Maritime System of Systems and Enterprises

Resilience while Balancing on the Edge of Chaos

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To be resilient, an organization must dramatically reduce the time it takes to go from 'that can't be true' to 'we must face the world as it is.'

Gary Hamel, Liisa Valikangas
"The Quest for Resilience"
Harvard Business Review
September 2003

Employment in the U.S.

"You work where?"

- U.S. ports play a key role in creating jobs.
- For every $1 billion in exports about 15,000 port jobs are created . (considering jobs to support new products and personnel, this figure swells to 30,000-45,000)
- Total ports-related employment in U.S. was estimated at 8.4 million people in 2006:
  - 1.4 million in providing goods and services to ports (such as longshoremen, stevedores, and security personnel)
  - 7 million in import/export related activities (such as transportation, warehousing, and distribution)
- Port activities brought in $102.8 billion in form of taxes and added nearly $2 trillion (14% of GDP) to the economy in 2006

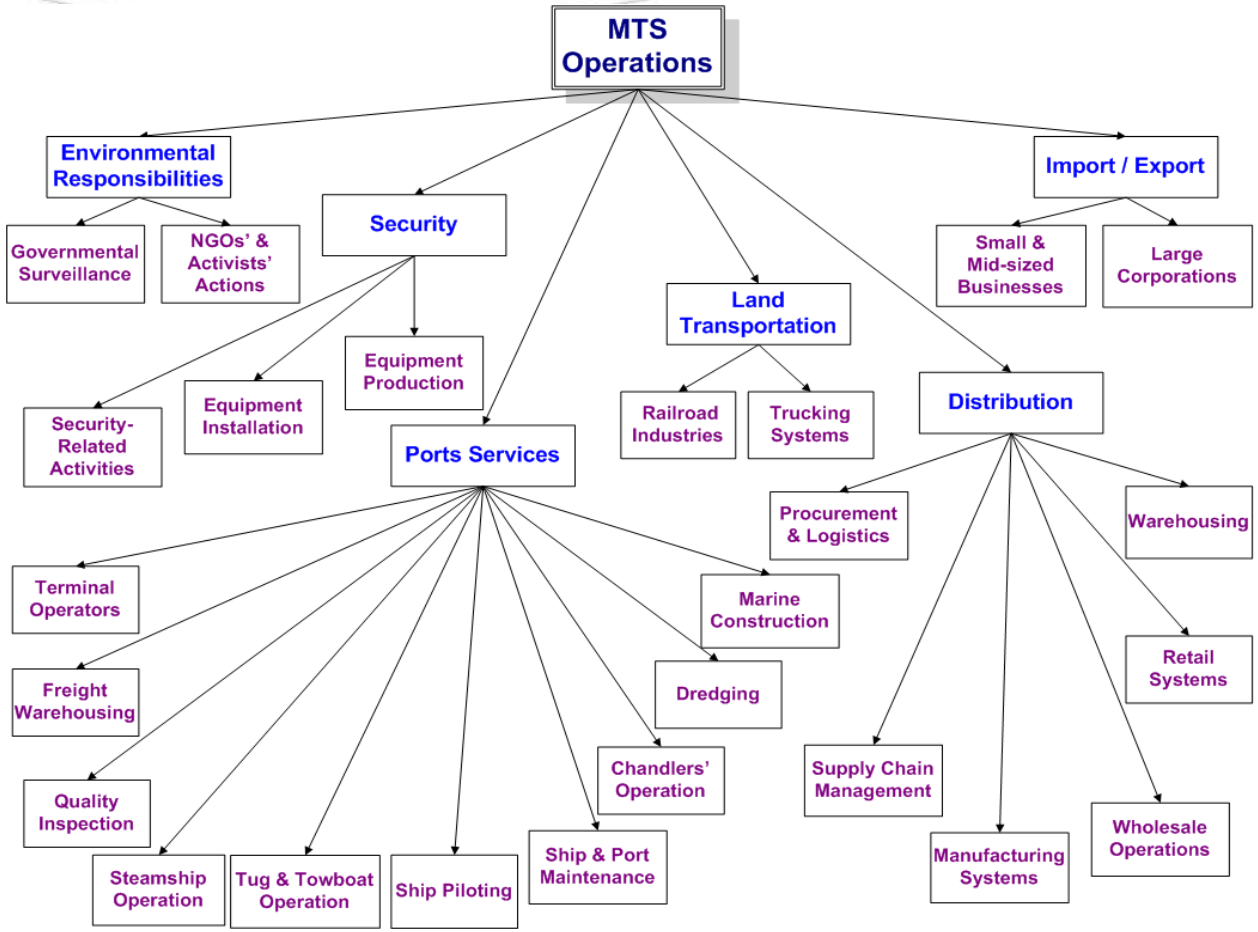
Source: American Association of Port Authorities

