation in the delivery and financing of transportation projects."[103] Legislators and private organizations and firms are beginning to recognize the power of PPPs. Railroads, for example, have begun forging successful relationships with the private sector that have loosened that industry's financial belt and enabled the community to contribute to global economic development. In addition to offering a viable funding alternative for rail infrastructure projects, the PPP concept can also be applied to other modes of transportation.

PPPs and the Rail Industry

Today, the rail industry is more industrious and competitive than ever. But, according to the American Society of Civil Engineers 2013 report card on *America's Infrastructure*, the rail industry's grade stands at a C+, implying the need for further improvement.[104] Business in the freight rail sector is growing and is expected to continue well beyond 2035. To keep up with the demands of global trade, freight rail firms will have to upgrade and/or increase their rail lines. Although the rail business is profitable, it is not sufficient to maintain and grow the infrastructure to keep pace with economic growth.

In 2012, the railroad industry spent $62.6 billion to run, maintain, and grow the industry.[105] Unlike highways, which receive federal funds via fuel taxes, there is no comparable system of funding for the freight rail industry. The *Freight-Rail Bottom Line Report* reveals that, "since 1980, government has provided 11 percent of all rail funding, while Class I railroads have provided 86 percent".[106] While states have contributed most of the public rail funding, these funds went primarily to the passenger rail system. In essence, the freight rail industry falls short when it comes to funding its entire infrastructure improvement requirement. Therefore, it is essential that freight rail firms consider other mechanisms to fund critical rail infrastructure projects.

While PPPs are not new to the rail industry, only a few exist in the freight rail sector. One of these successful PPP projects was the Chicago Region Environmental and Transportation Efficiency (CREATE) rail improvement program. This was the first public-private "partnership between the U.S. Department of Transportation (DoT), the state of Illinois, the city of Chicago, Metra, Amtrak, and the nation's freight railroads."[107] The project resulted in the development of 31 over/underpasses, improved grade crossing, enhanced safety, and widespread upgrades to tracks, switches, and signal systems.[108] Norfolk Southern has also been a leader in forming PPPs with the development of their Heartland Corridor Project connecting the Port of Norfolk to Chicago. This PPP, between the DoT, the state of Virginia, and Norfolk Southern, was the first multi-state, intermodal rail PPP.[109] Not only did it build needed infrastructure, but the project also created jobs and helped reduce highway congestion. Overall, projects like these demonstrate the potential benefits of PPPs.

PPPs and the Aviation Industry

The FAA funds capital development programs based on airport usage (current and forecasted), age of the facilities, and changing technology. Required updates or replacement to equipment and infrastructure are funded either through appropriated dollars or the Airport and Airway Trust Fund (Trust Fund).[110] In the *National Plan of Integrated Airport Systems (2013-2017)* the FAA estimates there will be myriad eligible infrastructure projects over the next five years, valued at $42.5 billion.[111] In 2010, Delta Air Lines, the Port Authority of New York/New Jersey, and John F. Kennedy International Airport (JFKIAT)[112] broke ground on a $1.2 billion project to enhance and expand Terminal 4.[113] As a result, the terminal received much needed upgrades to its existing infrastructure; Delta Airlines benefited as the only air carrier operating from the two major airports in New York City; and the City of New York benefited from the infusion of capital and jobs into the local economy. This PPP is a cutting-edge example of a combined investment platform, initiated to improve existing infrastructure, overall revenue potential at the terminal, and passenger satisfaction. It also demonstrates how the collaboration of stakeholder expertise and resources can be applied to solve a complex problem, address funding shortfalls and gaps, and build needed capacity.

Unfortunately, PPPs are not being leveraged with enough frequency to make a significant impact on the overall infrastructure shortfalls plaguing the industry. PPPs must increase significantly, especially in cities most affected by capacity shortfalls, and where the Airport Improvement Program (AIP) and the Passenger Facility Charge (PFC)[114] do not provide the needed funding. Congress can make a huge impact by offering tax incentives to encourage more PPPs. Without such leadership, this powerful funding option will be sorely underutilized.

