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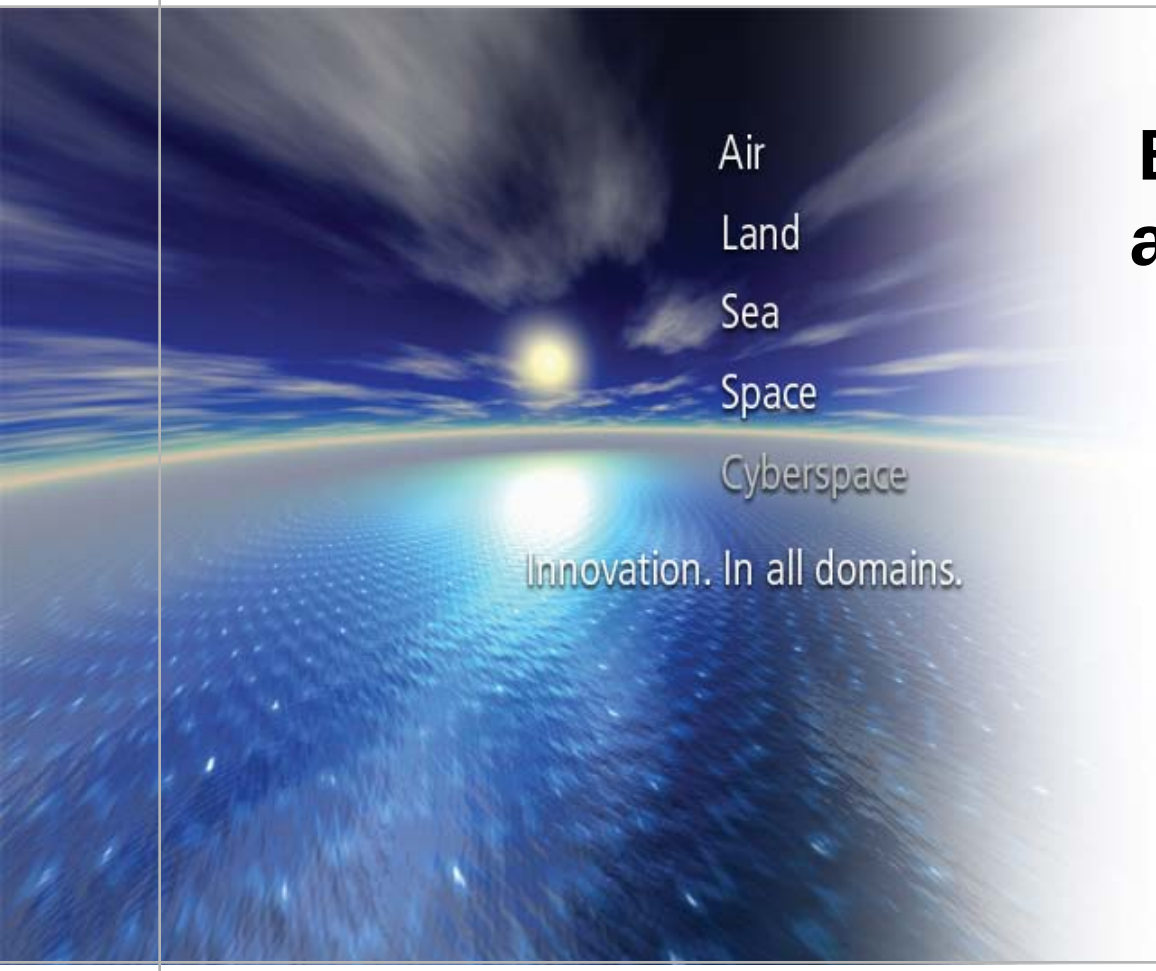

Energy Surety Behavioral Modeling and Training Using a Multi-Dimensional Architecture

GovEnergy Conference

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Think About This:
Power is a Complex System!

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The U.S. has:

- 3000 electric utilities
- 2000 independent producers, 10,000 generators feeding 120M residential + 16M commercial + 0.7M industrial = 700,000 miles of high tension lines owned by over 200 different entities … which becomes 5,000,000 miles of medium voltage transmission fed into **22,000 substations** owned by over 3000 entities

A complex "system" for sure!

