CRIM 3460 Introduction to Critical Infrastructure Protection
Spring 2016

Chapter 15 – Transportation

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Transportation Sector is transitioning from/to
- Disparate modes focused on efficiency and profitability
- Integrated intermodal network focused more in safety, security and regulation

Transportation Sector complexity
- Integration of intermodal services
- Increasing regulations (i.e. safety and security)

Transportation Sector agencies
- U.S. Department of Transportation (sector specific agency)
- DHS/Transportation Security Administration (PPD-21)
Challenges to Transportation Sector

- Maintenance and repair of infrastructure (i.e. cost)
- Aging infrastructure
- Modernization (infrastructure and systems)
- Technological change and expense
- “Plugging into” the global supply chain and impact on U.S. economy
Factors Affecting Transportation CI/KR

- Transportation is vast
  - Extensive multimodal network/infrastructure
  - Regulatory split between USDOT and TSA

- Transportation is in transition
  - Socioeconomic/political
    - Deregulation
    - Shifts in energy policy
    - Global intermodal supply chains
    - Rapid technological change reshaping transportation
Factors Affecting Transportation CI/KR (Cont.)

- Rising costs
  - Maintaining and modernizing greater than rate of GDP
  - Decline in gasoline taxes (why?)

- Interstate nation-builder
  - Interstate Highway System (1956, Eisenhower, defense)
  - 47,000 miles (1.2% of total highway miles; 3.9M)

- Redirection/transition
  - Intermodal Surface Transportation Efficiency Act of 1991
  - Transition from traditional point-to-point strategy to Integrated intermodal approach
  - Beginning of transition of transportation sector
Factors Affecting Transportation CI/KR (Cont.)

- Road resiliency
  - 160K mile National Highway System (NHS)
  - Highways are resilient and robust
  - Criticality of bridges (i.e. crossing Mississippi River)

- Disruptive railroads
  - Rapid rise/profound impact on society (internet mirrors)
  - First “technology bubble” providing stimulus for business
  - Led to first regulations (Interstate Commerce Act; 1887)
Factors Affecting Transportation CI/KR (Cont.)

- Competitive exclusion
  - Compares railroads with high-tech companies (Vanderbilt and Microsoft)
  - Economics of increasing returns
  - Railroad monopolies forced government regulation
  - Regulation/deregulation shaped railroads (most CI today)

- Commuter rail
  - 8,000 miles
  - Terror attacks exceeds that for commercial aviation (181 PAX rail 1998 – 2003 vs. 8 commercial aviation 1986 – 2012)
  - Easy and virtually unprotected targets
Factors Affecting Transportation CI/KR (Cont.)

- Air travel follows rail
  - Same technology diffusion as rail
    - Rapid build-out then saturation
    - Very competitive
    - Lackluster sustainability
  - Regulation reduced competition; deregulation restored competition

- Airline network structure
  - Deregulation created hub-and-spoke system
    - Efficient and reduces operating costs
Factors Affecting Transportation CI/KR (Cont.)

- Airline safety
  - Good safety record
  - Regulated by FAA and NTSB
  - National Transportation Safety Board (NTSB); independent and accident investigation/promote safety

- Air travel security
  - Responsibility of TSA
  - Airport security measures
  - Secure Flight stores passenger information
  - Terrorist Screening Center (TSC) implements Secure Flight
  - Alleged that Secure Flight and TSC violate 1974 Privacy Act
Factors Affecting Transportation CI/KR (Cont.)

- Airport games
  - TSA terrorist countermeasures using game theory tactical software
  - GUARDS is a game theory tactical software determining best use of defensive resources
  - Simulates “attacker” vs. “defender” in a airport environment
  - Outcome is a best mixed strategy of randomized countermeasures
Transportation Under Transformation

- Intermodal transportation – people and goods
- Difference modes of transportation working seamlessly together
- Globalization improved standard of living of trading nations
- USDOT created in 1967 consolidating existing transportation agencies
  - Initially focused on safety
  - Expanded role to include environment and multimodal and next generation transportation
  - May outstrip funding, which is principally gas-tax based
Transportation Under Transformation (Cont.)
Transportation Under Transformation (Cont.)

Figure 15.2 in Text
Transportation Under Transformation (Cont.)