PPPs and Highway Funding

Highway funding is typically accomplished through a combination of federal and/or state money.[115] The Federal Highway Trust Fund (HTF) is the primary source of federal funding and is comprised of receipts collected from fuel taxes and other fees. With the increased use of fuel-efficient vehicles, however, there has been a decrease in HTF revenues. According to the ASCE, this decrease, combined with the CBO's proposed new fuel efficiency standards, could put the HTF on the path to bankruptcy.[116] As previously mentioned, in 2012 President Obama signed Public Law 112-141, Moving Ahead for Progress in the 21st Century (MAP-21), which was intended to aid the Federal Motor Carrier Safety Administration (FMCSA) in executing its mission.[117] Unfortunately, this legislation eliminated the Highway Bridge Program and folded the funding of bridges into Section 1106 of The National Highway Performance Program, leaving bridges to compete with other infrastructure improvement projects.[118] Given the precarious state of highway funding, PPPs could serve as a viable funding option for infrastructure projects at the federal and state level. One potential model is near completion in Florida. The Port of Miami Tunnel (POMT) project is being built through a PPP between the Florida Department of Transportation (FDOT) and MAT Concessionaire, LLC. It is a $2.6 billion, 35-year concession agreement,[119] which reduces the up-front risk to FDOT by placing responsibility for the design, construction, financing, operations and maintenance with Concessionaire. The project, the first of its kind for FDOT, was procured in 2009, and construction is projected for completion in May 2014. Once finished, the POMT will provide a direct connection for port-related traffic to highways, reduce congestion in downtown streets, and keep the POMT, the county's second largest economic generator, competitive.[120]

PPPs and the Maritime Industry

The DoT Maritime Administration notes that ports are owned and funded through a variety of means, from local government to private corporations, or a combination of both.[121] Since 2009, public funding has become available in the form of competitive grants via the Transportation Investment Generating Economic Recovery (TIGER). To date, over $350 million has been awarded for projects.[122] However, a grants program, whether competitive or not, is not a substitute for a comprehensive plan. Funding for the construction and restoration of inland waterways and locks, for example, is shared between the Inland Waterway Trust Fund (IWTF) (50 percent) and federal funds (50 percent), while operations and maintenance is 100 percent federally funded.[123] The continued solvency of the IWTF is suspect due to decreasing revenues since 2005, which are partially attributed to cost overruns on projects and a decrease in collections.[124] The Maritime Transportation Security Act created a standardized way to look at and access security vulnerabilities within the nation's port complex and developed more formalized PPPs to work jointly with all stakeholders in this endeavor. It is a coordinated effort by private, public, and relevant industry stakeholders to affect the "safe, secure, and efficient short-term recovery of the Marine Transportation System, including partial restoration of critical functions and services".[125] Additionally, the Intermodal Container Transfer Facility (ICTF) at the Jacksonville Port Authority is an excellent example of a maritime PPP. The project will increase the efficiency and speed of container transfer between vessels and trains, as well as create long-term jobs. Organizations participating in the PPP include the Department of Transportation, Jacksonville Port, CSX, and the Florida Department of Transportation. In a recent article, Deputy Maritime Administrator Paul "Chip" Jaenichen, hailed this project as "an outstanding example of the type of public-private partnerships that Secretary Foxx has called for, and just the kind of transportation teamwork that we would like to see reproduced across the country."[126]

The Bottom Line

The various U.S. transportation sectors cannot financially maintain and grow their infrastructure alone. The federal government, states, the private sector, industry associations, and other critical stakeholders must work together to establish PPPs to address the nation's most pressing infrastructure needs. Recently, the House Committee on Transportation and Infrastructure recognized the need to look beyond government funding to support transportation programs and the potential benefits of PPPs. In a press release, in Jan 2014, Congressmen Bill Shuster and Nick J. Rahall, II revealed the creation of a panel to look at the use of and prospects for PPPs. According to the press release, the work the panel does will assist the Committee with writing legislation in addition to other improvement efforts to reinforce America's infrastructure.[127] With the public and private sectors working together, the nation's roads, ports, railroads, and skies will be better prepared to move people and freight to their destinations more quickly, more efficiently, and with reduced cost.