The North American electric power industry will purchase more than $20B in grid infrastructure equipment in 2005, nearly one quarter of the worldwide total of $81B. (From "Making the Grid Smart" by Joel Makower, October 2005)

High Level 3D Architecture for 'Proactive Reaction'

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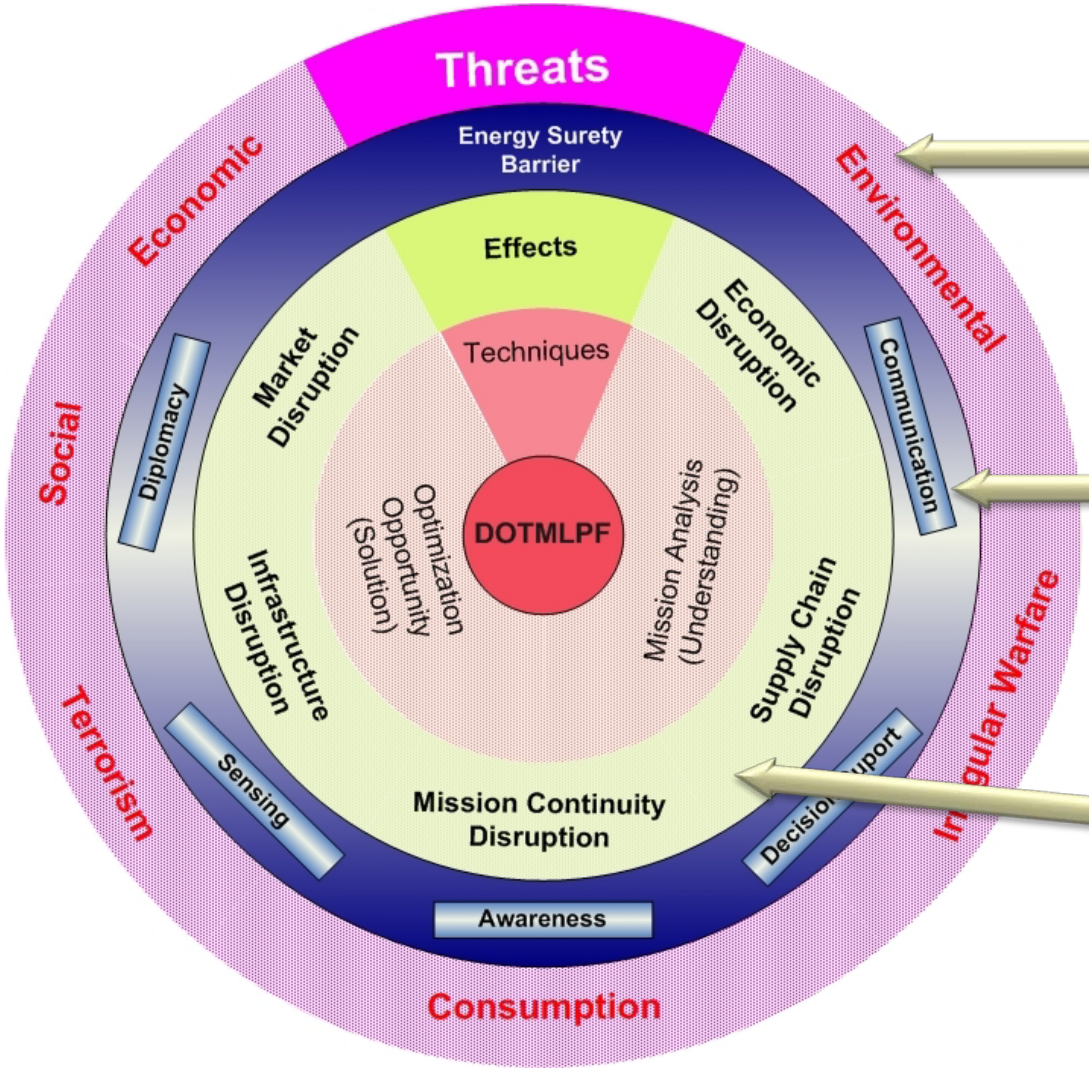

Threat/Physical Domain
Effect on:
Transformers, generators, supply chain

Control Domain
Ability to:
Re-route, alter levels repair, change the mission, etc.

Performance/Behavioral Domain
Reduce demand, increase uptime, optimize mission, etc.

