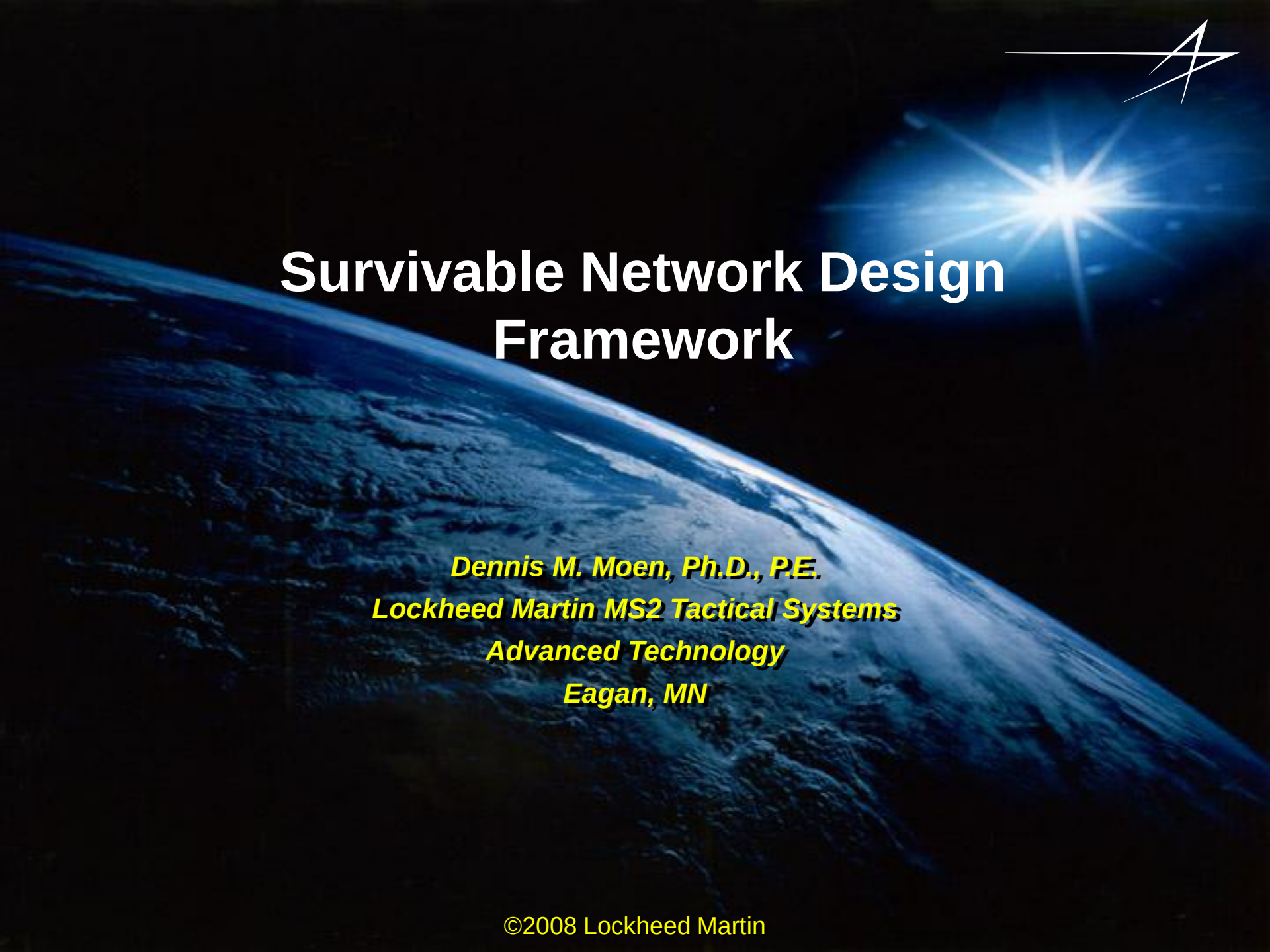

Survivable Network Design Framework

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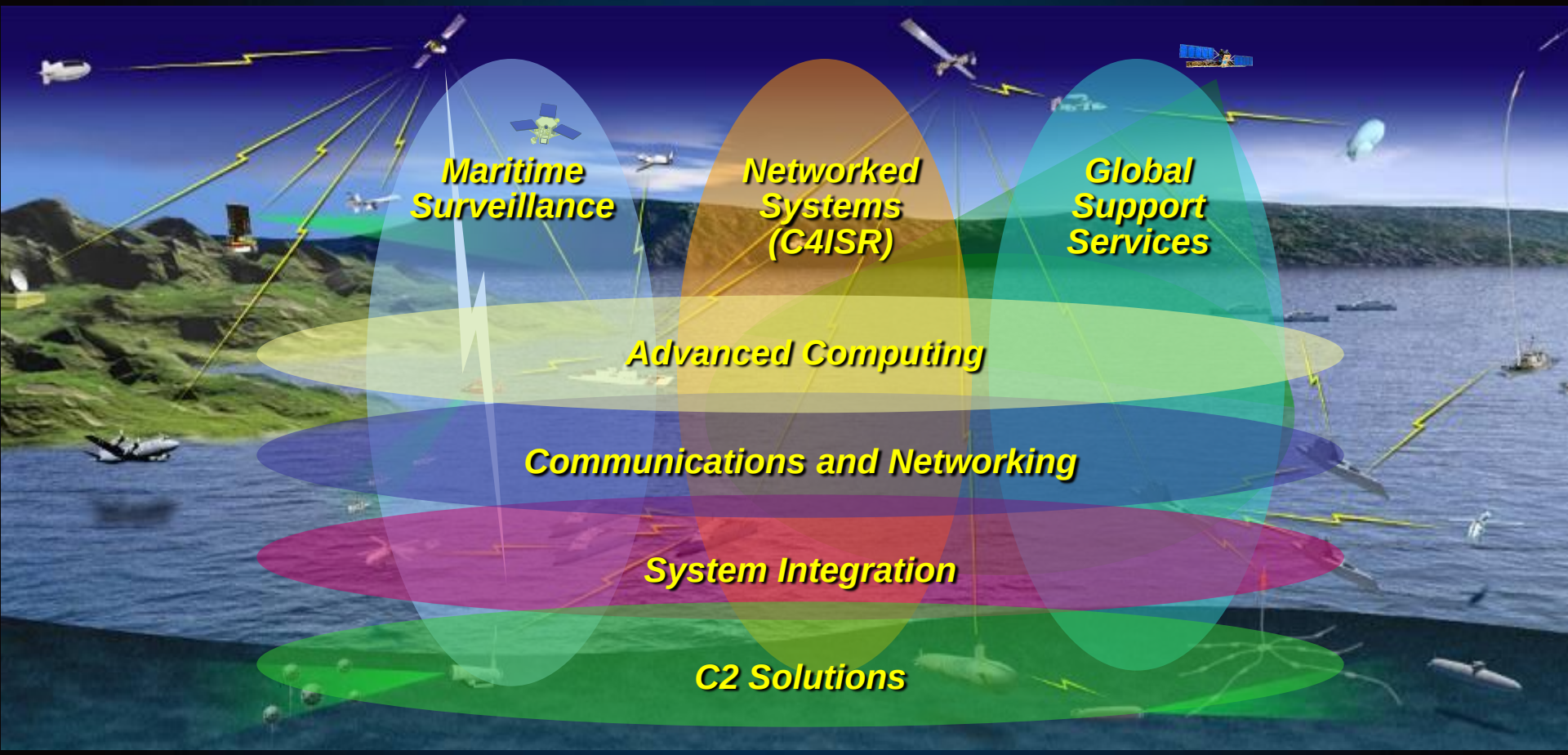
Agenda

- *MS2 Tactical Systems*
- *Motivation for Survivable Networks: C4ISR*
- *A Framework for cost-effective survivable network design*
- *Summary/Discussion*

MS2 Tactical Systems – C4ISR Products and Solutions



MS2 Tactical Systems Delivers and Supports Complex C4ISR Solutions

Motivation: Complexity of C4ISR and Battle Management

- ***Sensors: They are everywhere on many networks***
  - *Lots of data in many types and formats*
  - *Diverse capabilities: range, modality, maneuverability*
  - *Networks are poorly integrated*
- ***Communications and dissemination***
  - *Inter and intra networking*
  - *Networking platforms have different characteristics: mobility, power, line-of-sight, latency, bandwidth*
  - *Network-to-network adaptation: adaptive data rate and waveforms*
- ***"Always-on": Connectivity anytime, anywhere, anyhow***

