



*Non-Lethal Defense  
The Directed Energy Perspective*

# Boeing Is Providing Integrated Systems Solutions To Customers

## Commercial Aircraft



777



Business Jets



767

## Space & Communications



Launch Services



Human Space Flight & Exploration



Information & Communications



Missile Defense & Space Control

## Military Aircraft & Missiles



F/A-18 Hornet



AH-64D Apache Longbow



B-1B Lancer



SLAM ER

## Phantom Works

***Non-Lethal Defense Also Requires Integrated System Approaches***

Laser & Electro Optical Systems

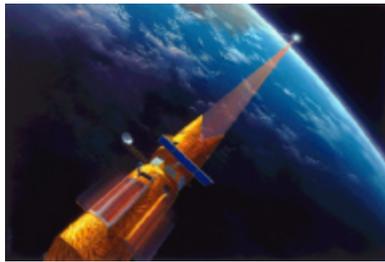
# Directed Energy Solutions Are Appropriate For Many Mission Areas

## Airborne Laser



- Missile Boost Phase Intercept
- Missile kill demonstration in 2003
- **ABL Prime Contractor**

## Space Based Laser/Relays



- End-game for National Missile Defense
- **SBL Team Leader**

## Tactical Lasers



- Multi-mission applications
- Tactical missile defense
- Non-lethal warfare (NLW)
- **Approved ATL ACTD**

## Ground Based Applications



- **National Technology Leader**

# Directed Energy Provides New NLD Capabilities and Options

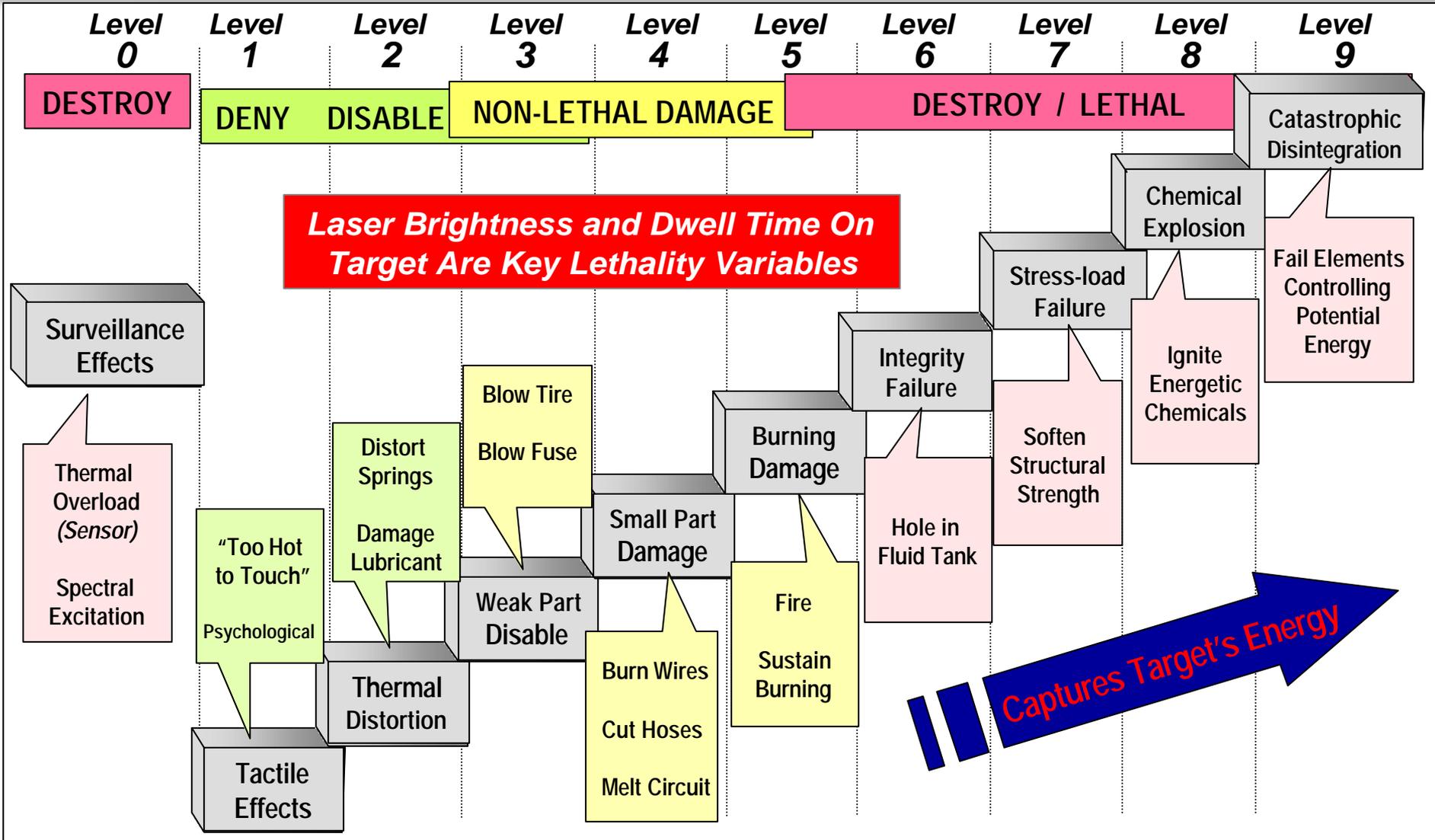
- **DE solutions are transformational**
  - **Speed of light**
  - **Ultra-Precision**
  - **Minimum collateral damage**
  - **Lethal or non-lethal options**
  - **Silent, invisible**
  - **Precision targeting system contributes to SA**
- **Tactical DE solutions are most adaptable to Non-Lethal Warfare/Defense**
  - **Advanced Tactical Laser (ATL)**
  - **Electro-optical discrimination and targeting subsystems**
- **Demonstrations are essential**
  - **Mature CONOPS and enabling technologies**
  - **To explore new applications with new users**