Architectures (hardware & software) Supporting the Multi-Dimensional View is an Imperative

The Architectural Goal

- **Defines the boundary between automated (machine) behavior and people behavior**
- **People are an element of all three domains!**
  - Linking the physical, control and performance domains is critical
  - **Many systems just focus on the physical (e.g., buy a smart meter or solar cell) and are often not linked to human activities in control or performance domains**
    - U.S. DoD is in unique position to optimize the human activities though mission redesign and behavioral modification
- **Mission Analysis helps understand the implications in each domain:**
  - Design (or redesign) the "mission" to support the goals
    - Change some doctrine, change some mission parameters, change some behaviors, improve the links to technological improvements
  - Design (or redesign) the system to support the mission
    - Picking the correct sensor feeds to support actual activities
  - Optimize the composite of: system, mission, operational decisions and training
    - Add Vision, Values, Mission, Goals into the Decision Support system

The Market Case for Surety and Monitoring - Civilian

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- **Northeast Blackout of 2003**
  - Affected 50 million people in eight states and Canada
  - Took days to restore, and caused a financial loss in the United States estimated to be between $4 billion and $10 billion
  - People lost water supplies, transportation systems, and communications systems (including Internet and cell phones). Factories shut down, and looting occurred ….could have been avoided
- **3,050 of the Gulf's 4,000 platforms and 22,000 of the 33,000 miles of Gulf pipelines were in the direct path of either Katrina or Rita**
  - As of May 3, 2006, shut-in natural gas production in the Gulf of Mexico from Hurricanes Katrina and Rita was equivalent to 12.95 percent of current daily gas production… millions of lost dollars and increased costs
- **Total damage to pipelines caused by 2008's Hurricane Ike was estimated between $80 million and $120 million**
  - Pipelines can average 100,000 barrels per day at about $289,000 per hour! ($69.50/bbl)

Man Made Disasters Are Even More Frequent - DoD

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- In Colombia rebels have bombed the Caño Limón oil pipeline over 600 times since 1995
- Nigerian militants have repeatedly attacked pipelines and related facilities including the simultaneous bombing of three oil pipelines in May 2007
- Roughly 170,000 miles of oil pipeline in the United States carry over 75 percent of the nation's crude oil and around 60 percent of its refined petroleum products
  - In the U.S. there are nearly 200 interstate oil pipelines
  - The U.S. natural gas pipeline network consists of around 210,000 miles of interstate transmission, 85,000 miles of intrastate transmission, and 40,000 miles of field and gathering pipeline. Around 100 systems make up the interstate network
- Energy/Environment is the "new age" of defense … defense of nations/society/business is now linked to environmental (food, water, climate) and energy (supply) issues

DoD FOBs are the Low Fruit

- The energy surety mission in Afghanistan boils down to a supply -v- demand model
  - With # of trips across hostile territory the variable to optimize
    - 75% of all NATO supplies are by road, 50% by weight is fuel:
    - July 09 alone exhibited 828 IED attacks on convoys
  - With inputs as simple as mission critical oil for generators
    - Vs. general hoteling, entertainment and “Other”
  - With inputs as complex as RFID of just in time re-supply, integrated supply chain, probability of IED disruption, etc.
- 3 Dimensional architectures are needed for actionable modeling:
  - Holding the physical domain (equipment) constant:
    - allowing the control domain to be variable can lead to significant “ah ha’ moments for C2 System redesign, mission redesign and optimization
  - Holding the physical domain (equipment) constant:
    - allowing the performance (people) domain to be variable can lead to significant “ah ha’ moments for personnel training and mission redesign

Human behavior vs. equipment acquisition

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- **Compare and contrast the different effects of human behavior to understand the outcomes of (modeled) various scenarios**
  - Mission Critical vs. Downtime optimization
    - A downtime behavioral CONOPS: What is the 'cost' of DT?
    - A crisis CONOPS: What happens if all heck breaks loose?
    - A multi-mission CONOPS: Peace, business, relief, war, disaster, R&R are simultaneous realities
  - All with an eye toward the effects of human behavior's affects in all three domains
- **What do you do with the new knowledge?**
  - **Buy:** → *More efficient machinery*
  - **Train:** → *'Better' human behavior*
  - **Define:** → *CONOPS doctrine/processes*
  - **React to:** → *Ad-Hoc events*

