

Assessment and Measurement of Port Disruptions

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Project Overview

Problem Statement:

“Following a disruption of port operations, what are the *secondary and tertiary effects of the port disruption on other modes of transport (trucking, rail, pipeline, etc.) and what are the economic impacts of such an incident?*”

Objectives and Knowledge Gaps:

- Conduct *what if* scenarios of critical infrastructure disruptions to shipping ports. [JV 3.0, Deloitte, NREL]
- Develop threat models in terms of cross-organizational, inter-infrastructure dependencies. [JV 3.0, BT]
- Identify and prioritize optimum prevention, mitigation and/or response strategies relative to stakeholder impacts. [USTRANSCOM, PEV AMSTEP Exercise]
- Data-driven approaches to quantify impact of disruptions to the MTS [JV 3.0, BT, USTRANSCOM]
- Continually conduct risk assessments virtually in an evolving natural and manmade environment. [JV 3.0, BT]

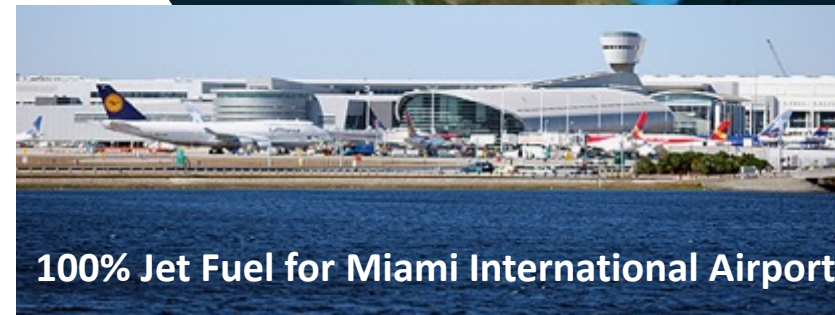
Total TEU via Port Everglades, FL FY2017

Orlando: 3613 TEU



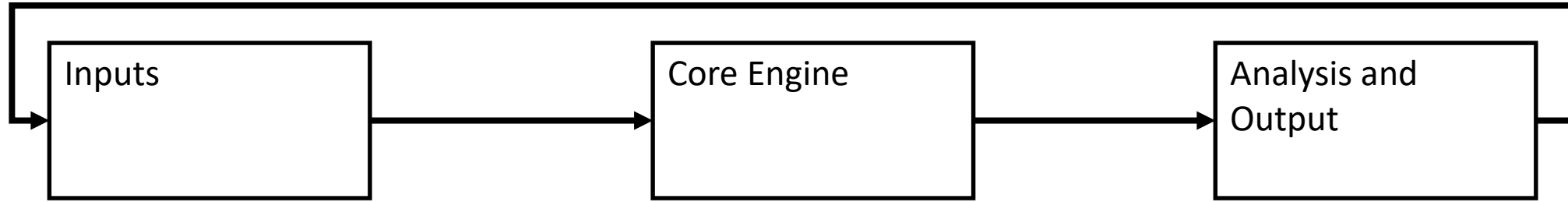
- Globally: The MTS accounts for more than 80% of global merchandise trade in volume and 67% of its value in 2017.
- Nationally: The MTS accounted for more than \$4.6 trillion of economic activity (1/4 of the US GDP) in 2014.

Miami: 295941 TEU



50 miles

Approach



Area	Information Fusion	Modeling & Simulation	Analysis & Visualization
Description	<ul style="list-style-type: none"> Integrate heterogeneous, disparate data sources. Explicitly represent Interconnected Critical Infrastructures (ICI) 	<ul style="list-style-type: none"> Apply simulation, emulation and optimization techniques to understand commodity flows through MTS. 	<ul style="list-style-type: none"> Economic analysis for direct business losses on exports Advanced visualization module
Approach	Extract network topologies and events <ul style="list-style-type: none"> Use open-source data [Catalog] Port-specific data as available. [Inventory] 	<ul style="list-style-type: none"> <i>Baseline:</i> Apply traffic simulation V&V techniques. [WinterSim 19] <i>Disruption:</i> Latin Hypercube to explore possible disruption effects <i>Optimization:</i> Extend CTSNDP Algorithm for Optimization [Paper] 	<ul style="list-style-type: none"> Integrate US Census data and port-specific economic data to estimate \$ per TEU Visualize measures of performance using a variety of techniques [Catalog]

Testing and Evaluation

1. Continuous fieldwork with stakeholders.
 - Port Everglades, FL (e.g. AMSTEP Exercise)
 - Jack Voltaic 3.0 (e.g. scenario injects)
2. *Baseline: Verification and Validation*
 - Multiple data sources
 - Measures of Performance for entities.
3. *Disruptions: Apply techniques from M&S*
 - Latin Hypercube sampling technique.
 - Work backwards to determine cyber.
4. *Outputs*
 - Research papers for specific analyses
 - Cloud-based portal with JupyterLab notebooks