-- Ms. Winifred Turner, Dept of Transportation

PART III: RECOMMENDATIONS AND CONCLUSIONS

U.S. transportation infrastructure faces myriad challenges. The preceding pages have identified the various issues facing each mode. It's important to emphasize that these modes do not operate in isolation. They operate as a complex system, a web of networks that relies on the health and success of the others to survive. Considering that interaction and realizing that the nation cannot solve every transportation ill at once, the following provides five recommendations. As stated early on, the U.S. Government has considerable responsibility in ensuring a robust transportation system, but it will be important to work all of these action in concert with industry. Considering the range and depth of issues investigated, those actions that provide the nearest term impact combined with strategic durability, will put the nation back on a path to world-class transportation infrastructure.

First, the U.S. Government and industry should **develop a comprehensive National Transportation and Freight Strategy**. Current funding for transportation programs and projects vary among modes. Separate trust funds, for example, are utilized for highways, inland waterways, harbor maintenance, and airports. How those funds are distributed can also vary. Similarly, funding bills, such as surface transportation and water, are submitted and deliberated separately. The net affect of disunity results in an inefficient allocation of scarce funds to transportation projects with varying levels of economic benefit. A comprehensive transportation and freight strategy is needed. As noted in a recent *Brookings* article, "A true national freight policy must recognize that the economy and freight are inseparable…but federal policies approach both in silos."[128] A true infrastructure strategy would, for example, examine key economic centers, critical freight corridors, and strategic choke points, and invest in intermodal projects that could provide the biggest return on investment. For example, the intermodal challenges in U.S. ports illustrated in the first essay would benefit greatly from an integrated effort.

Second, the government should **immediately identify sustainable funding sources for the HTF and move to a vehicle miles travelled (VMT) based tax.** Since 2008, declining fuel tax revenues have been unable to keep up with outlays and the HTF has required periodic transfers from the Treasury's general fund to keep the fund solvent. To address these funding shortfalls the federal government should begin transitioning to a VMT or fee system as the most viable long-term solution to funding and sustaining the HTF. Unlike fuel taxes and general fund revenues, VMT-based fees better reflect the costs associated with actual highway use in terms of congestion and pavement damage and would promote higher levels of efficiency by encouraging highway usage when benefits outweigh costs.[129] According to

the 2009 National Surface Transportation Infrastructure Financing Commission, moving to a VMT system would be, "the most viable approach to efficiently fund federal investment in surface transportation." Fuel taxes should be immediately increased and be indexed to inflation in out years. Once a VMT-based system is ready to be implemented, fuel taxes and other sources of revenue to the HTF (tire taxes, heavy-use vehicle fees) can be phased out.

Third, the U.S. should **delay the implementation of Positive Train Control.** To date, Class I railroads have invested $3 billion in PTC infrastructure, and plan $5 billion in further outlays before December 2015.[130] Even with this level of financial commitment, the primary commercial train management system is not fully operational or thoroughly tested.[131] While PTC is important, the rush to meet the government deadline could result in a less than fully integrated system. This could create gaps and seams that a potential attacker can exploit. Also, due to PTC's aggressive deadline, the Congressional Research Service assesses that railroads will divert money from other infrastructure improvements (such as hazardous crossing upgrades), and an incremental approach (beyond 2015) will be required for truly interoperable CBTC.[132] A delay would also allow the FRA, working with industry, to contract a lead system integrator for PTC to ensure standardization and interoperability, foment an enterprise approach to risk management, and significantly bolster PTC security.