Mission Based Decision Support Is a Key Discriminator

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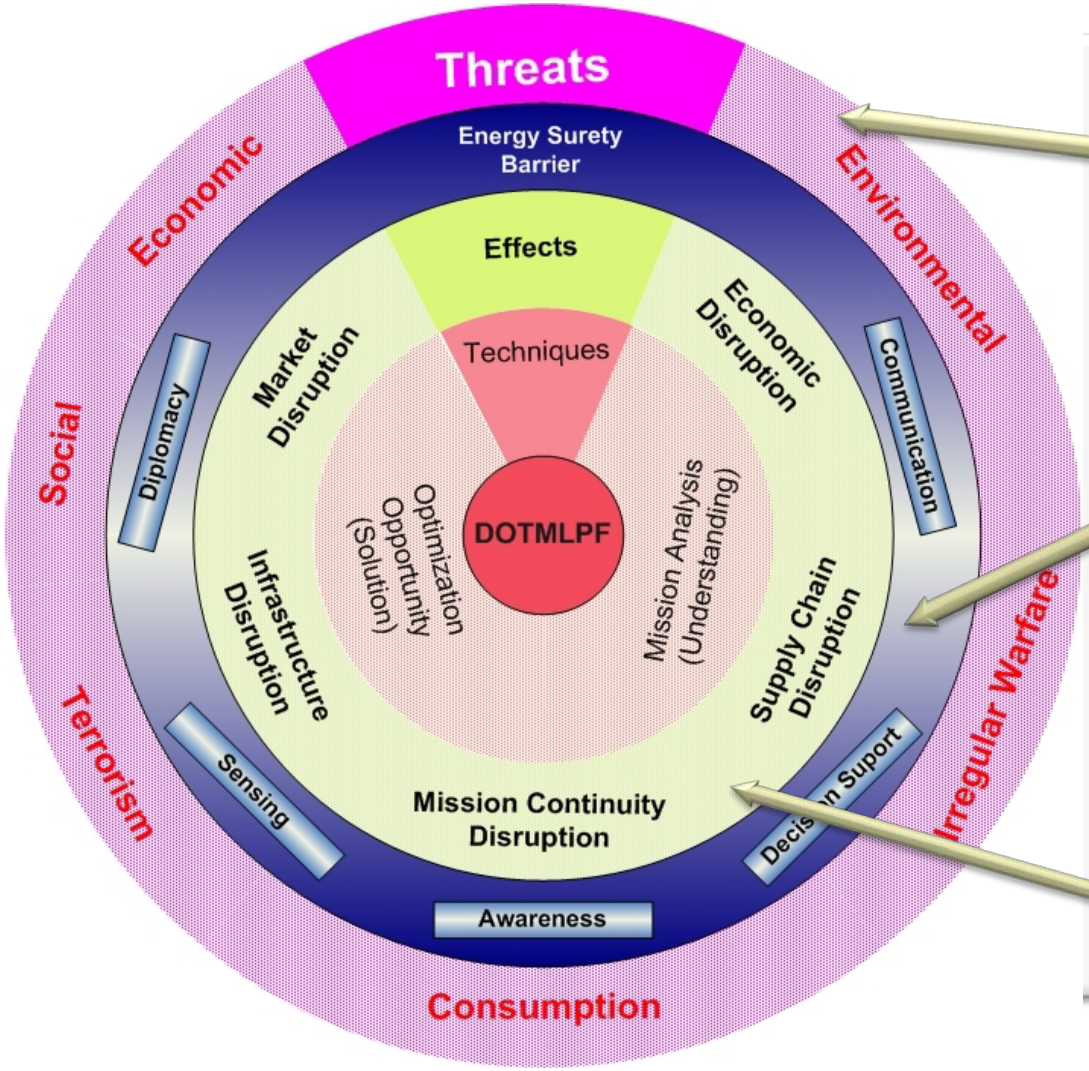

Threat/Physical Domain

Often not linked by process, people or technology

Control Domain

Often not linked by process, people or technology

Performance Domain

Balance Technology v. Interactions v. Supply/Demand

The Approach and Process: Mission Profiling (Pat., TM)

