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ABSTRACT

The transportation industry has direct relation with the country's economy and national security as a driver of goods and services for all the industries, guaranteeing the military power readiness and projection. Going through the four main transportation modes – Maritime, Trucking, Rail, and Air -- this study reflects the current US transportation industry situation from a comprehensive and strategic point of view, including issues of infrastructure, human capital, safety and security. Finally, several recommendations are proposed to highlight feasible solutions that leverage the national, state and local authorities to address presented issues. Solutions formulated vary from promoting research and development (R&D) in specific areas and development of new trends, to adopting political measures to ensure funding and government support for transportation improvement at all levels – national, state and municipal.

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INDUSTRY STUDY OUTREACH AND FIELD STUDIES

On-Campus Presenters

American Association of State Highway and Transportation Officials, Washington, DC
 American Roll On/Roll Off Carrier, Washington, DC
 American Short Line and Regional Railroad Association, Washington, DC
 FedEx Corporation, Washington, DC
 JB Hunt Trucking, Chantilly, VA
 Office of Maritime Security Response Policy, US Coast Guard
 US Transportation Command
 Washington Metro Area Transit Authority (WMATA), Washington, DC
 Waterways Council, Inc., Washington, DC

Field Studies - Domestic

American Trucking Association, Washington, DC
 Federal Aviation Administration Operations Center, Warrenton, VA
 Maersk Line, Limited, Richmond, VA
 MITRE Corporation, Center for Advanced Aviation Systems Development, McLean, VA
 National Transportation Safety Board, Ashburn, VA
 Norfolk International Terminal and Virginia International Gateway, Norfolk, VA
 Norfolk Southern Railroad, Richmond, VA
 Smithsonian Air and Space Museum, Udvar-Hazy Center, Chantilly, VA
 The RAND Corporation, Washington, DC
 UPS Freight, Richmond, VA
 US Coast Guard Sector New York, Staten Island, NY
 US Customs and Border Protection, DHS, New York City, NY
 US Department of Transportation, Washington, DC
 US House of Representatives, Transportation and Infrastructure Committee, Washington, DC
 US Senate, Committee on Commerce, Science and Transportation, Washington, DC
 Vane Brothers, Baltimore, MD
 Virginia Inland Port, Front Royal, VA
 Wells Fargo-Wachovia, New York City, NY

Field Studies - International

Duisburg Germany Port Authority, Duisburg, Germany
 UPS European Air Hub Distribution Facility, Cologne, Germany
 Van der Vlist Special Transport/Logistics, Rotterdam, Netherlands
 Futureland/Port of Rotterdam, Rotterdam, Netherlands
 Eurostar International, Limited, London, United Kingdom
 Royal Mail, London, United Kingdom

INTRODUCTION

“Christopher Columbus, you cannot fail us in finding a shorter trading route to the riches of the Eastern markets.” As an experienced merchant and sailing master, Columbus responded, “Queen Isabella and King Ferdinand, I will sail over the Ocean Sea to the West and find you a most profitable route.” And so began the birth of our nation, and an unexpected outcome while seeking smarter trade routes to improve economic benefits. Quickly, our nation began to grow, stimulated by ample waterways, delivering goods and people to promote expansion. As the US population grew, improvements to infrastructure slowly enhanced quality of life and commerce. Society developed roads, first for horse and buggy and later to accommodate the new automobile. Trains supported the expansion effort as well, not only moving goods at record speed across long distances when compared to river barges, but also to help carry war goods and soldiers during our nation’s Civil War.

Our nation has a history of impatience and high expectation, and our government must keep up with its desire for faster and cheaper goods and services. This means that today’s transportation industry must address its current challenges and shortfalls if it plans to contend with our ever-changing world. Today, everything relies on the availability of transportation, and without a reliable transportation system, globalization, national readiness, and the continued operations of all other industries critical to our nation would cease to function. As stated by President Obama in his 2014 statement on transportation infrastructure, “Investments by previous generations of Americans – from the Erie Canal in 1807, to the Transcontinental Railroad in 1869, to the Interstate Highway System in the 1950s and 1960s – were instrumental in putting the country on a path for sustained economic growth, productivity increases, an unrivalled national market for goods and services, and international competitiveness. But today, current estimates indicate that America’s transportation infrastructure is not keeping pace with demands or the needs of our growing economy, for today or for future generations.”¹ What the nation requires is an effective and efficient balance of commerce and timely arrival of goods in support of a US just-in-time logistics system, with the right amount of government oversight and intervention, while ensuring the safety and security of our nation and its people.

The Eisenhower School seeks to develop in its students a strategic perspective on the defense industrial base and its role in supporting the resource requirements for national security.² Unfortunately, resources are often viewed exclusively in terms of *stuff*, and the role of *services* is often understated. While the shrinking ability of our diminishing manufacturing base to produce essential materiel is often viewed as a security threat, it is within the service sector that we find the greatest risk, especially to our nation’s readiness, and it is the service-centric resource of commercial transportation capacity that must be evaluated, marshalled and managed to ensure the nation’s readiness.

All industries rely on an effective transportation system in order to operate or exist. The US recognizes this importance by identifying transportation as one of the sixteen critical information sectors that falls under the nation’s critical infrastructure protection plan. Critical infrastructure represents “systems and assets, whether physical or virtual, so vital to the US that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters.”³ And the important interdependency between transportation and all other industries must also be highlighted, because without an effective and safe transportation system, failure across the entire infrastructure spectrum is possible.

Given transportation's significant contributions to globalization, national security, and the nation's critical industries, having confidence in its strength, dependence on its reliability, and assurance in its efficiency become critical in how the government establishes its role in the system's performance, safety, and growth.

THE INDUSTRY DEFINED, AND CURRENT CONDITIONS

As presented above, the US transportation industry is critically important to domestic and global commerce, passenger transit, and the overall growth of the global economy. This integrated network of ground, air, and maritime activities supports the demands of a highly competitive environment where customers expect timely products, and firms want to continue to extend their reach into different markets. For the US Transportation Command (USTRANSCOM), the command's top priority is preserving the nation's readiness by ensuring access to commercial transportation networks.⁴ In 2013, the transportation sector accounted for approximately \$1.4T in transportation goods and services, which equates to 8.6% of the US Gross Domestic Product (GDP). Within the US, the transportation network includes more than 4 million miles of roads, over 19,000 public and private airports, approximately 140,000 miles of freight and passenger railroads, and 25,000 miles of navigable waterways.⁵ This section of the report will assess four modes of transportation that the nation relies upon to ensure its continued economic stability and national readiness: maritime, trucking, rail and air.

Maritime. The movement of goods across oceans into and out of the US and through waterways within the nation's borders continues to be a critical necessity in ensuring an efficient globalized commerce system. More than 90% of trade travels by sea, and with maritime vessels carrying 38% of exports and 53% of imports for the US (the largest percentage of any transportation mode), the reliance on maritime freight movement is vital. With current positive trends in global volume evident (3.4% growth in 2013, and the same in 2014), it is safe to assume that continued global economic development and increases in consumer demand in developing economies will further promote this growing trend.⁶

With the US currently maintaining 25,000 miles of navigable domestic waterways, 182 ports, 239 lock chambers, and 8,231 cargo handling docks, its footprint across the nation is significantly large.⁷ IBISWorld recognizes this industry as mature, with stable economic growth and consistent contribution to GDP growth as well. A recent period of streamlining, with some companies forced to exit based on declining profit margins, has strengthened the larger companies. High barriers to entry provide some level of protection to those who are currently in the industry. Competition within the maritime industry comes more from other modes of transportation, especially regarding intercoastal waterway freight, where competition with rail is based on rail's ability to transport at low cost and with similarly low environmental impacts.

Competitive advantages within the transportation industry have been highlighted by the innovative use of technology. Recent advancements in real-time tracking of goods and cargo, as well as better assurances of the safety and security of goods during transport, have provided significant benefit in ensuring customer confidence and trust. Smaller companies within the industry have also learned that focusing on core competencies is a better road to success than working to monopolize such a diverse market.