Fourth, **accelerate and complete NextGen.** Improving Air Traffic Control is a top priority in aviation, and as is often the case, funding from government and industry is a problem. NextGen is a technology solution to aviation congestion whose benefits are being proven through its incremental deliveries. The U.S. Government clearly has a primary role in implementation, though it is a PPP of sorts. NextGen is primarily paid for via the Airport and Airways Trust Fund,[133] but only covers 68 percent of the bill; the rest supplied from the general treasury.[134] Therefore, a thorough review of the complex and expansive taxes and fees paid by the U.S. airlines and passengers, and close consideration of just what those funds are paying for would set the stage for properly funding NextGen (and other challenges listed in the modal analysis).

Fifth, government and industry should **investigate and implement PPP's for critical infrastructure projects.** Federal, state, and local funding cannot fully address all of the nation's infrastructure requirements. Therefore, alternative sources of funding will be required moving forward. PPPs are one such alternative and provide a viable option to mitigate these shortfalls. As discussed in the third essay, a number of PPPs have been conducted to address complex problems in the rail, road, and air industry. The success of PPPs, like the JFK Terminal 4 project and the Chicago Region Environmental and Transportation Efficiency (CREATE) rail improvement program, demonstrate how various public and private stakeholders can come together to forge projects that reduce congestion, create jobs, and spawn economic growth. Other PPPs, like the I-495 toll lanes in Virginia, are serving as a model for how the nation's most populated urban areas are innovating to improve traffic flow and reduce congestion.

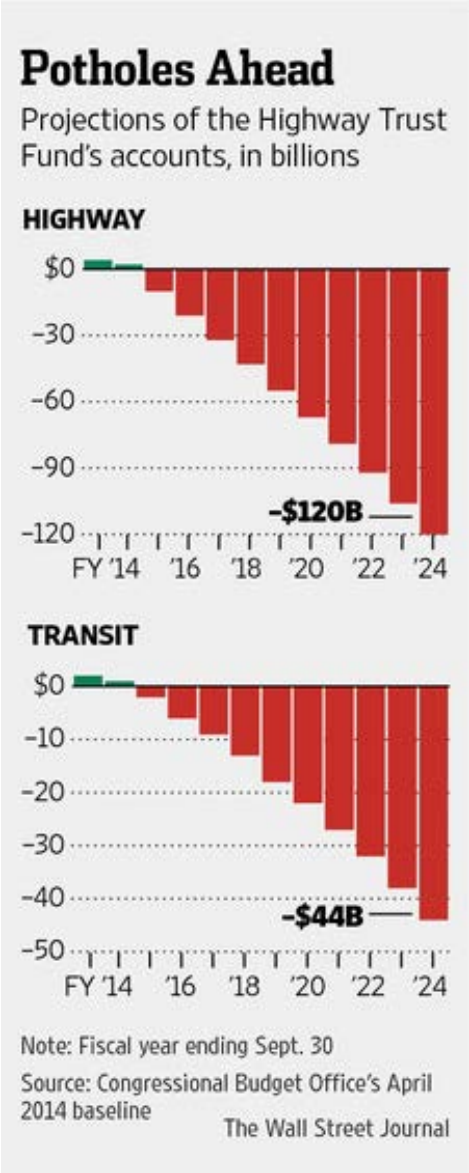
In conclusion, the transportation challenges facing the U.S. are inhibiting today, but also portend greater congestion, slower movements of personnel and freight, and increased costs to firms and consumers, all adding to the drag on the nation's economy. U.S. economic might and national security are directly dependent on transportation infrastructure. Ensuring this nation's viability and competitiveness moving forward requires commitment, leadership, and an integrated effort. The U.S. must address the critical transportation infrastructure issues that threaten its economic prosperity and national security. Proper focus will return the nation's transportation infrastructure to the economic engine that it once was and establish a firm foundation well into the future.