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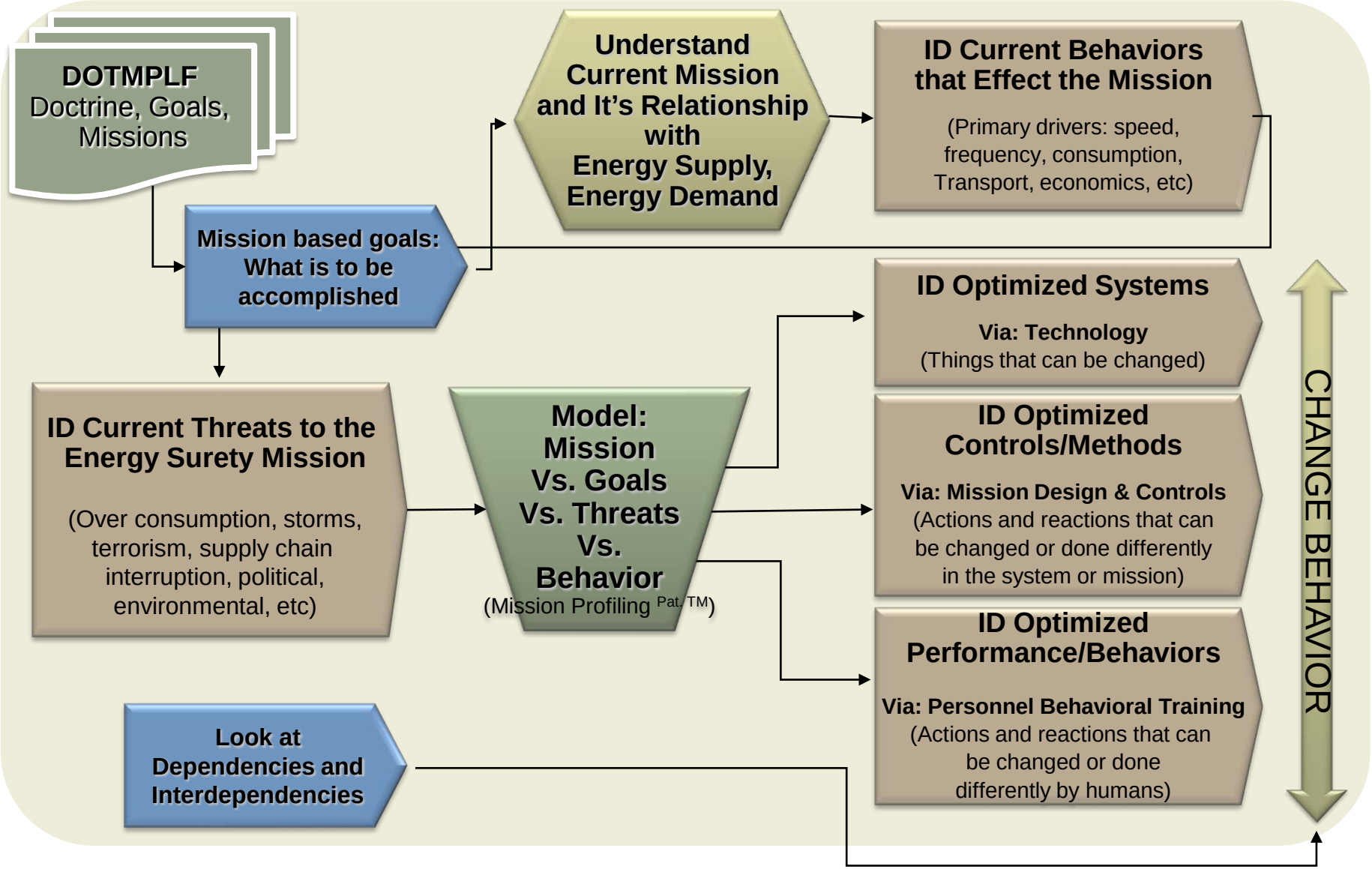