Objective: Reliable information transfer under dynamic conditions with QoS

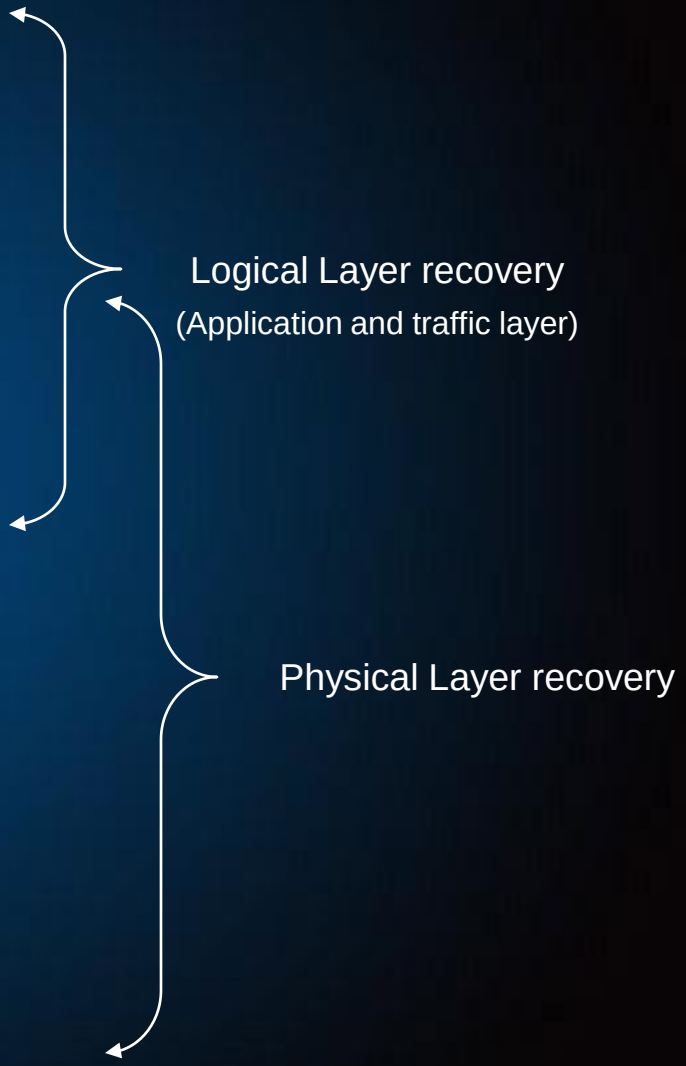
What is a Survivable Network?

A survivable network has the characteristic that essential services are preserved under disruption and recover full services in a timely manner

- ***Disruption can result from many factors***
  - *Congestion resulting from excess offered load*
  - *Protocol Interworking failure (configuration)*
  - *Physical disruption*
  - *Security failure (Denial of service)*
- ***Service recovery***
  - *Priority of restoral*
  - *Automated vs manual*
  - *Efficiency (recover full service in a timely manner)*

Survivability Framework: Three levels of Network Integrity during undesirable events

- ***Network availability (planned)***
  - *Normally associated with maintenance and configuration faults (single fault)*
  - *Represents the majority of faults*
  - *Automated recovery or inherent reliability in the design*
- ***Single, worst case failure (node, link, etc)***
  - *Environmental failure*
  - *Accident*
  - *Manual recovery (minutes/hours)*
- ***Disaster-based event: Several links or nodes fail simultaneously***
  - *Natural or man-made event*
  - *Manual recovery (lengthy-hours/days/weeks)*



Network Level Emergent Behavior: System View

- ***System Requirements need to be integrated with survivability requirements at node and network level***
  - ***Organize into essential and non-essential services***
  - ***Organize by user or business function***
- ***Survivability imposes new types of requirements***
  - ***Emergent behavior: collective behavior of node services communicating across the network***
  - ***Adaptive behavior, function, and resource allocation***

Example: Functions and resources devoted to non-essential services could be reallocated to essential services

Sample Survivability Measures

- ***Connectivity based measures***
  - *Route availability ratio*
  - *Probability of node isolation*
- ***Traffic based measures***
  - *Average network blocking given a failure*
  - *Average number of lost calls given a failure*
- ***Desirable characteristics of measures***
  - *Technology independent*
  - *Measure survivability under the three described levels of failure*
  - *Can be applied to a subnetwork of the network*
  - *Can measure the customer/user impact*

Survivability Framework: Analysis

Survivability Level / System Criteria	Level 1 Network Availability	Level 2 Single, Worst Case Event	Level 3 Disaster-based Event
Performance (Fault Tolerance + Security)			
Availability (System Reliability)			
Recovery Time (Modifiability)			
Life Cycle Cost			

Optimization Techniques

- ***Architectural trade analysis using design patterns and styles***
  - ***DoDAF modeling***
  - ***Exhibit 300***
- ***Formal methods using Markov modeling and simulation***
  - ***Hamiltonian Cycle based analysis***
  - ***Generalized graph methods for clustering***
  - ***Minimum-cost vertex-connectivity analysis***
- ***Scenario based methods***

Service Recovery and Efficiency

- ***Maintainability: Fewer unique installations***
  - *Default configurations*
  - *Training*
  - *Logistic support*
- ***Operational availability***
  - *Faster restoral*
  - *Swap like components*
  - *Priorities: Know when I need a service*
- ***Life cycle cost management***

Objective: Commonality across the Enterprise

Summary

- ***The emphasis on net-centric operations makes it essential that we create effective methods for survivable network design***
- ***We can apply system engineering methodologies similar to those we apply to other systems in order to define "essential" services***
- ***We can use spiral model of analysis and design with appropriate measures to obtain desired properties***

Questions?

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