APPENDIX A – ASCE REPORT CARD SUMMARY

Mode of Transportation	Aviation	Railways	Roads	Bridges	Ports	Inland Waterways
ASCE 2013 Report Card Grade	D	C+	D	C+	C	D-
Source of Funding	-Airport and Airway Trust Fund (68%) (User Fees) -Airport cash flow -Revenue and general bonds - Grants, federal, state, & local - Passenger facilities charges	- Private - Federal through grants, although small and infrequent usually to small railroads	- Federal Highway Trust Fund (User Fees) -State & local funding - tolls	- Federal Highway Trust Fund (User Fees) -State & local funding - tolls	- Private - State - Local - Federal through Grants	**Construction** - Inland Waterway Trust Fund (IWTF) (50%) - Federal funds (50%) **Operations & Maintenance** - Federal (100%)
Planning Process	Airports Capital Improvement Plan	National Rail Plan (Rqd but not submitted)	None Identified	None Identified	None Identified	Under Consideration 20 year plan. Law not passed
Cycle Timing	Annual	15 Sept 12	N/A	N/A	N/A	N/A
Responsible Party	DoT / FAA	DoT / FRA	DoT / FHWA	DoT / FHWA	DoT MARAD	Dept of Army
Quantity	Airports 3300 existing 25 planned	160K miles track 76K bridges 600 tunnels	4M miles 3T vehicle miles which 11M are trucks 2011	~189,372	600 major	12K navigable miles 200 locks
Number of Deficient / Functionally Obsolete			32% of major roadways	1 in 9 151,497- 2012 30% exceeded 50 year lifespan		
Average Age				42 Years		Locks avg 50 Years
Capacity Freight	70% domestic tonnage $563B	43% intercity freight 33% exports ~12.5B tons		~210M trips daily in 102 Metro areas	~76% exports $460B ~70% imports $930B 2010 (by tonnage)	500M tons $152B valued Equivalent to 51M truck trips yearly
Passenger	728M - 2011	31.2M 2012				
Due to Deficiencies Current Cost to Economy	$22B FY-12	~42% remain congested ~$101B wasted time/fuel	$67B yearly ~42% congested 1.9B gal. gas ~34 hours = $101B 2010			
Anticipated Cost to Econ	$34B 2020 $63B 2040	$200M	$130B 2010	Included w/Roads		
Primary Inter-relationship to National Security	CRAF Program & Freight Movement	Freight & Equipment Movement	Personnel, Freight, & Equipment Movement	Personnel, Freight, & Equipment Movement	Personnel, Freight, & Equipment Movement	Freight & Equipment Movement