Sample Response Flow

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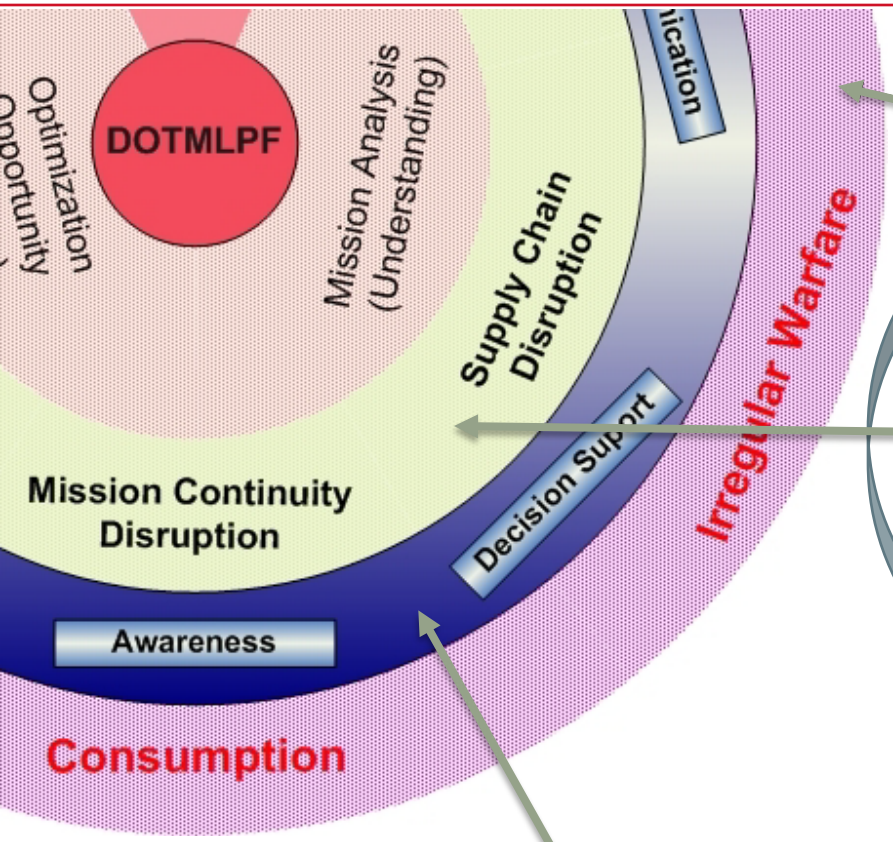

Cause:
- Supply Chain Interruption
- Storms
- Over Consumption

Effects:
- Broken Pipelines, Broken Roads, etc.
- Loss of Oil Supply for Generators
- Workforce disruption
- Down Communications

Response:
Follow Emergency CONOPS
- Damage control and repair *(physical)*
- Rerouting of oil, gas, electricity, *(control)*
- Redesign of mission to accommodate new supply limitations – *(performance)*

Notification to effects:
- System notifies of location and severity of broken pipelines
- System notifies of "time to empty" energy Surety
- System notifies of rates of consumption, etc.
- System provides recommendations from SMEs

The architecture ensures response is multidimensional

Conclusions

- The basic idea is to use system dynamics modeling and the Mission Profiling process with the 3D architecture to model energy supply, demand and controls:
- The user can do ‘what-if’ and ‘sensitivity analysis’ to find places to change:
  - behavior, equipment, the mission, and optimize controls of equipment.
  - The model can show how decisions ripple through the system, how a change in one system or behavior impacts another.

Backup

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From Wikipedia

- DOTMLPF is an acronym used by the United States Department of Defense. [1] DOTMLPF is defined in the Joint Capabilities Integration Development System, or JCIDS Process. In this sense, the JCIDS process provides a solution space that considers solutions involving any combination of doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF). Since combatant commanders define requirements in consultation with the Office of the Secretary of Defense (OSD), they are able to consider gaps in the context of strategic direction for the total US military force and influence the direction of requirements earlier in the acquisition process.
- It also serves as a mnemonic, to remind Pentagon staff planners of the issues to be considered whenever establishing a new national security capability. Prior to undertaking a new effort, military planners are expected to complete a DOTMLPF Study.
- Doctrine
- Organization
- Training
- Materiel
- Leadership
- Personnel
- Facilities