The US relies heavily on large international corporations, like Maersk and Hapag-Lloyd, to provide international maritime freight services, where strong competition exists across the international shipping market. Within domestic maritime shipping, the Jones Act (officially known as the Merchant Maritime Act of 1920) still allows protection from foreign competition

within US maritime markets; however, costs to maritime companies (and to their customers) are significantly higher than non-Jones Act carriers. Internationally, a lackluster freight demand has resulted in intense price competitions, ultimately resulting in the merger and acquisition of smaller businesses by larger companies. Unfortunately, this has also resulted in excess capacity, which may worsen given the current trends in large shipbuilding in order to meet more stringent global safety and emissions requirements, and to accommodate greater volume with less vessel trips. Shipping may need to make critical business decisions to retire older tonnage carriers in order to combat the issue of excess capacity.

Access to nearby foreign ports will also begin to emerge as a competition issue. Port operations play a pivotal role in the maritime industry, linking maritime cargo to their landside destinations. Port and harbor operators are responsible for uploading and downloading cargo, completing customs and shipping paperwork, and transferring maritime cargo to landside transportation systems (rail, truck, barge and pipelines). Port operation profitability is directly connected to freight volumes, and the increased consumer demand for imports has experts forecasting 3.8% annual growth in the US port and harbor operations from 2015-2020.⁸ These projections may be affected by foreign anchorages, as ports in Canada and Mexico are now being considered in lieu of those in the US due to their ability to support a growing volume of cargo.

As a direct contributor to the nation's military readiness, US reliance on a dated Maritime Readiness program, plagued by limited availability of Jones Act-certified ships and merchant marines, is currently inhibiting the industry's ability to support our National Security Strategy. Military reliance on the US commercial industry is critical. This military reliance is also considered an investment, and cost savings to the tax payer are realized, as it is significantly less expensive to provide stipends to US commercial industry participants than it is to fully invest in a DoD-provided maritime surge fleet. The cost to industry, however, to maintain this ready fleet is well above the current stipend of \$3.5M paid annually by the US Government, and discussion is ongoing on whether increasing the stipend to \$5M is a viable response. Also, it is not just the limited accessibility to vessels that is creating a readiness risk. If commercial companies are called upon for support to a military surge, the US relies on a significant sized maritime force to provide manpower for surge requirements in manning these vessels. This will be further discussed in the major issues section of this report.

Much attention has been given to physical security threats, which will be further discussed as a focused issue in an upcoming section of this report. Additionally, attempts to address various types of cyber threats will also be discussed in detail. Economic, environmental, and social challenges that face the maritime industry include (1) growing and concentrated traffic volumes brought about by ever-increasing ship size; (2) the cost of adaptation of port, and port hinterland infrastructure measures; (3) national budget constraints limiting the possibilities of public funding for transport infrastructure; (4) stricter environmental regulations and emissions controls; (5) effects of trade agreements like the Trans-Pacific Partnership and the Transatlantic Trade and Investment Partnership; and (6) threats from cyber hackers and terrorists.⁹

Regarding the outlook of the maritime industry, one can be either pessimistic or optimistic. A pessimistic outlook might say, "The outlook remains uncertain and subject to many downside risks, including: (1) continued moderate growth in global demand and merchandise trade; (2) the fragile recovery in Europe; (3) diverging outlooks for net oil consumers and producers; (4) geopolitical tensions; and, (5) a potential rapid slowdown in developing economies, in particular the large emerging economies, as well as uncertainty about the pace and the implications of the slowdown in China."¹⁰ Optimism exists, however, within maritime as

well. “In the five years prior to 2020, industry revenue growth is expected to accelerate. Economic growth in the US and its key trading partners will increase trade and demand for freight shipping. As a result, the deep-sea freight shipping segment’s capacity surplus will narrow, enabling companies to charge higher shipping rates. Moreover, continued demand for oil and gas transportation will increase demand for the industry’s coastal services.”¹¹

Trucking. The nation’s system of roadways is vital in moving people and goods throughout the country, totaling more than 4 million miles of public roadways.¹² “These roads provide over 11 million trucks with direct access to our ports, rail terminals and city centers, driving our economy and enabling goods to get to market.”¹³ The American Society of Civil Engineers (ASCE) reports that 32% of the nation’s major roads are in poor or mediocre condition, while urban area roads are in a state of greater disrepair, resulting in a rating of “D,” costing US motorists who are traveling on deficient pavement \$67B a year in vehicle repairs.¹⁴

The trucking industry is characterized by low barriers to entry and low concentration, with owner-operators accounting for over 90% of the industry firms, nearing a perfect competition structure. With high levels of fragmentation, industry operators experience intense price competition and generally earn low profit margins with an industry average around 5.6%. In the future, the trucking industry will likely continue to be the most widely used mode of freight transportation, although the industry will see greater competition from the rail industry due to effects from unstable fuel prices, infrastructure constraints, and concern for environmental responsibility and sustainability.¹⁵

The trucking industry is the major mode of freight tonnage transportation within the US. In 2015, the American Trucking Association (ATA) reported that freight trucking was a \$749B industry and represented 80.5% of the total revenue across all transportation modes of intra-US freight transportation.¹⁶ The trucking industry’s healthy dominance over the other modes of freight transportation is attributable to its unique capability to provide not only “first” and “last-mile” transportation services to customers, but also to specialized, tank, and temperature controlled trucking.¹⁷ Most firms in the trucking industry are domestically owned and operated at the local level, resulting in reduced industry globalization, though some firms have operations in Canada and Mexico.¹⁸ Therefore, the international competition within the US for the trucking industry is extremely limited to nonexistent.

The challenges facing the trucking industry and the nation’s road network are a continuing trend, which include eroding infrastructure; increasing road congestion; diminishing federal, state and local resources dedicated to the repair of that infrastructure; and an increasing shortage of truck drivers. The state of the Nation’s road network will grow worse as the population increases and urban growth stresses an already maximized roadway capacity. The situation is so dire, that by 2020, the ASCE projects the road network deficiencies and bridge conditions to increase by 82%, and 351% by 2040 which will cost the national economy, cumulatively, \$334B in GDP, and rise to \$1.9T.¹⁹

Revenue generated in 2015 equated to over 10.3 billion tons of freight, or 69.2% of all freight tonnage.²⁰ During 2009, the trucking industry experienced a 20% reduction in its revenues as a result of the Great Recession. This crisis led larger firms to acquire smaller ones as a strategy to reduce competition and to expand geographically.²¹ Customer demand for a more comprehensive approach to moving goods is also driving strategic decisions in the industry, further encouraging larger firms to attain a competitive advantage by focusing their attention on mergers and acquisitions that widen the array of services they offer.²²

Forty-two percent of the nation’s major urban highways are congested, costing the

economy an estimated \$101B in time and fuel annually.²³ Even with federal, state, and local capital investments increased to \$91B annually, the level of investment is insufficient and projected to result in a decline in conditions and performance in the long term.²⁴ The Federal Highway Administration (FHWA) estimates that \$170B in capital investment would be needed on an annual basis to significantly improve the road network's condition and performance rating.²⁵ Funding for highway infrastructure primarily comes from the public sector, with around 75% of expenditures coming from state and local governments, and the rest coming from the federal government.²⁶ In the past 10 years, according to a report by the Congressional Budget Office, "outlays from the HTF [Highway Trust Fund] have exceeded revenues by more than \$52B, and outlays will exceed revenues by an estimated \$167B over the next eight years if obligations from the fund continue at the 2014 rate."²⁷

During 2015, President Obama signed a five-year, \$305B law called the Fixing America's Surface Transportation (FAST) Act. "The FAST Act is intended to provide financial support for projects that contribute to air quality improvements and provide congestion relief in areas where carbon monoxide and/or particulate matter are above the national average."²⁸ Additionally, the Department of Transportation (DOT) continues progress on its proposed plan for a \$478B reauthorization called the Grow America Act.²⁹ This plan would authorize \$317B for highway programs that the FAST Act does not address.

In 2015, 10.3 billion tons of freight moved by truck in the United States,³⁰ and the DOT estimates that freight tonnage transported via truck will grow 20% by 2026.³¹ Meeting this demand will be a challenge due to the shortfall of qualified drivers within the industry. The driver shortage data projections, provided by ATA, indicate the industry-wide shortage will climb to around 175,000 commercial drivers by 2024.³² In the event of a major military activation, enormous amounts of military equipment will need to be moved. Currently DOD relies on the trucking industry to assist in transporting military equipment to the nearest rail hub, maritime port, or airport. Given the current shortfalls in drivers, it would be difficult to support a surge demand outside current levels without significantly impacting the local economy.