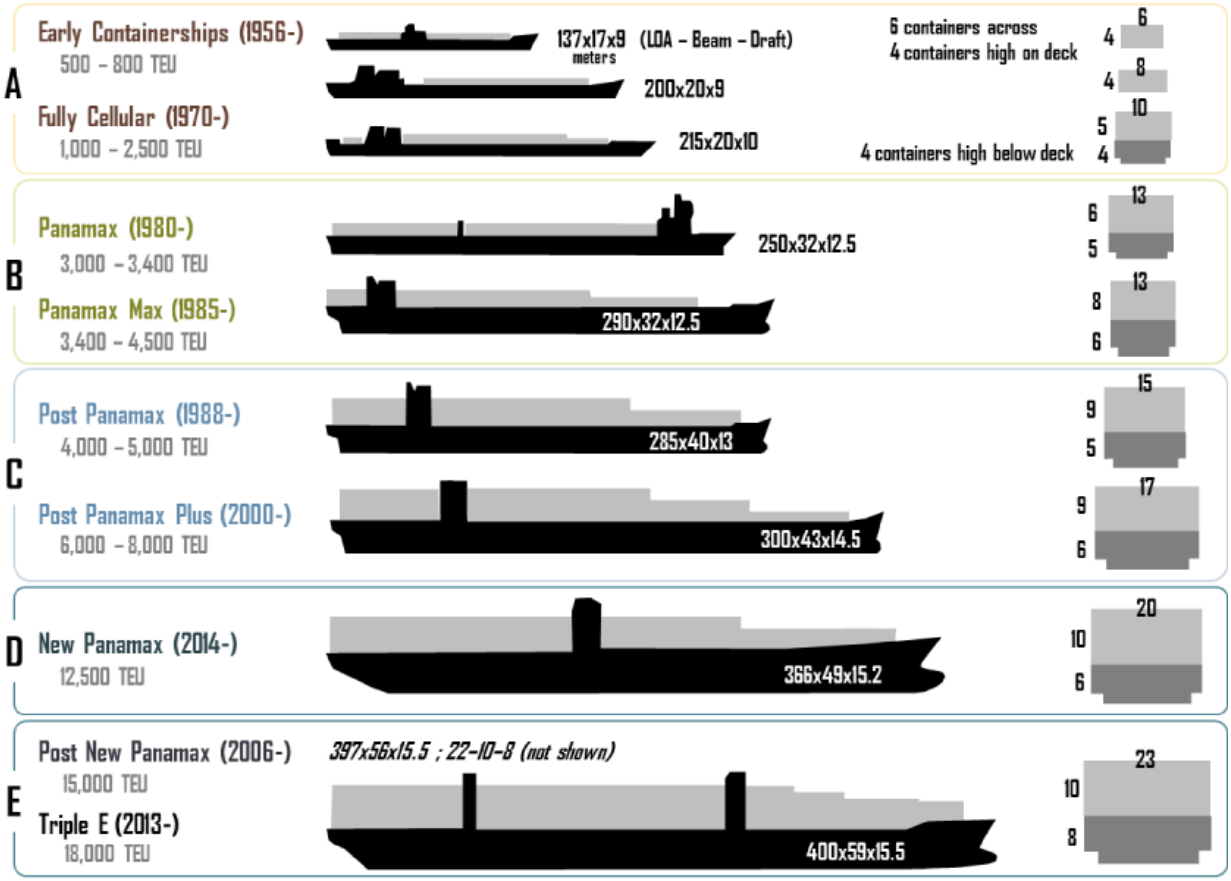
Source: ASCE, "2013 Report Card For America's Infrastructure," http://www.infrastructurereportcard.org/a/#p/rail/conditions-and-capacity

APPENDIX B – HIGHWAY TRUST FUND DEFICIT PROJECTION



Source: The Wall Street Journal

APPENDIX C: CONTAINER VESSEL CLASSES



Source: Source: Ashar and Rodrigue, 2012. All dimensions are in meters. LOA: Length overall. TEU: Twenty-foot Equivalent Unit

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[104] American Society of Civil Engineers (ACES) 2013 Report card For America's Infrastructure, March 2013, 4.
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[106] American Association of State Highway and Transportation Officials, Transportation Invest in America, Freight-Rail Bottom Line Report, 85.

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[109] http://www.mwcog.org/uploads/committee-documents/Z15WV19a20110708135950.pdf

[110] U.S. Federal Aviation Administration, National Plan of Integrated Airport System (NPIAS) 2013: Report to Congress (Washington, DC: U.S. FAA, September 27, 2012), iv.

[111] U.S. Federal Aviation Administration, National Plan of Integrated Airport System (NPIAS) 2013: Report to Congress (Washington, DC: U.S. FAA, September 27, 2012), iv.

[112] Terminal 4 is one of the largest, most spacious terminals in the New York area. More than 30 international and domestic airlines carry millions of passengers annually. Regarded as `The Terminal of Choice', the facility is in the second phase of a major expansion project for Delta Air Lines, which adds additional capacity and state-of-the-art technology. JFKIAT, LLC, the operator of Terminal 4, offers airlines a dedicated management company that oversees all landside, airside and terminal operations. Terminal 4 at JFK International Airport is a successful paradigm for air terminal management and a model of public-private partnership.