(Multi-) Stakeholders Perspectives

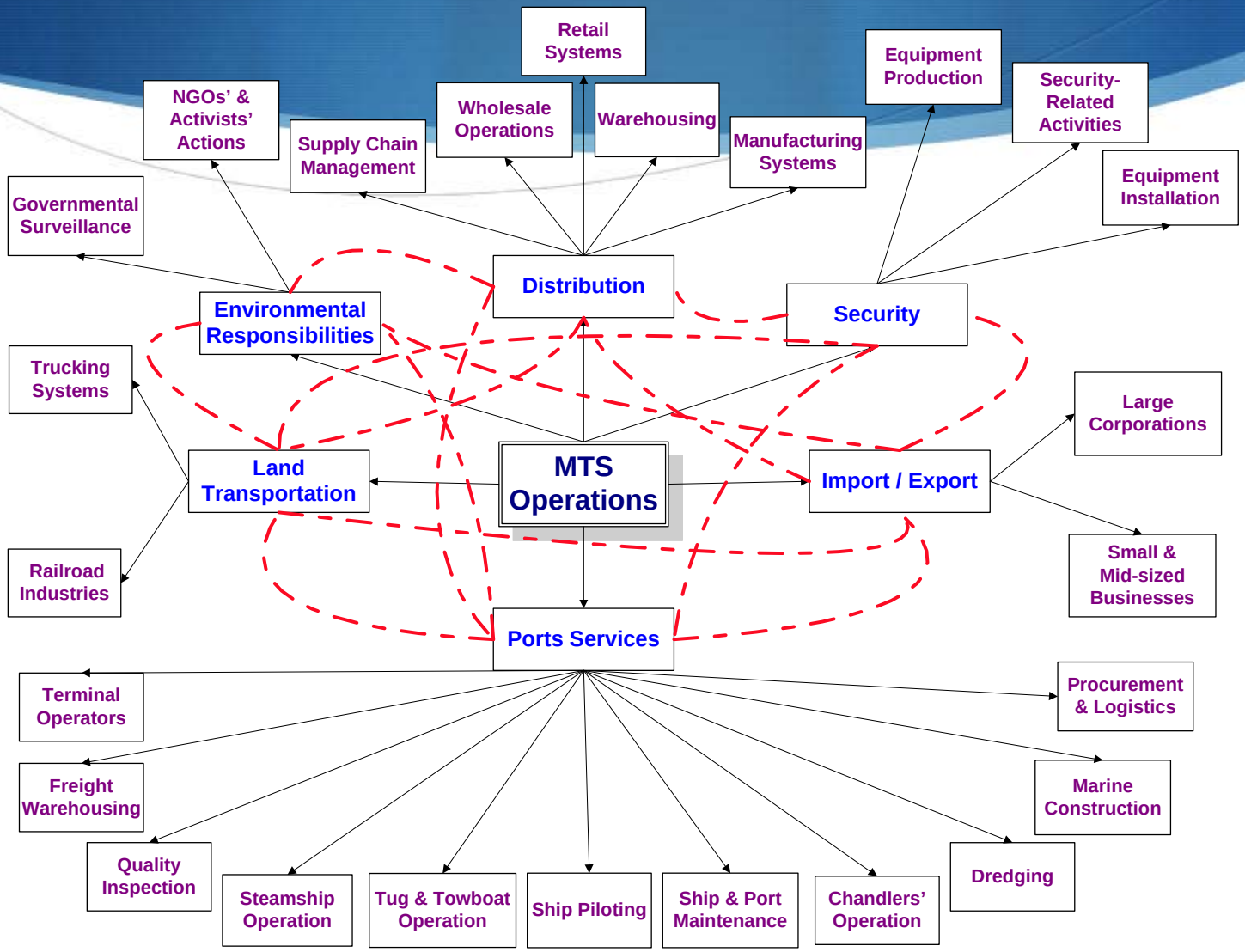
"My perception is my reality, and we are both right."