Based on the percentage of freight tonnage transported and the current projections for future growth within the trucking industry, it is clear that the trucking industry remains an important mode of transportation impacting the nation's future economy. However, a failing road and bridge infrastructure, coupled with a nationwide truck driver shortage, may soon have a detrimental impact that will cause a significant lag in the nation's economy and a negative impact on the ability to support our National Security Strategy.

Rail. The US rail industry is predominantly a freight system, with passenger rail comprising only 3.8% of total industry revenue. The freight rail industry has 584 railroad firms. Seven of these are considered Class 1 railroads, which is defined by having annual operating revenue of \$378.8M or more. Four of the seven Class 1 railroads capture 87.6% of the total market, with CSX Corporation (CSX) and Norfolk Southern Corporation (NS) controlling most of the market east of the Mississippi River; and Union Pacific Corporation (UP) and Burlington Northern Santa Fe Corporation (BNSF) controlling most of the market west of the Mississippi. These Class 1 firms are efficient transporters of high volume, bulk commodities and industrial goods and operate in a quasi-monopoly fashion within their respective regions.³³ The remainder of the firms are smaller and mainly operate on regional spurs or branch lines.

Overall, the freight rail industry is highly concentrated, has high barriers to entry that limit intra-industry competition, and places its competitive focus on taking market share from other modes or growth through expansion of intermodal shipping. The ability of trucking and

inland maritime industries to increase market share hauling bulk cargoes (the mainstay of freight rail) is limited by the inability of trucks to efficiently move large volumes at low cost, and by the limited geographical reach of the inland waterways.

Freight rail is a highly cyclical industry, with bulk freight and intermodal services dominating the industry, and accounting for 94.5% of revenue.³⁴ Key market segments of rail are agriculture, forestry, coal, chemicals, automobile manufacturing, petroleum and intermodal, with intermodal being the fastest growing sector of the rail industry.³⁵ In 2015, industry revenue was \$83.9B with projected growth of 2.8% - 3.8% each year through 2020. With gross profits totaling \$39.5B and projected to grow similarly, 18% of revenue is reinvested in the industry's infrastructure, with 18.5% expended in personnel costs, and 32% returned to shareholders.³⁶ Beginning in mid-2015 the industry faced a cyclical slowdown, with the greatest effect in coal, oil and imported goods from China, resulting in employment in the rail transport subsector declining in 2015.

Most recently, key threats to the industry included another round of consolidation, increased anti-trust regulations, and expanding environmental and safety regulations, as well as uncertainty over technological challenges of implementing Positive Train Control (PTC). In 2015, Canadian Pacific (CP) continued attempts to establish a coast-to-coast network by purchasing a major US east coast Class 1 firm, seeking benefits in increased efficiency and the ability to bypass mid-west congestion points, such as Chicago. A large merger would likely cause other Class 1 railroads to seek mergers in order to compete, but would raise concerns with a significant growth in captive shippers.

Required capital investments, needed for improvements to meet recent federal regulations and newly established standards, left the rail industry in a financial dilemma. In 2015, environmental regulations continued to threaten the rail industry in regard to types of cargo to be hauled and in standards for the operation of the railroads rolling stock. Federal, state and local governments began implementing new regulations for shipments of crude oil by rail, which includes expensive capital investment costs to refit or replace tanker cars.³⁷ Additionally, all locomotive engines manufactured after 2015 must meet US Environmental Protection Agency standards announced in 2008, reducing emissions of diesel particulate matter by 90% and nitrous oxide by 80%, further raising the costs of new locomotives.³⁸ Given Congress' delay on the implementation of the aforementioned PTC until the end of 2018, the rail industry is still spending significant capital designing and integrating PTC networks, and ensuring interoperability among the major and minor railroad companies. All the while, US Government Accountability Office (GAO) reports suggest that the US government needs to provide additional oversight to ensure its successful completion.³⁹

Population trends pose a serious challenge for US transportation infrastructure. By 2050, 75% of US inhabitants will converge and live in megaregions, projected to cause further traffic congestion and a resulting loss of productivity. With a growing population and economy, the railroad industry will need to increase capacity for moving freight and passengers in order to enable the US to maintain its economic leadership and to provide for robust investment in its national security needs in the coming decades. Additionally, rail transport is one of the key modes that guarantees the military's strategic mobility and readiness required for military power projection. Trains are largely used to transport heavy and tracked vehicles from bases to seaports of embarkation in the continental US (CONUS), and to deploy personnel and equipment in theaters abroad. Domestic military railways rest on two strategic pillars: Defense Freight Railroad Interexchange Fleet (DFRIF)⁴⁰ and Strategic Rail Corridor Network (STRACNET).⁴¹

The first pillar, DFRIF, is owned by DOD, where locomotives and railcars are distributed among military units (Army and Marine Corps) in a small portion, and in a large amount to the railway companies that provide transportation support. The second pillar, STRACNET, is a complex continuous and interconnected railroad network that is the property of several freight train carriers. In the event of a surge deployment, DOD, in partnership with the Federal Railroad Administration (FRA), identifies key tracks and facilities of the National Railways network and coordinates their use with train companies and other national, state, and local railway entities.

Most experts have a positive outlook for the industry in the future due to its many advantages; however, to realize its potential growth in the overall transportation industry, several concerns need to be addressed. These include improvements to infrastructure and the current PTC initiative, which are further discussed in the issues section of this paper.

The rail industry is also highly regulated by several government entities that exercise strict control and coordination over various aspects, to include: safety, security, finances, environment, labor, and national defense. Trains bring important benefits to society (positive externalities) like relief from highway congestion, decreased mortality rates and losses due to traffic accidents, reduction in the effects of CO² emission, and preservation of public goods (highway infrastructure). Regulatory policy has seen limited changes since the railroad industry was deregulated with the Staggers Act in 1980, so there is a current need for an effective federal regulatory policy renewal that addresses rail capacity, aging rail infrastructure, innovation, environmental regulations and safety.

Air. The air freight industry performs a critical function in today's world. This multifaceted industry, which includes express services, traditional freight, and cargo, significantly enables economic growth and development. It supports trade, connects communities, and assists companies with extending their global reach. While air freight represents less than 10% of world trade volume, it accounts for more than 30% of the world trade value, as air freight is primarily focused on time-sensitive or high-value items.⁴²

MarketLine Industry Profile defines the air freight industry as that which draws revenues from the domestic and international transportation of freight, mail, express, and diplomatic bags.⁴³ The majority of major air *freight* companies, including UPS and FEDEX, utilize other modes of transportation, such as truck or rail, to provide end-to-end service to the customer. Because these companies use multiple modes of transportation, they are also considered part of the courier and express delivery service industry. Conversely, the term air *cargo* is usually used when identifying the relatively narrow air segment that relies *exclusively* on the air mode of transportation and uses another company for follow-on ground movement.

The holistic global air freight market is captured under IBISWorld's Global Courier & Delivery Services (H4921-GL).⁴⁴ This code includes traditional air freight and express services. The express service component of air freight is the fastest growing industry in the air sector and overall global transportation sector. It is differentiated from its transportation sector competitors and highly sought after because of its multi-modal structure.⁴⁵ The US Census Bureau describes the courier and express delivery industry as such: "This industry comprises establishments primarily engaged in providing air, surface, or combined mode courier and express delivery services of parcels.... These services are generally between metropolitan areas, urban centers, or international, but the establishments of this industry form a network that includes local pick-up and delivery to serve their customers' needs."⁴⁶

According to the Boeing World Forecast, "the distinction between express and general air cargo continues to blur. Traditional providers are expanding their time-definite offerings, and

express carriers, freight airlines, and postal authorities are consolidating.”⁴⁷ As a subsector of the air freight industry, express services like UPS and FEDEX account for approximately 62% of the freight share with solely *air cargo* services comprising most of the remaining percentage.⁴⁸

Market share concentration in the air freight industry is medium. The major firms in this industry include, in market share order, FEDEX, UPS, and Deutsche Post AG. These three firms account for a total of 50% of the market share, with the other 50% made up of a multitude of smaller firms.⁴⁹ Thus, this industry is best described as an oligopoly. As home to two of the industry’s three largest firms, North America (mostly the US) makes up 36.2% of industry revenue, followed by Europe with 22.9%, and North Asia accounting for 19.2%. As other regions develop economically, regional demand for air freight services is expected to grow, eventually making up a larger share of revenue.⁵⁰

Competition in the air freight industry is high and increasing as the industry grows.⁵¹ That said, there is far greater competition at the lower end of the market due to ease of entry, and somewhat less competition at the higher end of the market due to barriers to entry. Overall, barriers to entry in this market are medium, but these barriers are starkly contrasted at different ends of the market.⁵² The primary reasons for lofty barriers are the high capital costs, such as buying or renting a fleet of aircraft and attaining acceptable real estate at major airports. Entry on a global level is also difficult due to the major players that already occupy significant operating space at these airports.⁵³ Because of these factors, the threat of new entrants is very low.