[113] Delta Air Lines, "Delta Air Lines, JFKIAT and Port Authority of New York and New Jersey Break Ground on $1.2 Billion Enhancement and Expansion of Terminal 4 at JFK Airport," http://news.delta.com/index.php?s=43&item=1192, March 12, 2014.

[114] According to the FAA website, the Airport Improvement Program (AIP) provides grants to public agencies — and, in some cases, to private owners and entities -- for the planning and development of public-use airports that are included in the National Plan of Integrated Airport Systems (NPIAS). The Passenger Facility Charge (PFC) Program allows the collection of PFC fees up to $4.50 for every boarded passenger at commercial airports controlled by public agencies. Airports use these fees to fund FAA-approved projects that enhance safety, security, or capacity; reduce noise; or increase air carrier competition.

[115] "Freight Key Transportation Challenges," linked from The U.S. Department of Transportation Homepage: at "Freight Management and Operations," http://ops.fhwa.dot.gov/freight/ publications/ fhwaop03004/finan.htm (accessed March 12, 2014).

[116] The American Association of Civil Engineers, 2013 Report Card for America's Infrastructure, 49.

[117] "MAP-21 – Moving Ahead for Progress in the 21st Century Act," linked from The U.S. Department of Transportation Homepage: at "About Map-21," http://www.fmcsa.dot.gov/ mission/policy/map-21-moving-ahead-progress-21st-century-act (accessed March 9, 2014).

[118] Moving Ahead for Progress in the 21st Century, Public Law 112-141, 112th Cong., 2nd sess. (January, 3, 2012), 22.

[119] A concession agreement is an agreement allowing a private sector company to design, build, finance and operate a State infrastructure over a long period of time and return it to the State in a prescribed condition at the end of the period. In this case, FDOT entered into a concession agreement with MAT Concessionaire, LLC in a competitive bidding process to design, build, finance, operate, and maintain the POMT project over a defined term.

[120] *The Port of Miami Tunnel Home Page*, http://www.portofmiamitunnel.com/project-overview/project-overview-1/ (accessed May 13, 2014).

[121] The U.S. Department of Transportation, Maritime Administration Homepage, http://www.marad.dot.gov/ports_landing_page/ports_landing_page.htm (accessed March 11, 2014).

[122] The American Association of Civil Engineers, 2013 Report Card for America's Infrastructure, 43.

[123] The American Association of Civil Engineers, 2013 Report Card for America's Infrastructure, 40.

[124] The American Association of Civil Engineers, 2013 Report Card for America's Infrastructure, 1.

[125] United States Coast Guard, Commandant Publication 16700.4, Navigation and Vessel Inspection Circular NO. 9-02, change 4, 12 June 2013, enclosure 5.

[126] http://www.dot.gov/fastlane/tiger-grant-fuels-public-private-partnership-port-jacksonville

[127] http://transportation.house.gov/news/documentsingle.aspx?DocumentID=367010

[128] Adie Tomer, "Building a National Freight Policy; One Proposal at a Time," *Brookings Online*, May 6, 2014, http://www.brookings.edu/blogs/the-avenue/posts/2014/05/06-national-freight-policy-tomer (accessed May 10, 2014).

[129] Kile, *Highway Trust Fund and Paying for Highways*, 3-4.

[130] American Association of Railroads, Op. Cit.

[131] Smith, Op. Cit.

[132] Peters, Op. Cit., p. 15.

[133] American Society of Civil Engineers, *2013 Report Card for America's Infrastructure: Aviation*, http://www.infrastructurereportcard.org/aviation/, (accessed March 15, 2014).

[134] American Society of Civil Engineers, *2013 Report Card for America's Infrastructure: Aviation*, http://www.infrastructurereportcard.org/aviation/, (accessed March 15, 2014).