- Hundreds of organizations are involved in conducting MTS business.
- Governmental, civil society, and private sectors are the stakeholders of MTS and each has a different perspective.
- Combination of these perspectives is a constraint for decision-making.
- While DHS is concerned about national security, private sector businesses demands acceleration of process time, and NGOs look at the problem from another angle, at the same time.
- That makes the optimization process very challenging.

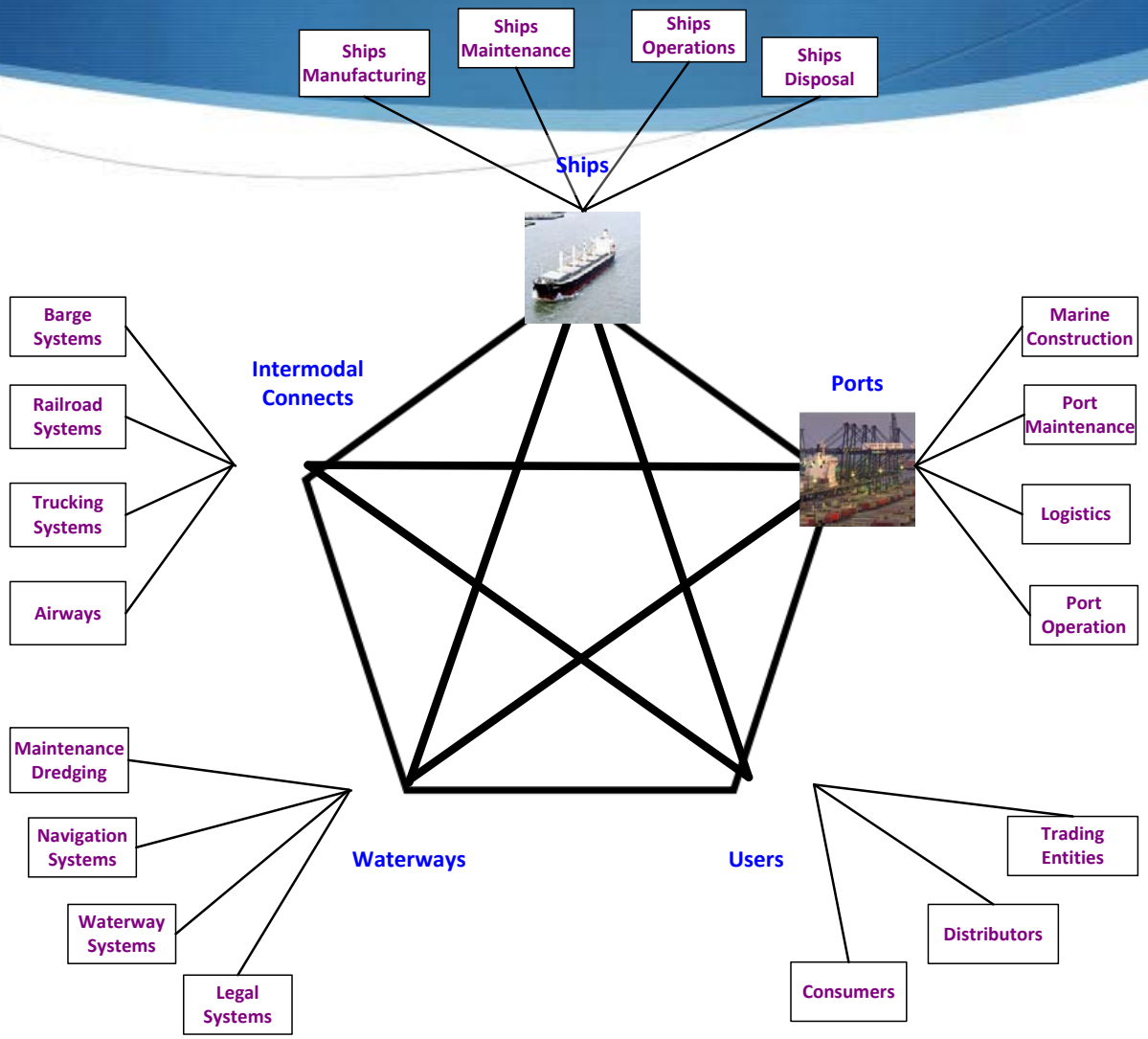
Hierarchy of Operational Roles



Holarchy of Operational Roles



Holarchical View of MTSoS



Resiliency is…

- The capability of a system to provide and maintain an acceptable level of service in the face of major changes or disruption
- The ability of a system to be less susceptible to disruption, and be able to recover rapidly from major sudden changes by returning back to a near original service delivery level
- The main characteristics of resiliency are:
  - Less vulnerability to disruption
  - Ability to absorb external shocks and return back to an acceptable service level timely