- U.S. Department of Transportation
  - Federal Aviation Administration
  - Federal Highway Administration
  - Federal Railroad Administration
  - Federal Transit Administration
  - Federal Motor Carrier Safety Administration
  - Pipeline and Hazardous Material Safety Administration
  - Maritime Administration
  - Others
Evolution of Transportation Legislation

- Intermodal Surface Transportation Efficiency Act (1991)
  - First post-Interstate Highway Act legislation
  - Redirected national strategy to intermodal and transit
- Transportation Equity Acts (TEA)
  - 1998 - TEA for the 21st Century (TEA-21)
  - 2005 – Safe, Accountable, Flexible, Efficient TEA; A Legacy for Users (SAFETEA-LU)
  - Moving Ahead for Progress in the 21st Century (MAP-21)
- Above legislation moving non-highway, integrated and intermodal transportation programs forward
Economic Impacts

- Interstate Highways
  - Have lowered costs in almost every industry sector
  - Contributed to productivity growth, but at a declining rate

- Declining contribution based on increase in costs

- Major reasons for decline
  - Funding from gas tax and Congressional appropriations diverted to mass transit
  - Increased maintenance costs of aged infrastructure
160K miles consisting of 5 major components
- 47K miles of Interstate Highway System (i.e. I-93)
- Principal Arterials link major roads to ports, airports, etc.
- Strategic Highway Network (STRAHNET) provides access to military bases, ports and depots
  - STRAHNET Connectors link installations to STRAHNET
  - Intermodal Connectors links intermodal to the above

What is STRACNET?
- Most resilient/robust CI/KR
- NHS is redundant
Interstate Highway Network

- Resilient against cascade failures (i.e. traffic congestion and propagating bridge/road damage)
- Alternate E-W and N-S routes
- Robust via many alternate routes
- Provides easy connections between major cities
- Virtual hub of network is Chicago
- Alternate routes make it hard to “damage” severely
- Survived:
  - 2005 Hurricane Katrina
  - 2012 Superstorm Sandy
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  - 2007 I-35 bridge collapse
Rail in General

- Emergence of rail in mid 1800s parallels rise of internet in late 1900s
- First technology deployment to obey technology diffusion
- Diffusion starts small, gathers momentum over time and grows exponentially for short period and then flattens out due to saturation
- Competitive exclusion and increasing returns impacted railroads in early years
Regulation

- Rise of railroads coincided with rise in big business and precipitated Interstate Commerce Act of 1887
- Sherman Antitrust Act of 1890 broke up trusts and prevented monopolies
- Railroads became overbuilt because of speculation
- Elkins Act of 1903 prohibited rebates and kickbacks
- Hepburn Act of 1906 put ceilings on rates and extended regulation to pipelines
- Mann-Elkins Act of 1910 allowed shippers to pick routes
- Federal government took over railroad operations in WWI
Rail in General (Cont.)

- Regulation (Cont.)
  - Transportation Act of 1930 permitted Interstate Commerce Commission (ICC) set shipping rates to yield a fixed rate of return (6%)
  - Emergency Transportation Act of 1933 increased federal intervention in the management of private railroads
  - Motor Carrier Act of 1935 added trucking to regulatory oversight
  - Transportation Act of 1940 added water-borne carriers to regulatory oversight
  - Reed-Bulwinkle Act of 1948 legalized rate setting associations under ICC control
Rail in General (Cont.)

- Regulation (Cont.)
  - By 1970 PCRR was bankrupted 3 times after the merger of Eastern railroads leading to the creation of Conrail
  - This was a turning point for Congress to start deregulation
  - Staggers Act of 1980 relaxed price setting
  - Motor Carrier Act of 1980 deregulated entry into trucked increasing completion
- Rail infrastructure tended to be vertically integrated rather than oversubscribed oligopolies
Rail in General (Cont.)