Relatedly, regulation at the lower end of the market is minimal, but increases at the higher ends of the market, particularly with regard to companies that own aircraft fleets.⁵⁴ Overall, there is minimal market failure in this industry, although FEDEX Chief Fred Smith believes changes in government policy regarding infrastructure and education would further benefit the industry, such as more spending on transportation and alternative energy infrastructure, and less spending on education.⁵⁵

The air freight industry is in the mature state of its life cycle.⁵⁶ It is highly globalized and is strongly tied to global economic growth. As more products are purchased on the internet, “a greater number of goods need to be transported using air freight services.”⁵⁷ The air freight industry will remain critical to economic growth, world trade and international investment, considering the fact that the global air freight industry is generating total revenues of \$147.5B (representing a 2.3% increase between 2011 and 2015), and global economic conditions continue to improve (with an industry projected to grow at an annualized rate of 7% by the year 2020, reaching \$207.1B).⁵⁸

The air freight industry is also vital to US national security. Companies such as UPS and FEDEX have consistently delivered critical, time-sensitive items to DOD and other US government agencies. A key support mission that the air freight industry provides for DOD is its participation in the Civil Reserve Air Fleet (CRAF). This agreement between industry and the federal government allows DOD to call up CRAF aircraft during times of emergency when airlift requirements exceed the capability of the military air fleet. This program is beneficial for both parties because carriers participating in the program are given preference in carrying commercial peacetime cargo for DOD.⁵⁹

As the air freight industry continues to grow, there is the potential for a shortage of pilots within the next 20 years. Growth in technological advances within the industry, such as the Next Generation (NextGen) Air Transportation System, could also lead to capacity issues with servicing airports. While the NextGen system brings increased efficiencies with air traffic

control and management, the Federal Aviation Administration (FAA) will face new cyber security challenges, discussed in greater detail in the issues section of this paper.

MAJOR ISSUES

This section focuses on three major areas of concern: Infrastructure, Human Capital, and Safety and Security. These areas of concern were identified as special emphasis based on their continuous and consistent mentioning during numerous discussions with government and industry representatives, and therefore warrant further assessment.

Infrastructure: Throughout the 20th, and into the 21st century, national economies have rapidly integrated into a single global economy. To support this integration the expanding US economy relies heavily on its transportation system, and one pillar of the transportation system reliance is its infrastructure. In supporting this demand, US infrastructure becomes obsolete and insufficient very fast in order to keep up with the evolution of the transportation industry's needs. This fact signifies a huge challenge for the US, only solved through wise resourcing strategies, a commitment of funds to prioritized issues, and the support of Congress and the American public.

-Maritime. US inland maritime infrastructure (which includes waterways, locks and dams) is currently rated as a "D" by ASCE, and is limiting the industry's competitiveness with rail and truck transport.⁶⁰ Over half of the 239 locks maintained by the US Army Corps of Engineers (USACE) are more than 50 years old, require increasing costly repairs, and are incapable of servicing today's larger, modern barges.⁶¹ USACE maintains comprehensive data on lock usage, and data shows a direct link between lock age and downtime. According to USACE estimates, there were 150,000 hours of lock shutdowns in 2012, and delays are growing every year.⁶² To help relieve these costly delays, USACE's operations and maintenance funding was increased to a record \$3.09B in 2016, but the increase will not put a dent in what a Congressional Research Study estimated is a \$60B USACE navigation project backlog.⁶³

US ports represent another major portion of the US maritime infrastructure, primarily composed of wharfs, piers, cranes, warehouses and cargo transfer equipment. Unlike locks and dams, ports are primarily owned by city or state port authorities with the terminals operated by private companies. Port congestion and port capacity are a major infrastructure issue for maritime mode, where inefficiencies within the port result in costly delays, measured in varying degrees from hours to days. In fact, a 2012 study of US port congestion reflects that seven of the top ten largest US ports average delays greater than one day, and the ports of Los Angeles and Long Beach average 3.2 and 4.2 days per large vessel respectively. To complicate this issue, port authorities are increasingly challenged to meet the infrastructure requirements for the much larger post-Panamax ships. These larger vessels require deeper channels, longer piers, larger cranes, higher bridges, larger container storage areas and more efficient port connectors. The costs for these upgrades are tremendous, with DOT providing \$357M over three years for port improvements, USACE's \$13.5B in appropriations for dredging, and the private sector's investment of an estimated \$46B to improve port infrastructure through 2017.⁶⁴ According to the DOT, the unfunded cost to "improve the condition" of the nation's port connectors is an additional \$4.3B, and "the cost to repair and upgrade the system to safely and reliably meet current and future demands may exceed what the nation can afford."⁶⁵

-Trucking. Trucking is significantly affected by poor infrastructure. In spite of the Highway Trust Fund (HTF) created in 1956 to ensure a source of financing for the National System of Interstate and Defense Highways, our national highway system and its bridges are

suffering from material degradation and disrepair. Because of changing demographics in terms of where people live and how they commute, the national highway system is at a critical point.

Within the 161,000-mile national highway system, there are 62,657 miles designated as the Strategic Highway Network (STRAHNET), deemed necessary for emergency mobilization to connect military installations to ports.⁶⁶ These roads require specific engineering standards for movement of heavy cargo and include over 79,000 bridges.⁶⁷ In a 2002 study by the Federal Highway Administration (FHWA), nearly 40% of those bridges were considered deficient or obsolete, and 30% of routes under bridges did not meet the 16-foot clearance requirement.⁶⁸ Also, most bridges are built with a 50-year life span, and the average age of bridges across the US is currently over 42 years old, while 11% of the Nation's bridges average 65 years of age and are categorized as poor.⁶⁹ The Nation's bridges are in a serious state of disrepair resulting in a rating of "C+" by the ASCE.⁷⁰ FHWA estimates that \$20.5B in annual investment would be required to eliminate the Nation's bridge deficiency backlog by 2028, while only \$12.8B is currently being appropriated.⁷¹ STRAHNET also includes last-mile surface connectors to the port boundary or installation gate. These connectors are in local systems and struggle to find funding in states already burdened with inadequate money for an aging road network.⁷²

-Rail. The US rail infrastructure network is made up of more than 160,000 miles of track, 76,000 rail bridges, and 800 tunnels across the nation that are shared by all operators moving freight and passengers.⁷³ The US freight rail system is globally considered as one of the most efficient and cost-effective freight systems in the world. Freight railroads are operated by private firms and are instrumental in helping to ease highway congestion, save energy, and reduce carbon emissions.⁷⁴ Sadly, rail infrastructure issues, such as rail capacity and aging infrastructure, are having a negative impact on rail's positive contributions, affecting both freight and passenger rail systems. Both freight and passenger rail systems have been investing heavily in their tracks, bridges, and tunnels, as well as adding new capacity for freight and passengers. For instance, since 2009, capital investment from both freight and passenger railroads has exceeded \$75B.⁷⁵ These rail infrastructure improvements, however, are not maintaining pace with the growing requirements of an aging network, some of whose major components are over 100 years old. A leading transportation research center estimates that with projected freight volumes expected to increase, the industry will not be able to generate sufficient income from revenue growth to offset needed infrastructure investment.⁷⁶