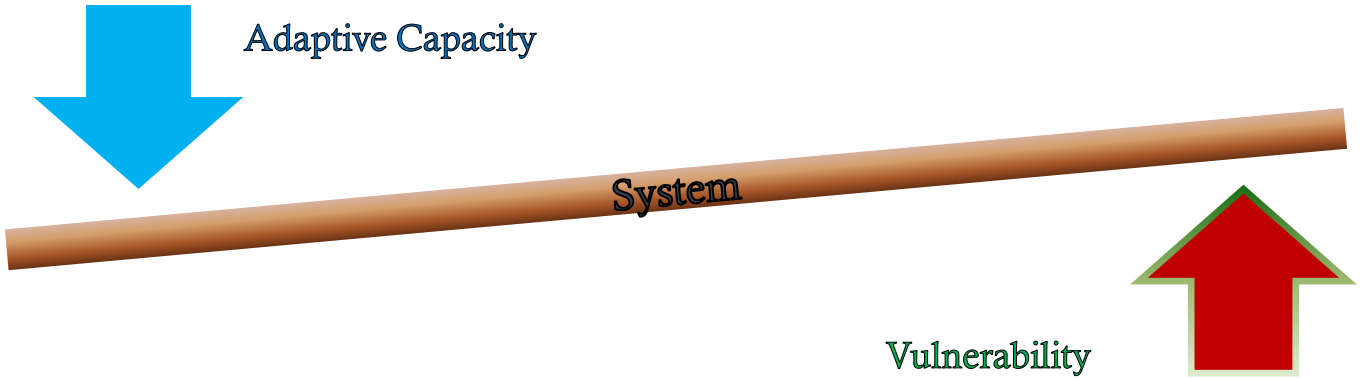
Watch your behavior…

Imposed changes as a result of a shock to the system

Robustness	Adaptability	Flexibility	Agility	Resiliency
Rigidity of the system against undefined , unexpected , and undetermined external forces.	Capability of the system to modify its procedures and functionality to cope with imposed changes.	Ability of the system to change its structure or operations in accordance with changes.	Capability of the System to predict external pulses and modify its structure before facing changes.	Ability of the system to be less vulnerable and to recover timely against imposed major changes.

Resiliency in a System

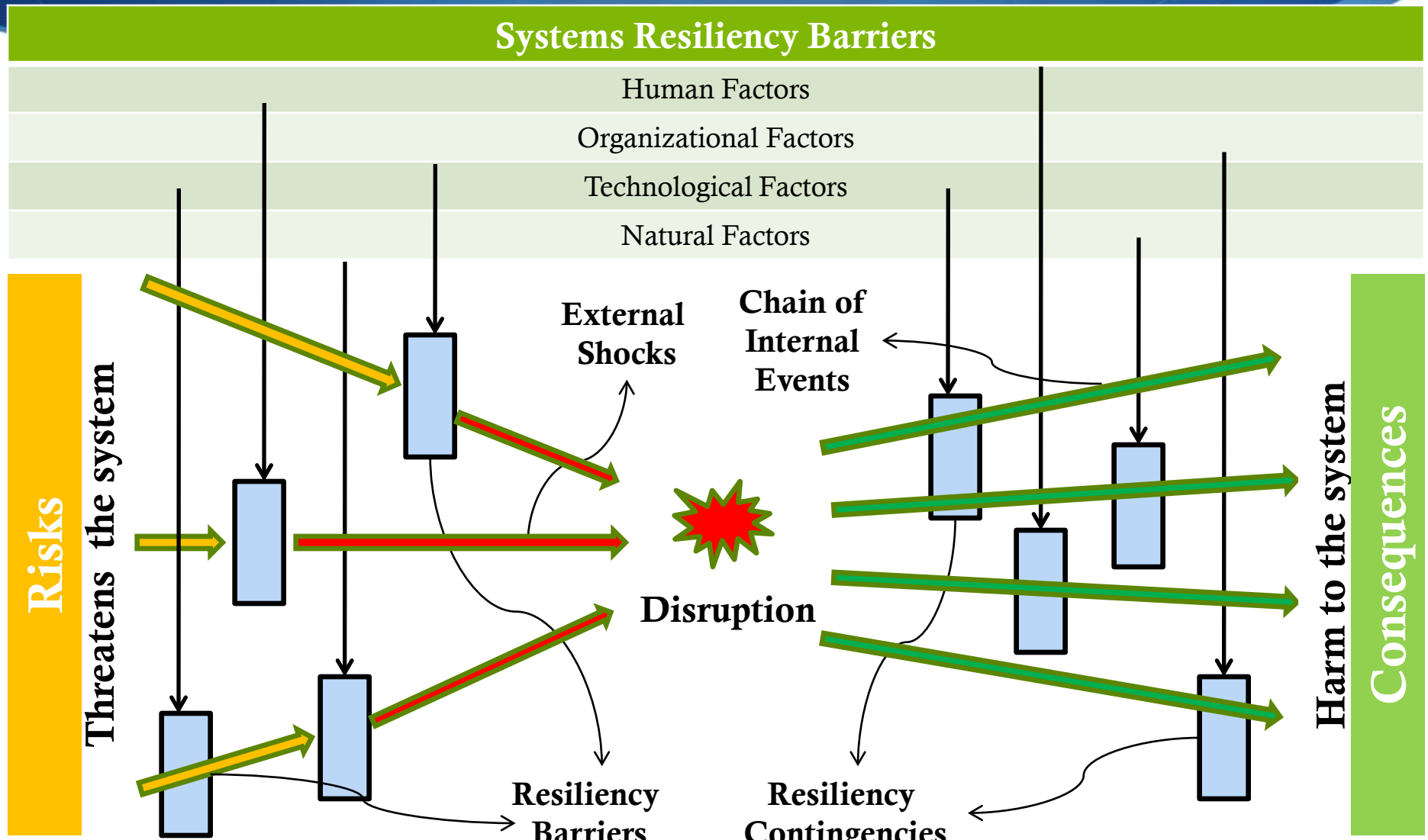
- Resiliency can be defined as a function of vulnerability and adaptive capacity.
- In order to make a system more resilient, we want to:
  - Reduce the likelihood of disruption (minimize system's vulnerability)
  - Manage the consequences (maximize the adaptive capacity)