General Energy Surety Concept Architecture

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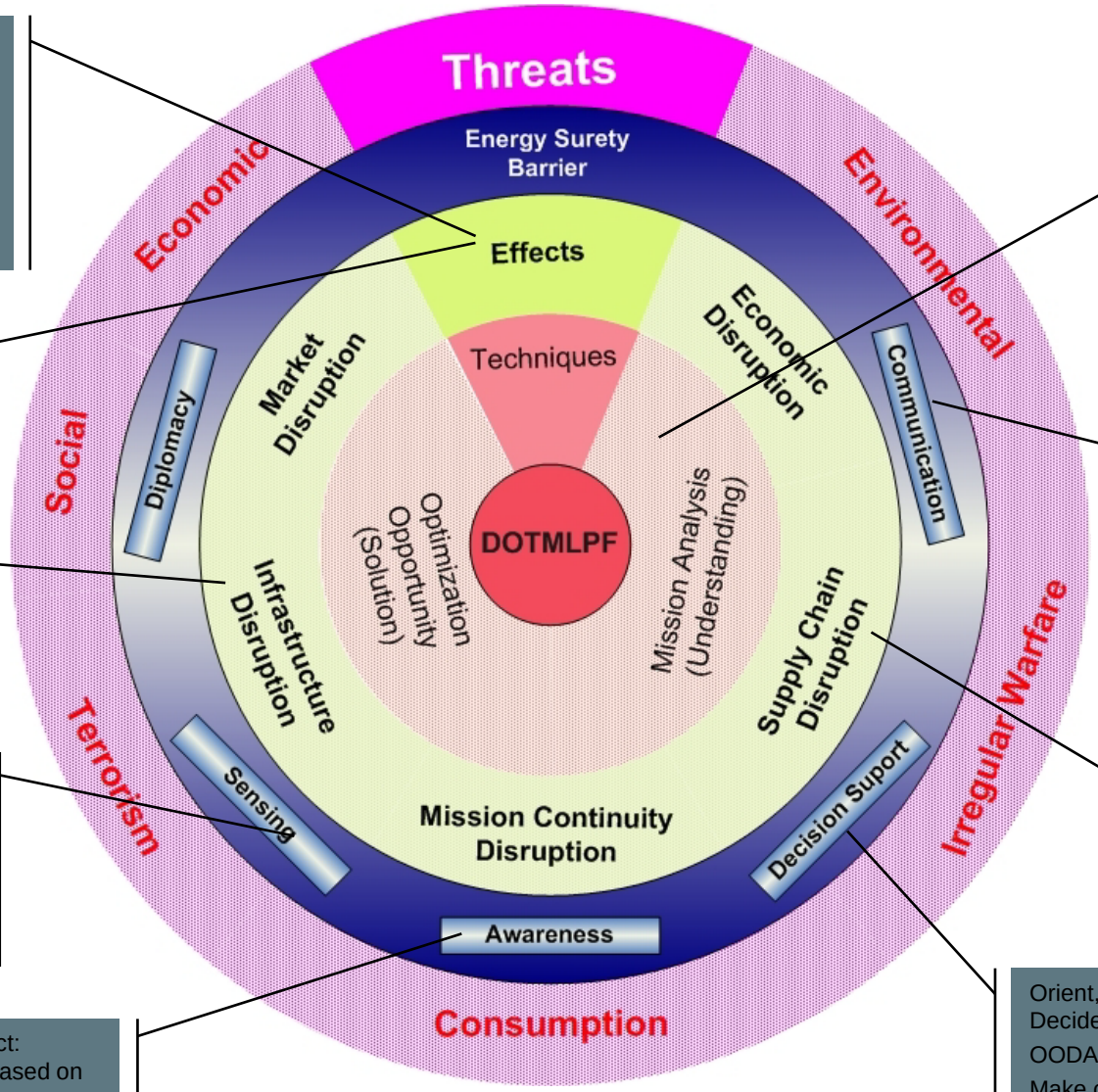
Areas Of Responsibility
Local
Regional
National
International
Global
In Theater

Actionable Knowledge and Awareness:
Recommendations and hot-spot alerts

Roads
Bridges
Trains
Pipelines
Supply Paths

Monitoring
Oil Usage
Demand
Consumption
Weather
Pipeline Security Etc.

Situational Awareness to Effect:
Training/Mission Re-Design Based on
Inputs from Monitoring, Modeling, Etc.



Mission Based Modeling:
Confluence Pat. Pend.

Data Collection
Advanced Notice
Real-Time Awareness
Intel

Supply Chain Interruption
Terrorism, Shortages , Over Consumption, Failures, storms

Orient, observe, Decide / Act
OODA Loop
Make changes to current situation