- Congress repeatedly applied transportation regulation and deregulation model to other CI/KR sectors in 3 phases
  - Intervention via regulatory restrictions and laws
  - Allowed natural monopolies to promote efficiencies, access and to preserve critical infrastructure
  - Deregulation that opens up a new generation of competitors
- Last phase used to deregulate transportation, energy and communications
Freight Rail

- Has a mature private sector infrastructure shaped by government regulation
- Major cog in the U.S. intermodal supply chain
- Several rail corridors are critical to the supply chain
  - Chicago to Seattle/Tacoma
  - LA/Long Beach to El Paso/Dallas/Houston (NAFTA)
- The railroads have less than a dozen critical links in the freight rail infrastructure (why?)
Passenger Rail

- Focus of security due to history of terrorist attacks
- 431 fatalities from 181 attacks from 1998 – 2003 (as compared to 69 aviation incidents resulting in 33 deaths for the same period)
- Attractive target because of a large number of people in a concentrated area
- Most likely weapon is IED (discuss active shooter)
- IEDs – London, Moscow and Madrid
- Principle consequence is fear!
Commuter Rail

- Light rail commuter trains are not resilient (why?)
- Structure is largely linear and loss of a single line can impact operation (2015 Snowmaggedon)
- Hub and spoke network radiating from the center
- Vulnerability of lack of redundancy
- Nearly every link and node is critical
Aviation

- Shaped by regulation and deregulation
- 1978 transitioned commercial aviation from regulated to semi-deregulated
- Prior to 1978 Civil Aeronautics Board (CAB) determined routes and airfares
- Post 1978 industry became market driven
Aviation (Cont.)

- Regulations
  - Kelly Act of 1925 allowed contractors to carry mail
  - Air Commerce Act of 1926 promoted development of industry
  - Civil Aeronautics Act of 1938 put regulation under one agency
  - Air Safety Board of 1938 created independent body to investigate accidents
  - Reorganization Act of 1940 split Civil Aviation Authority into and Civil Aviation Administration and CAB
  - Federal Airport Act of 1946 created 50%/50% funding split
Regulations (Cont.)

- Federal Aviation Act of 1958 transferred safety to new FAA
- DOT Act of 1966 created USDOT, which absorbed FAA, and sent CAB’s accident investigation to NTSB
- Airport and Airway Development Act of 1970 established planning, development and grant programs
- Airline Deregulation Act of 1970 made competitive markets
Aviation (Cont.)

- Technical advances (i.e. wide body aircraft) increased capacity and reduced passenger-mile costs
- Airline industry is “naturally competitive” and not monopolistic
- Cargo carriers can fly any route and charge whatever the market would bear (i.e. UPS and FedEx)
- Most airports are private/public partnerships, but some are quasi-government (i.e. DCA and IAD)
- Accident rates increased for decades, but declined after 9/11
Aviation (Cont.)

- Hub-and-spoke network
  - Created by regulation and deregulation
  - Increased travel efficiency and cost effectiveness
  - Reduces resiliency of the complex CI/KR
- Airport closures, cancelled flights, etc. produce cascade effects via delays and cancellations
- Ten key airports keep the network from “disjoint islands” (hub-and-spoke)
- ATL is essential in the network
- Hardening (against cascade failures) essentially eliminates CI/KR collapse
Security of Commercial Air Travel

- TSA mission – “...protect the nations transportation systems to ensure the freedom of movement for people and commerce.”
- Moved from USDOT to DHS in 2003
- At USDOT, TSA primary role was to prevent bombings on airplanes
- 1972 bomb sniffing K9 created TSA Explosives Detection Canine Team Program
- Secure Flight and No Fly List provided by TSA to airlines; considered in violation of Privacy Act
Security of Commercial Air Travel (Cont.)

- Computer-Assisted Passenger Prescreening System (CAPPS) also considered in violation of Privacy Act
- Concerns is that combined with other records from other agencies (i.e. FBI and CBP) more information may be obtained
- GAO reported on violations in 2005 confirming the alleged violations
- TSA has work-arounds and uses other technologies and techniques to prevent terrorists from boarding airplanes (i.e. screening, biometrics and imaging)
GUARDS

- One example of simulations and games to address security
- Software program that games fending off terrorist attacks
- TSA uses it to allocate limited resources and defensive measures
- Gaming considers asset pairs based on an “attacker” and a “defender”
- “Defender” considers same targets as “attacker” in the game
Squares – Limited resources of Defender
Triangles – Limited defensive measures
Circles – Targets identified by Defender and Attacker
GUARDS (Cont.)

- Strategy development uses combinations of resources, defenses and target selection
- Randomization makes up for shortage of resources
- Resources diminishes the successfulness of an attack
- Outcome/decision is to have enough data to choose between additional resources and costs to lower risk or allocate less and live with the consequences
- USCG uses a similar model named PROTECT to determine optimal strategies