Raising Resiliency Factors

	Human Factors	Organizational Factors	Technological Factors	Natural Factors
Systems Resiliency Barriers and Contingencies	Human error analysis	Effective communication	MIS & DSS	Meteorology
	Decision-making models development	Systematic documentation	Security instruments & system	Prediction of natural incidents
	Educational systems and training	Instructions & manuals	Surveillance technology	Analysis of existing data and occurrence likelihood
	Flow of Information	Clarity of responsibilities	Integrated intelligent security systems	Crisis management,
	Ergonomic design	Integration among stakeholders	Security maritime domain from Sky or under water	Recovery and Mitigation
		Clarity of rules, regulations & laws	Geographical information system	Markovian plots

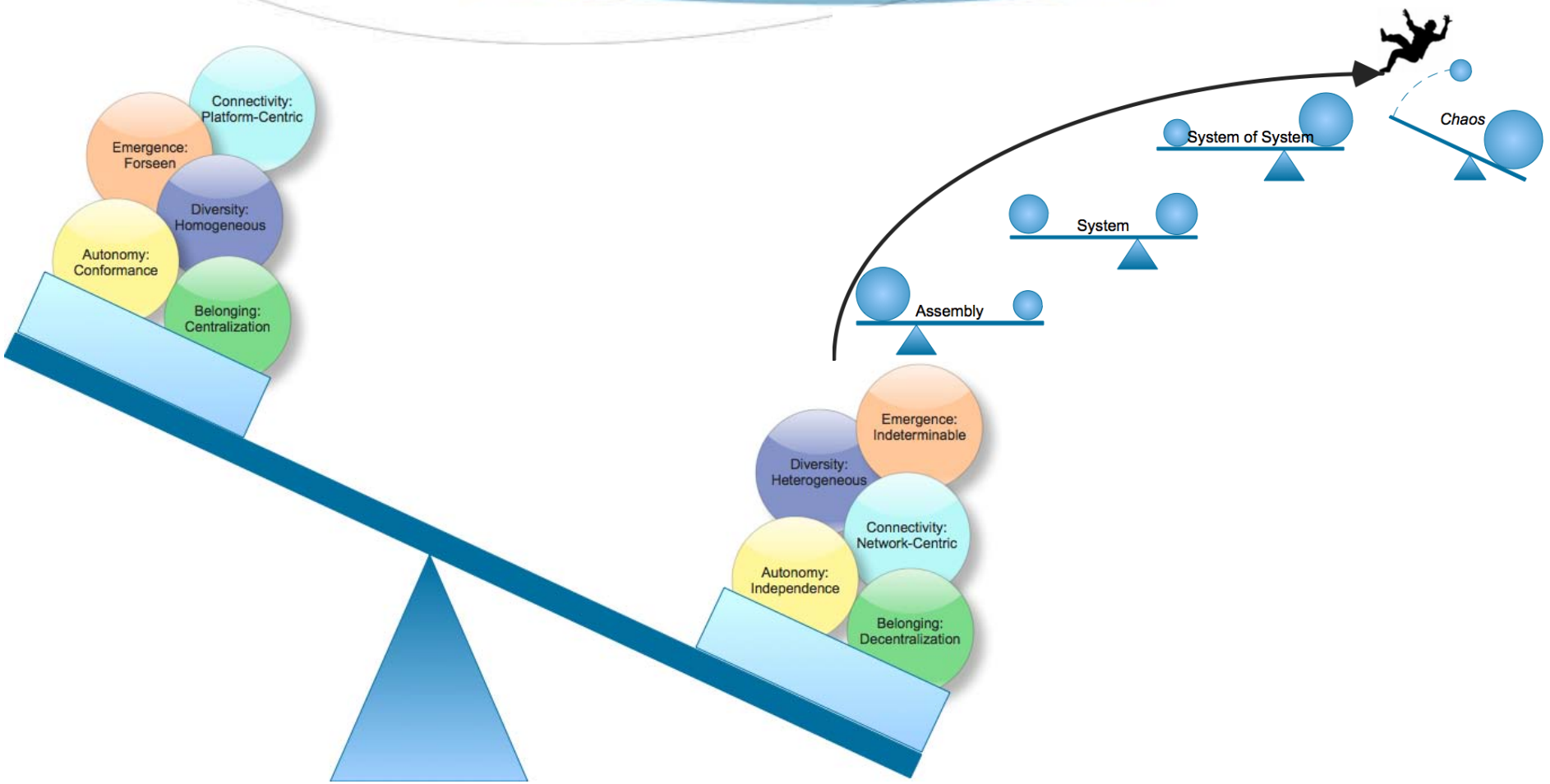
Disruption Scenario and Resiliency (Bowtie Model)



Paradox and Finding your Balance

System of Subsystems		***System of Systems***
Conformance Autonomy is ceded by parts in order to grant autonomy to the whole	*Autonomy*	**Independence** Autonomy is exercised by constituent systems in order to fulfill the purpose of the SoS
Centralization Parts are akin to family members; they did not choose themselves but came from parents. Belonging of parts is in their nature.	*Belonging*	**Decentralization** Constituent systems choose to belong on a cost/benefits basis; also in order to cause greater fulfillment of their own purposes, and because of belief in the SoS supra purpose