The American Society of Civil Engineers (ASCE) scored the US rail infrastructure a grade of "C+," also stating that the rail industry requires \$200B in funding to meet the projected 2035 rail infrastructure improvement demand.⁷⁷ Although there are large sums of money invested in rail infrastructure yearly by rail firms, the grade by the ASCE and their analysis indicates the current funding and revenue is not enough to maintain pace with the growing demand.⁷⁸ Not only does the community rely on the services of the rail industry, it is also critical to national defense readiness. The Defense Freight Railway Interchange Fleet (DFRIF) is a key asset for military mobilization and is used to supplement commercial transportation industry capability. Composed of rail assets necessary for mobilization, to include flat and special purpose cars, the current status of the DFRIF is not encouraging.⁷⁹ According to Volpe, a current DOD contractor, the "DOD fleet contains 120 locomotives with an average life span of 50 years. This fleet is in critical need of new, modern equipment to increase the efficiency, reliability, and safety of operations on US Army installations and US Navy facilities."⁸⁰

-Air. America's air transportation infrastructure lags well behind the rest of the developed world. Air transportation infrastructure spending has plummeted from \$21B in 2004 to \$13B in

2014.⁸¹ Due largely to a shortage of airports, runways, and gates, US air travel is the most congested in the world.⁸² To address these shortcomings, the FAA and Congress are driving the introduction of new regulations and legislation that could deliver significantly greater efficiency in the industry. For example, the FAA is nearing completion of a major air transportation modernization program with NextGen, which will replace or enhance existing radar and UHF-based infrastructure with a satellite-based platform that integrates weather, traffic, and communications into a largely automated system. NextGen requires significant investment at both airports and onboard aircraft, including aircraft avionics upgrades that are mandated for completion by 2020. Once finished, the FAA forecasts \$79B in benefits for passengers due to decreased time delays, \$51B in airline benefits, and \$2.4B in industry benefits.⁸³

Simultaneously, Congress introduced the Aviation Innovation, Reform, and Reauthorization (AIRR) Act in 2016 that focuses on increasing safety and efficiency, providing greater customer reliability, fostering innovation, and keeping America globally competitive. Major components of the AIRR Act include the privatization of Air Traffic Control (ATC) services into an independent corporation, streamlining and empowering the FAA, and providing “robust funding” for airport improvement.⁸⁴ Thus, while America’s airway infrastructure has significantly fallen behind its global competitors over the past decade, programs such as the FAA’s NextGen program and Congress’s AIRR Act promise to increase industry efficiency. That said, unlike simply pouring concrete on a dilapidated road, these programs will not produce immediate benefit. It will likely be another decade before the US sees significant improvement in its congested airways and airports.

Human Capital: An effective and reliable transportation system must have a healthy and resilient workforce. Unfortunately, serious concerns exist across the industry.

-Maritime. The US merchant marine has proven vital to transporting the vast preponderance of American military forces, equipment, and supplies to every major theater of conflict. During the Gulf War, 95% of all cargo went by ship, supported by 10,000 US mariners and 220 shiploads.⁸⁵ It is credited most recently with carrying over 90% of the war supplies to and from Iraq and Afghanistan.⁸⁶ Despite its crucial role, systemic cycles of political neglect of the merchant marine during cyclic periods of economic downturn have been a reality.

National Security Directive 28 was signed in 1989 by President George H.W. Bush, and is the foundational document establishing sealift as a national security priority. National Security Directive 28 is supported by various US laws, most notably the Merchant Marine Act of 1920, commonly known as the “Jones Act.” This legislation specifically protects the US merchant marine and the shipbuilding industry by requiring “all goods transported by water between US ports to be carried on US-flagged ships, constructed in the US, owned by US citizens, and crewed by US citizens and US permanent residents.”⁸⁷ It is from this pool of US-flagged vessels and American mariners that the DOT and DOD draw from in times of national emergency. This has put stress on the available number of vessels that the US can rely upon during an emergency, though limited accessibility to vessels is not the only readiness risk.

First, as the number of ships decreases in response to decreasing requirements for movement of DOD cargo and other manner of government cargo preference, so too will the number of available mariners.⁸⁸ What further compounds this concern is the potential loss of the number of companies that can provide this level of support. “As ships get bigger and companies aim at achieving economies of scale, there remain fewer companies in individual markets,” especially those that can continue to identify themselves as Jones Act certified.⁸⁹ If called upon, the US relies on the availability of not less than 13,000 mariners in order to crew the necessary

number of maritime vessels. The Maritime Administration (MARAD) currently reports mariner levels as sufficient (Amber) to support the initial activation of 63 surge fleet vessels, but unable to activate enough to support prolonged operations (beyond a 6-month period). More disturbing is that this trend continues negatively towards “red.”⁹⁰

Second, the existing merchant mariner population is not being replaced by new entrants to the profession. The allure of long periods at sea and traditional, time-intensive promotion models are not appealing to today’s Millennials. Companies must adopt creative means to bridge the gap between what the industry has historically favored and what interests the upcoming generation. Additionally, as women and veterans are under-represented in the profession, there exists labor sources yet to be sought out.

Third, the merchant mariner labor pool is a perishable capability due to the required credentialing and experience necessary to assume senior engineer and management positions. Once the institutional knowledge is lost, it takes years to regain. “New, more stringent Standards of Training, Certification and Watch-keeping for Seafarers (STCW) licensing requirements are an ongoing issue that have factored significantly into the challenges of expanding and retaining high numbers of merchant mariners who are discouraged by the administrative burden of pursuing management-level licenses.”⁹¹ Paul Jaenichen, Administrator for MARAD, briefed Congress that the “sharp decline” in US-flag afloat jobs is due to STCW requirement increases intended to take effect in 2017.⁹² Many mariners let their credentials lapse and lack the desire to restart the process again. Regarding job opportunities, the Bureau of Labor Statistics (BLS) does not project maritime job openings for the “deep water” merchant marine market segment supported by MARAD and the Maritime Sealift Command (MSC) under USTRANSCOM. Consider as well that the US Merchant Marine Academy and the nation’s six state-sponsored maritime academies only graduate 900 licensed officers per year at their maximum capacity.⁹³ Over the same 10-year period from 2012-2022, the maritime academies will produce 9,000 new licensed officers, a deficiency of 55,593 mariners compared against the BLS projections.

According to MARAD the US has only 11,280 mariners with the necessary credentials and recent sea service to operate large oceangoing ships.”⁹⁴ According to USTRANSCOM, DOD is dependent on a healthy US Merchant Mariner pool critical to the ability to meet military requirements, claiming they are currently at medium risk with around 11,300 mariners available, and moving toward high risk.⁹⁵ With only 11,300 mariners available for surge, a reducing platform of vehicles from which to rely upon, and a lack of desire for maritime industry partners to continue to meet DoD and federal requirements in accordance with Jones Act, maritime human capital stands to set intolerable risks to national security and economic stability.

-Trucking. The nation’s reliance on the trucking industry is undeniable. In 2015, 10.3 billion tons of freight was moved by truck, representing 69.2% of all freight tonnage in the US.⁹⁶ Within the industry there exists a significant shortfall and that has industry professionals concerned about its ability to keep up with the continued growing demand for freight transportation by truck. The shortfall is within the truck-driving labor force of the industry, and according to the American Transportation Research Institute, this is the second most critical issue, followed by the regulation on hours of service (HOS).⁹⁷ The driver shortage data projections, provided by the ATA, indicate that the industry-wide shortage accounts primarily for heavy-duty tractor-trailer (Class 8) drivers, where the majority of shortage exists within the over-the-road, non-local truck load (TL) segment of commercial drivers. According to BLS, employment projections for Class 8 truck drivers made the list of occupations with the most potential for job growth in the years 2014 to 2024 based on economic trend projections.⁹⁸ This

projection indicates an increased demand for commodities and goods transported within North America, creating a requirement for new carriers to enter into the industry, and existing fleets to expand capacity to haul the additional freight. With the projected shortage of truck drivers to meet that need, however, this gap creates significant concern within the industry.