Stakeholder Data Sources					
Use	Sector	Org.	Data Source	Version	Entities
Network	Transportation (G_{Trans})	PEV	Southport Map	Current	Roadways, Gates, etc
			Google Earth	Current	Roadways, Gates, etc
	Cyber (G_{Cyber})	PEV, POAL	Interviews, OSINT	Current	Hosts, switches, routers, etc.
Flows	Transportation (K_{Trans})	PIERS (IHS Inc.)	Commodity Group Origin-Destination Pairs	FY2017, FY2018	Loaded TEU Import/Export
		PEV	Vessel Calls	FY2017	Vessel
	Cyber (K_{Cyber})	PEV, POAL	Emulated Packets	Current	Protocols: MySQL, HTTP



Measures of Performance			
Sector	Name	Stakeholders	Description
Transportation	Number of TEU	Port Wide, Operators, Landlord ports	Number of TEU in the System
	Direct Business Losses	Supply-Chain Consumers	Dollar value of number of TEU not delivered on time
Cyber	Jitter	Operator, Landlord Port	Variance in latency (via iperf)
	Packet Loss	Operator, Landlord Port	Via iperf

Milestones and Accomplishments

Track	Outcomes Achieved	Objectives Ahead
Research	Maturation and Extension (FY2018.O1-O4)	Transitional Research (FY2019.O2)
	<p>PDT Core Services</p> <ul style="list-style-type: none"> • Compute optimal commodity routes given a disruption and priorities*. • Mature simulation [WinterSim 2019]. <p>Advanced Cyber Module</p> <ul style="list-style-type: none"> • Translate measures of performance in communications/IT network to measures of performance in transportation network. <p>Economic Analysis Module</p> <ul style="list-style-type: none"> • Compute direct business losses from disruption. 	<p>Model Builder / Scenario Wizard</p> <ul style="list-style-type: none"> • Evaluate ability to use open-source data sources to construct shipping port models and disruption scenarios. • Develop an easy-to-use interface so targeted customer segment can employ PDT to their ports. <p>Maturation of PDT Core</p> <ul style="list-style-type: none"> • Improve scalability and fidelity of results using measures of performance.

*Delay in deliverable due to complexity of extending existing method to address stakeholder-driven requirements as well as personnel changeover.

Project Impact

Customer Segment	Value Proposition (FY2020 Workplan)	Supporting Fieldwork	Committed Partners
 Ports	<p><i>Manager.H1:</i> Strengthen proposals---whether grants for infrastructure improvement or for port security planning---through data-driven holistic risk assessments.</p> <hr/> <p><i>CISO.H1:</i> Provide a holistic approach to risk assessment to bridge IT/OT divide and communicate effectively with board and operators.</p>	<ul style="list-style-type: none"> Port of Anchorage interview. Jack Voltaic v 3.0 Planning Meeting* <hr/> <ul style="list-style-type: none"> Ports of Auckland Port of Charleston, SC 	<p>Army Cyber Institute at West Point via Jack Voltaic Program</p> <ul style="list-style-type: none"> Quantify impact of scenario injects for port disruptions Cyber-originating disruptions on power projection Proposal under legal review at West Point [Proposal]
 Consulting	<p><i>Consultant.H1:</i> Help municipalities conduct holistic risk assessments on a continual basis, both in person and virtually.</p> <hr/> <p><i>Consultant.H2:</i> Drive organizations to invest in security by using software risk assessment tools to provide purchasing/decision making units with a dollar amount for business disruptions due to technical debt.</p>	<ul style="list-style-type: none"> British Telecom in-person interview, Savannah. <hr/> <ul style="list-style-type: none"> British Telecom in-person interview, Savannah 	<p>British Telecom</p> <ul style="list-style-type: none"> CRADA for Customer Development process via 20-30 min interviews <p>Deloitte</p> <ul style="list-style-type: none"> CRADA for integration of PDT with city-scale simulation and Deloitte supply chain strategy.

*Resulted in proposal submitted to Army Cyber Institute to develop PDT Fort to Port analyses in their final report to the Pentagon.

Transition Plans

Track	Outcomes Achieved	Objectives Ahead
Tech Transition	Market Analysis (FY2019.01)	Commercialization (FY2020)
	<ul style="list-style-type: none"> • Customer Development <ul style="list-style-type: none"> ○ Build on local NSF I-Corps in Fall 2019 ○ Jack Voltaic v 3.0 Planning Meetings ○ Interviews with Customer Segments • Market Analysis <ul style="list-style-type: none"> ○ Illinois Business College Students ○ Spring 2020 Research • Patent Submitted <ul style="list-style-type: none"> ○ March 2020 via UIUC OTM • Stakeholder Working Group Established <ul style="list-style-type: none"> ○ Based on customer segments • Venture Fellow Program <ul style="list-style-type: none"> ○ Participation in AVG Venture Fellow Program for VC education. 	<ul style="list-style-type: none"> • National NSF I-Corps (FY2019.03) <ul style="list-style-type: none"> • Proposal being submitted at advice of advisory board member. • Improve chances of sustainable, long-term funding for PDT technologies via SBIR/STTR. • Customer Segments <ul style="list-style-type: none"> • Port Security Managers/CISOs • Risk Consulting Companies • Insurance Companies • Retailers • Channel Partners <ul style="list-style-type: none"> • Explore potential channel partners to distribute technology and engage with end users.