Platform-Centric Prescient design, along with parts, with high connectivity hidden in elements, and minimum connectivity among major parts	*Connectivity*	**Network-Centric** Dynamically supplied by constituent systems with every possibility of myriad connections between constituent systems, possibly via a net-centric architecture, to enhance SoS capability
Homogeneous Managed i.e. reduced or minimized by modular hierarchy; parts' diversity encapsulated to create a known discrete module whose nature is to project simplicity into next level of the hierarchy	*Diversity*	**Heterogeneous** Increased diversity in SoS capability achieved by released autonomy, committed belonging, and open connectivity
Foreseen Foreseen, both good and bad behavior, and designed in or tested out as appropriate	*Emergence*	**Indeterminable** Enhanced by deliberately not being foreseen, though its crucial importance is, and by creating and emergence capability climate, that will support early detection and elimination of bad behaviors

Resilience on the Edge of Chaos

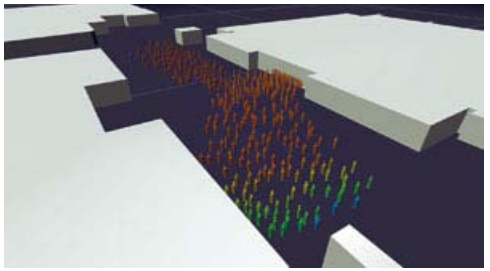


If it was obvious, we would all do it…

The Economist, Crowd Modelling: Model behaviour, March 5, 2009

- Lord of the Rings

- Building Evacuation



SEED, The Hive Mind, April, 2009

- The Hive Mind

- Selfless Actors

Ask me a question and I will give you three in return…