Poor driver conditions have the potential for greater shortages of drivers. According to IBISWorld the customers that rely heavily on trucking are construction, manufacturing, wholesale trade, and retail trade, whose annual revenue is over \$1.5T of an overall \$18.7T, or 8% of US GDP.⁹⁹ Due to the scope and number of customers that rely on trucking, any disruptions, delays, or shortages would negatively impact these industries, possibly resulting in a negative national economic impact, like a slowdown or recession, especially in light of the current sluggish national and global economic conditions. As the largest TL carrier in North America, Swift Transportation is constrained by the driver shortage in the TL and refrigerated segments, and has experienced situations where the company has turned away freight for two reasons: (1) parked tractors for lack of drivers and (2) driver turnover.¹⁰⁰ Con-way Truckload reports the same findings and indicates that a number of drivers they do hire to fill the gap seem to rotate quickly, jumping to other carriers with no great influx of new candidates to replace them.¹⁰¹ This high turnover rate creates a significant strain on the profit margin of carriers due to administrative and driver training cost increases. The costs of turnover and disruption within these companies, however, does not compare to the loss of revenue to the industry caused by the lack of new drivers choosing to enter into the commercial driver pool.¹⁰² Movement of controlled military assets is also of concern. In his testimony to the Senate, the USTRANSCOM Commander told legislators that the Arms, Ammunition and Explosives transport, a highly specialized and limited capacity, is specifically affected as qualified drivers retire and are not replaced.¹⁰³

-Rail. The rail industry workforce does not see the significant human capital issues that other modes are experiencing. With the industry having undergone significant consolidation over the last 40 years, the rail workforce size is now stable at 161,183 and is projected to increase by 1.5% to 2.5% each year through 2021. Due to the complexity of rail operations, the average rail employee earns \$87,125 per year, with salaries projected to increase slightly each year reaching \$89,165 by 2021. Due to the competitive wages and benefits, the freight rail industry does not suffer labor shortages similar to other land modes of transportation.¹⁰⁴

-Air. The aviation industry also faces some of the same manpower woes akin to trucking and maritime. An impending pilot shortage and an increase in labor costs call for a comprehensive human capital strategy going forward. The demand for aviation is growing and expected to more than double in the next 20 years.¹⁰⁵ The growth market comes in developing countries with large, young populations that are increasingly educated and prosperous.¹⁰⁶ The rapid growth in demand is simultaneous to a pending hemorrhage of baby boomer pilots reaching their mandatory retirement age. Currently, 3,000 pilots retire each year, and that number may jump to 10,000 a year over the next ten years.¹⁰⁷ On top of that, recent FAA regulations are increasing the number of pilots required for aviation firms. The number of flight hours required for US commercial copilots has grown from 250 to 1,500, and more rest time between flights for aircrews is now required.¹⁰⁸ These regulatory requirements are expected to create an additional 5% increase for the number of pilots required by the industry.¹⁰⁹ With increases in demand, a resultant increase in labor cost will follow, with labor expenses currently consuming about 23% of US airline expenses. Since 2005, airline mergers and consolidations have seen nine major US airlines shrink down to just four.¹¹⁰ These four super carriers now control 80% of the US market

in what can be called an uncompetitive oligarchy.¹¹¹ As these mergers have occurred, airlines have had to negotiate higher salaries and better working conditions to secure union buy-in, driving a 25% increase in labor expense per average seat mile over the last five years.¹¹²

The workforce challenges in aviation are significant. More than 2.7 million new aviation industry employees will be needed by 2025.¹¹³ Human capital strategies are needed to recruit, train, and retain a viable workforce in the wake of rapidly increasing demand and a quickly diminishing labor pool. Solving these workforce issues is critical to the solvency of the aviation industry.

Safety and Security: Safe, secure and efficient transportation is vital to the growth of the national economy and consumer quality of life. Firms are continuously researching and implementing innovative technological advancements and operating procedures, which include initiatives and regulatory requirements such as hours-of-service driver restrictions within the trucking industry, PTC within the rail industry, and NextGen within the air industry. Most of these improvements are designed to increase capacity, enhance safety, and potentially decrease the probability of human error.

-Maritime. The maritime industry is critical to the nation's economic growth and stability. Its importance highlights the nation's enduring principle of safety and security across the seas. The maritime environment within the US, with its narrow channels, limited approaches, and the number and size of ships seeking accommodation, puts our nation's ports and waterways at risk from the air, ground, surface, and subsurface. These risks increase operating costs, increase manpower requirements, and cause delays in the free flow of trade that could jeopardize our economy and our national security.

With 90% of trade occurring over the water, a ship carrying one of the 15.1 million TEUs (twenty-foot equivalent units) received annually at US ports can be a delivery mechanism for a weapon of mass destruction, making port security ever more challenging. Leading US security efforts is the Department of Homeland Security (DHS) through US Customs and Border Protection (CBP), the Transportation Security Administration, and the US Coast Guard, working in concert with other federal, state, local, and tribal entities. Each of these agencies works to ensure that the intent of the National Strategy for Maritime Security is met, which identifies three principles to guide the nation's maritime security activities: preserving freedom of the seas; facilitate and defend commerce; and facilitate the movement of desirable goods and people across our borders, while screening out dangerous people and material.¹¹⁴ The post 9/11 environment brought an extensive expansion of laws governing security to help DHS in its efforts. In total, there were six laws between 2002-2007 that made import security a key component of US trade policy, many of which are continuing to find meaningful implementation and return on investment. Within some of these guidance documents, the successful employment of technology and the use of a common operating picture shared with security stakeholders has been effective in reducing delays and providing better visibility of cargo. The 2002 Trade Act established CBP's Automated Commercial Environment, which authorized advanced cargo screening, scanning and inspection as well as the requirement for importers and exporters to submit advanced manifest information prior to the cargo's arrival at US ports. Armed with this information, CBP is able to employ a risk-based targeting process from their National Targeting Center to determine if and what additional security measures are necessary for specific vessels and cargo.¹¹⁵

Numerous landmark initiatives now contribute to increasing maritime security, to include: the Container Security Initiative (CSI); government regulations requiring the

establishment of the Nationwide Automatic Identification System (NAIS); and Transportation Worker Identification Credential (TWIC). CSI, launched in 2002, provides identification of high-risk maritime shipping containers for prescreening before shipment to the US. Through x-ray and gamma ray technologies, containers can be quickly processed without significant delay, and many times without need for physical inspection.¹¹⁶ The NAIS, created by the Maritime Security Act of 2002, utilizes digital very high frequency (VHF) radio waves to continuously transmit vessel location, source, and speed from ship-to-ship, ship-to-shore and shore-to-ship communications. On any given day, the NAIS receives 92 million transmissions from 12,700 unique vessels.¹¹⁷ “Informed by a comprehensive view of traffic on the nation’s waterways, decision makers are better positioned to respond to safety and security risks. NAIS improves the safety of vessels and ports through collision avoidance and strengthens national security through detection, identification and classification of potential threats while they are still offshore.”¹¹⁸

Though much attention has been given to physical security threats, what continues to be a pressing uncertainty are the various types of cyber threats that have the potential to significantly impact the global movement of freight. Cyber risks have the potential to significantly threaten a nation’s economic stability, national security, and public health and safety; therefore, it is of vital national importance to protect systems from cyber threats that could lead to disruption. Avoiding these threats falls upon the private companies and government entities who own and operate maritime facilities and assets, ensuring minimal loss of efficiency and continued economic stability should an event occur. For government-operated entities, this ability to minimize, if not eliminate, cyber risks is critical to a state or district’s livelihood.

-Trucking. The trucking industry is the major mode of freight tonnage transportation within the US. With its significant presence on the nation’s roads, there is an industry commitment to developing and advocating innovative, research-based policies that promote highway safety and security. These policies and regulatory guidelines are established by DOT, which provides standards for over-interstate highway driving, commercial driving licensing (CDL), hours of service and roadworthiness of vehicles.¹¹⁹ Even with these efforts, however, the trucking industry has had consistent issues with safety-related operations. The US Department of Labor claims that workers in the trucking industry experience the most fatalities of all occupations, with those involving trucking accounting for approximately 12% of all worker deaths.¹²⁰ The DOT and the trucking industry have attempted to address some of the safety-related issues in the industry with mixed results. In 2012, the Federal Motor Carrier Safety Administration modified the hours interstate truckers could drive per day, and during a week. The intent of the DOT to reduce fatigue-related crashes and long-term health problems among truckers, by implementing the HOS policy, inadvertently resulted in greater levels of fatigue, lower quality of life, negative financial impacts, and more truckers on the road during the week and during daylight hours.¹²¹ Moreover, additional drivers are required to move the same amount of freight, impacting road congestion, efficiency and productivity.¹²²

Reviewing numbers provided in Appendix A reveals that the number of trucks involved in *fatal crashes* and *injury crashes* increased significantly after 2011.¹²³ Even though the 2012 HOS policy resulted in an increase of daylight and weekday driving (which is when there are statistically more accidents), there is no direct correlation between the HOS policy and the statistics in Appendix A; however, it is possible the HOS policy is one of the contributing variables to the significant increase in fatal crashes and injury crashes.

-Rail. The rail industry is investing heavily in technology to increase efficiencies and safety. The Federal Railroad Administration (FRA) is using big data to improve operations, and

resulting data analysis is paying dividends with safety. The FRA reported two straight years of record-breaking safety performance and significant reductions in all types of accidents since 2008.¹²⁴ Safety investments include track maintenance, where track and rail defects account for 34% and 26% of rail accidents. There does remain, however, concerns with implementing recently dictated safety requirements and their actual overall contribution to safety.

The Rail Safety Improvement Act 2008 (RSIA) has mandated the installation of PTC by the end of 2015 on main lines that carry hazardous materials, and on lines that involve passenger operations. This upgrade is mandatory, even though PTC-preventable accidents constitute only around 4% of mainline accidents.¹²⁵ The FRA issued its final rule in January of 2010, on the design, requirements and implementation of the new technology, where the rule is expected to impose significant new costs for the rail industry at large.¹²⁶ To assist firms in implementing this new technology, the bill authorized \$250M over 5 years for Railroad Safety Technology Grants. The original intent of the authorization was to provide \$50M per year in grant funding.¹²⁷ As is the norm in transportation budgets, only authorizations for this funding exist, and to date no funds have been appropriated in any submitted budget. Also, this policy has become “the most costly federal mandate in US railroad history - \$13.2B price tag and a 20-to-1 cost-benefit.”¹²⁸

-Air. The previous and current Administrations identified security of the cyber domain as a critical concern. In 2008, President George W. Bush assessed that the federal government’s program to protect itself against cyberattacks was not synchronized or effective. As a result, President Bush signed the Comprehensive National Cybersecurity Initiative (CNCI) that increased the intelligence community’s responsibilities with monitoring and protecting the federal government’s computer systems against cyber risks.¹²⁹ President Obama continued his emphasis on cybersecurity by issuing Executive Order 13636 which directed the DHS to work with the FAA to identify cybersecurity risks, establish voluntary cybersecurity measures, and share information on cybersecurity threats.¹³⁰ The inability to clearly define the threat and pair it with an effective method to prevent it is causing the industry much consternation in how best to resource and develop solutions to this problem.

It is difficult to refute that the nation’s air transportation is a complex system that is interconnected through different modes and information technology systems that control scheduling, movements, and safety protocols. With the volume of passenger and commercial movements, it is imperative that federal and private agencies identify potential vulnerabilities to infrastructure or platforms. Even with Presidential Directives and Executive Orders, there continues to be a significant concern with cyber security threats to aircraft, air traffic control systems, and airports. These concerns will only grow as new technologies such as NextGen continue to be implemented into air operations. Since the attacks of 9/11, the US has taken steps to improve passenger screening, and to a lesser extent cargo screening; however, improvements to the network have not made the same strides to improve security and resiliency.

According to a 2015 PricewaterhouseCoopers survey, 85% of airline Chief Executive Officers (CEOs) assess cyber security as a significant risk, identifying major concerns with the vulnerabilities to flight systems and the implications to airline operations.¹³¹ Technology is improving air operations by improving connectivity with the aircraft, ground crews, and air traffic control systems; however, this enhanced technology provides more opportunities for those seeking to exploit these advances. Over the last ten years, the FAA has attempted to update the system and gain efficiencies. While attempting to gain efficiencies by transitioning its 40-year old legacy air traffic control system to the NextGen air traffic control system, the FAA has also

increased overall system vulnerabilities. Given the internet connectivity and software upgrades, the NextGen system is more vulnerable to cyber hackers.

GOVERNMENT ROLE AND RECOMMENDATIONS

An efficient, competitive transportation network is critical for the US economy to be able to transport the goods and services that maintain US global economic leadership. Investments in transportation provide for the Nation's security by enabling investment in sufficient defense, giving the US a qualitative and quantitative edge. As a consequence, the transportation industry's health has become one of today's top priorities.

According to White House reports, if the government is efficient in its role, then the transportation system should support keeping jobs in America, encourage competition and allow businesses to expand, provide low prices on goods to American families, allow businesses to manage their inventory and transport goods cheaply and efficiently, and ensure businesses have access to a variety of suppliers and markets for their products.¹³² The government spends a large amount of funds on building, rehabilitating, maintaining, operating, and administering the infrastructure system, primarily supported by government revenue generated from several sources, including user fees, taxes from transportation and non-transportation-related activities, borrowing, or grants from federal, state, and local governments.¹³³ The government must ensure appropriate developing and growing conditions to the transportation industry by also promoting a competitive and safe environment. Therefore, government intervention in this industry is justified, however, it will vary depending on the transportation mode and the aims pursued.

After the events of 9/11, the transportation sector was heavily affected by tightened security measures. These safety and security regulations continue to be promoted and enforced by the government due to their high impact on national security, in spite of the fact that sometimes they hinder industry profits, an issue hotly debated by interest groups and industry representatives. From a military power perspective, the US government is also focused on the transportation industry's effectiveness as it relates to the strategic readiness of the military to project power. While the defense industrial base strives to ensure the country has the essential materials to resource national security, the transportation network is key to move and deliver that materiel and resources to the fight.

Given current conditions of the industry and those challenges currently being faced by the Nation in order to meet the high demands of the transportation industry, the authors of this paper have policy recommendations and suggestions regarding government involvement and intervention. As the challenge at the federal level is the balance between limited resources and an exhaustive list of shortfalls and concerns, actions taken, such as those presented below, must provide high impact with minimum revenue reliance.

1. Promote the development of intermodal logistics systems and transportation mode partnerships across the industry. In many instances the nation is constrained by its ability to expand its infrastructure capacity. This provides opportunity to promote industry improvements through the endorsement of transportation solutions based on consolidated and collaborative mode approaches. Considerations through an intermodal mindset can have numerous positive outcomes, such as minimizing the growing reliance solely on trucking - an already overstressed mode. With an effective freight policy, uncommitted to mode but simply to most efficient delivery, beginning at the Federal level, freight rail can better support its share of America's growing transportation requirement. Frequently discussed as part of this course, industry is frustrated due to the federal government's strict conditions and transportation

requirements in moving government freight. Several industry representatives have shared their beliefs that these restrictions and constraints have forced government costs to be higher than is necessary, where better logistical planning could have provided the same level of service and security at a much lower cost. Allowing logistics planning to focus on intermodal movement would allow logistics planners to optimize available transportation networks and intermodal relationships that best benefit the nation and the industry.

Intermodal logistics systems can best be serviced through the establishment of inland ports and hub-designed transportation centers. Inland ports can have significant positive effect on numerous factors, to include: intermodal efficiencies; reduction of road congestion; demand shifts to local trucking, versus long-haul; and regeneration of regional contributions to waterway delivery systems. One of the Port of Rotterdam's solutions to easing their land and road congestion problem is the goal to push 55% of the cargo via barge traffic upriver to inland ports, such as Duisburg, where cargo can be moved to inland distribution centers and further distributed by truck, barge or rail.¹³⁴ Similar domestic successes such as the Virginia Inland Port, which has seen significant benefit despite a limitation to only two modes (trucking and rail), can also be used as an example of positive externalities through intermodal planning. The establishment of this inland port has reduced unemployment in the State of Virginia, increased state revenue, encouraged commercial companies to invest in warehouse and distribution centers near the inland port, increased local residency, and encouraged state investments in local interstate hubs and road improvements near the property. Developments such as these will not only decrease truck congestion at the ports, but will also decrease haul length to customers which better supports just-in-time logistics. This will, in turn, improve the quality of life for truck drivers by providing more commercial out-and-back day jobs, while decreasing the over-the-road non-local truck load requirements. By establishing a prioritized list of potential inland port sites, state and local governments could adapt zoning and long-range regional plans to build areas surrounding rail terminals and inland waterways into efficient cargo distribution centers.

When it comes to determining who has the ability to shift behavior to an intermodal way of thinking, it falls to legislation. FHWA is receptive to finding ways to shift reliance among modes, and would welcome legislative intervention to assist in initiating this transition.¹³⁵

2. Identify approaches to increase revenue growth and protect revenues collected through transportation-related revenue activities to ensure their use within the industry.

Expenses necessary to maintain the nation's transportation infrastructure are significant. Operations and maintenance and capital expenditures cost the nation more than \$300B annually. Distribution of expenses reflect an average of 65% to highways, 16% to transit, 16% to air, and 4% to maritime. According to the 2014 Government Transportation Financial Statistics report, between the years 2000 to 2016, 66% of Federal transportation expenditures relied on revenue generated from transportation-related activities, while 33% came from the General Fund and other external sources.¹³⁶ Sources of transportation-related revenue activities (also referred to as own-source transportation revenue) include excise taxes, charges or fees, property/car taxes, income taxes, investment income, and fines/penalties. Unfortunately, with these forms of revenue only able to accommodate 66% of expenditures, reliance on the US government's General Fund becomes necessary. Additionally, "about 11% of revenue generated from transportation-related sources was diverted to other uses."¹³⁷

As demand for more revenue becomes necessary to address continuing infrastructure challenges, coupled with the discontinued reliance on the General Fund, it will fall to federal authorities to develop methods to address these shortfalls. Transportation grants, loans and

federal funds, restricted to use on transportation priorities as determined by national security strategies and critical infrastructure plans, will be necessary. Revenue increase approaches should consider: (1) the regulation of brokerage fees charged by third-party intermediaries to cap percentage of freight pay that can be charged, allowing investments by industry for innovation improvements; (2) streamlined funding processes that allow revenue to go directly to the industry without the current politically-influenced process of coordinating across multiple agencies who have competing priorities; (3) increases in property and fuel taxes, such as a vehicle miles travelled (VMT)-based tax; (4) creative toll road usage, such as use of express toll lanes, with lane usage costs driven by shifting congestion factors throughout the day; and, (5) complementary legislative decisions at the appropriations level to ensure authorized obligations to transportation priorities can be secured and not lost in political debate and competition.

Though raising the gas tax tends to be an extremely sensitive subject, the nation has not seen an increase in federal taxes on gas since 1993, which set the gas tax at 18 cents per gallon. Since that year, the price per gallon has increased by an average of 144%, with no additional revenue provided to contribute to federal transportation expenses, warranting a consideration for increase.¹³⁸ Also, the recent 29-cent excise tax increase on diesel fuel should be continued.

3. Gain public endorsement and support for the nation's transportation industry through education and marketing. In a recently released report, Secretary of Transportation Anthony Foxx stated, "Everywhere I go, I see incredible examples of communities that have a vision for transportation and how it will impact the quality of life, mobility, economics, and opportunity."¹³⁹ His strong endorsement provides a firm recommendation to gain public support for the Nation's transportation system through an aggressive education and marketing campaign. If our Nation's communities understand the impact that the transportation industry has on their daily lives and activities, then encouraging them to take a role in contributing to its improvements and solutions is absolutely necessary. The City of Rotterdam, Netherlands has become a community whose residents are committed to the operation of its port, and actually revere this facility with an outward display of national pride. Rotterdam citizens understand that the contribution of this transportation hub improves the global economy and trade market, as well as their city and their livelihood. Given this, Rotterdam is confident that investing revenue to continue the port's development and innovative systems will make the facility an even greater asset to the global transportation industry.

One positive externality to the promotion of the role of transportation in our lives is a growth in demand to work in the industry. By highlighting the benefits of employment within the transportation industry, current human capital shortfalls could be addressed through soft recruitment techniques in marketing. Educational incentives for attendance at state maritime academies and other transportation-industry supported institutions could also be considered. The Washington Metropolitan Area Transit Authority (WMATA) shared the fact that failing to make a strong public case, and present the economic benefit of transit has cost them investment and improvement opportunities, given that their riders consider Washington's transit system a "convenience" and not an economic principle. Using their experiences and lessons learned as one example of the need to remarket transportation's value to the nation, it becomes clear that an educated and supportive public is a significant area for investment.¹⁴⁰

4. Encourage industry to further invest in research and development, innovation, and newly developed best business practices. Secretary of Transportation Anthony Foxx shared his insights on the need for a flexible and transitional approach to the nation's transportation needs with a vision "towards proactive, forward-looking transportation networks

that match the changing demographics of where people in this country live and work, that fosters innovation and remains nimble as technology evolves, and that provides access to opportunity for people and communities across America.”¹⁴¹ Whether it is regulated improvements like fatality and accident avoidance through PTC, improvements in air congestion through NextGen, or science-fiction meets reality in autonomous vehicles, the effects of innovation and technological advances have been significant. This trend must continue if the Nation is to seek innovative solutions to the complicated problem of our overburdened and antiquated transportation network. Innovative solutions to issues such as safety, security and infrastructure are sorely needed in the industry, and federal incentive programs that encourage ideas must be a consideration. These ideas include incentives to industry partners and academic sources, such as graduate programs and university innovation laboratories that can present ideas that specifically address our Nation’s transportation challenges.

CONCLUSION

The transportation industry is the most important economic activity to spur growth in the US. The US Government has four primary economic policy levers: (1) access to the US market, (2) access to US goods and services, (3) US capital and financial system, and (4) access to US government largesse.¹⁴² The transportation industry has a direct impact on two of these levers: access to the US market and access to US goods and services. Transportation also plays an equally important role in the Nation’s defense industry readiness, ensuring DOD can mobilize in the most efficient and expeditious manner possible. Without a well-developed and maintained transportation system, the US cannot maintain or fully realize its economic advantages, or be prepared to effectively support the National Security Strategy.

The maintenance and development of the Nation’s transportation system must be a combined effort by both the private and public sectors. A healthy transportation system can reduce operation costs, increase efficiency, promote safety and service quality, and increase overall global competitiveness. To ensure the US is maintaining its global economic competitiveness and national security readiness, it must combat some of the current and looming issues within the industry. All modes of transportation are experiencing concerns with innovation, infrastructure or labor force. The trucking industry is one of the modes most affected by poor infrastructure, due to the US national highway system’s degradation and disrepair. Also, it is experiencing significant difficulties with maintaining an adequate labor force. The maritime industry is facing similar issues, complicated by port congestion and port capacity concerns, and adequate numbers of mariners to operate “deep water” vessels. Although the infrastructure and labor force for the air and rail industries are in a somewhat better state than the maritime and trucking industries, there are concerns on the horizon. Concurrently, there is the ever-present cyber threat, as all industries attempt to innovate to increase efficiencies and safety.

These issues are having a dramatic impact on the nation’s ability to support national security objectives. The US government must make it a priority to improve the transportation infrastructure by identifying approaches to increase revenue and protect funds identified for transportation infrastructure purposes. It must look at transportation as a supply chain of intermodal approaches. It must develop a full spectrum strategy from the local to federal level that sets transportation priorities and educates the public on the importance of transportation to economic development and national security. With these sensible and feasible measures, smartly applied, the Nation can ensure sustained private and public sector competitiveness, while efficiently meeting ever-growing transportation demands

APPENDIX

Appendix A

Traffic Safety Facts 2012 Data and 2014 Motor Vehicle Crashes: Overview US DOT National Traffic Safety Administration

Year	Number of large Trucks Involved in Fatal Crashes	Number of large Trucks Registered	Number of large Trucks Involved in injury crashes
2005	4,951	8,481,999	82,000
2006	4,766	8,819,007	80,000
2007	4,633	10,752,019	76,000
2008	4,089	10,873,275	66,000
2009	3,211	10,973,214	53,000
2010	3,494	10,770,054	58,000
2011	3,633	10,270,693	63,000
2012	3,802	10,659,380	77,000
2013	3,981	10,597,356	88,000
2014	3,903		92,000

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- ¹³⁹ US Department of Transportation, “Transforming Communities in the 21st Century”, (Washington, DC: 2016) p. 2
- ¹⁴⁰ Washington Metropolitan Area Transit Authority, “WMATA”, discussion/lecture, Eisenhower School Industry Study, National Defense University, Washington, DC, March 1, 2016
- ¹⁴¹ US Department of Transportation, “Transforming Communities in the 21st Century”, (Washington, DC: 2016) p. 2
- ¹⁴² Dwight D. Eisenhower School for National Security and Resourcing, “National Security and Economic Policy, ENS-19: Economic Instruments of Power”, lecture and presentation, November 5, 2015, National Defense University, Washington, DC, Slide 10