# DE Is Transformational, But Is It Really Non-Lethal?



# DE Effects Can Be Managed For Intentional Lethal or Non-Lethal Engagements



# DEW System Surveillance and Targeting Sensors Provide SA Needed for NLD

- DEW systems employ multi-sensor solutions for battle management and fire control

- Ultra-precision stabilization and pointing capabilities
- Cueing and targeting sensors and algorithms
- High resolution optics



- Enhanced Situational Awareness (SA) is a DEW byproduct that will contribute to NLD/W

# Boeing's ATL Is A Modular, Multi-platform, Multi-mission System

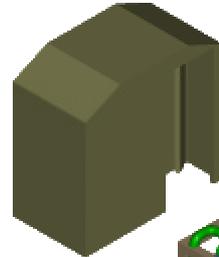
## Manned Control

- Surveillance and Tracking Controls
- Situation Awareness
- Battle Management/Communications
- Laser Control



## Laser/Beam Director

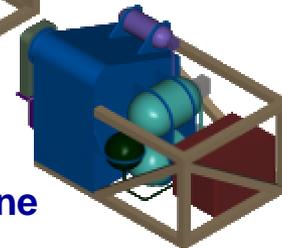
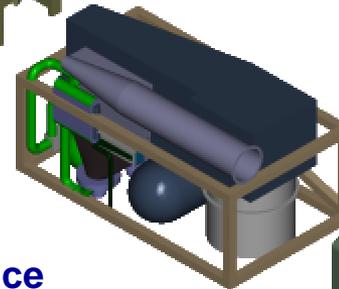
- Laser Generation
- HEL Pointing
- Large Optics Surveillance
- Precision stabilization



## Airborne High Energy Laser Subsystem

### Energy Storage

- Chemical Magazine
- Sealed Exhaust



## Airborne Targeting Subsystem

### Leverage large optics

- 40cm beam director
- Passive and active sensing options
- P<sup>3</sup>I beyond the baseline ACTD requirements



## Logistics



### Fuel Regeneration System

- ### Electro-chemical Regeneration
- Recover and recycle laser "fuels"
  - Similar to recharging a car battery
- ### Modular, roll-on, roll-off design
- Facilitates maintenance

# Current Tactical HEL CONOPS Include Non-lethal and Anti-Material Missions

- Covert Imaging/Engagement at Stand-off
- Ultra-Precise Day/Night Targeting
- Rapid Re-Engagement / Re-Targeting
- Adjustable Delivered Force
- Minimal Collateral Damage



Urban Operations  
areas occupied by  
non-combatants



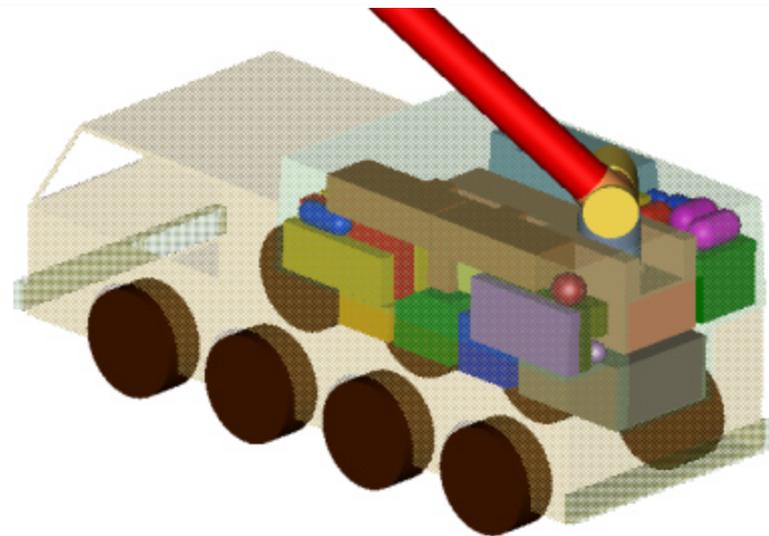
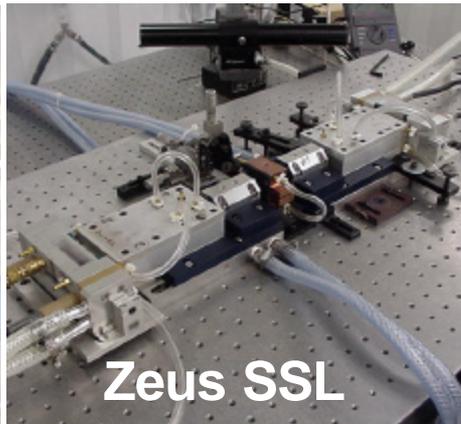
Vehicle Disable/Stop  
without damage to occupants



Infrastructure  
Comms, POL, Power, etc.

# Surface HEL Operations Are Also Feasible

## ATL Mobile Ground Example Shown



### Multiple Laser options for current and future DEW Systems

- Match the laser device and system components to mission requirements
- Boeing develops laser technology (e.g. Solid State Lasers) to enhance our system design & integration capability
- Our focus is systems, not components

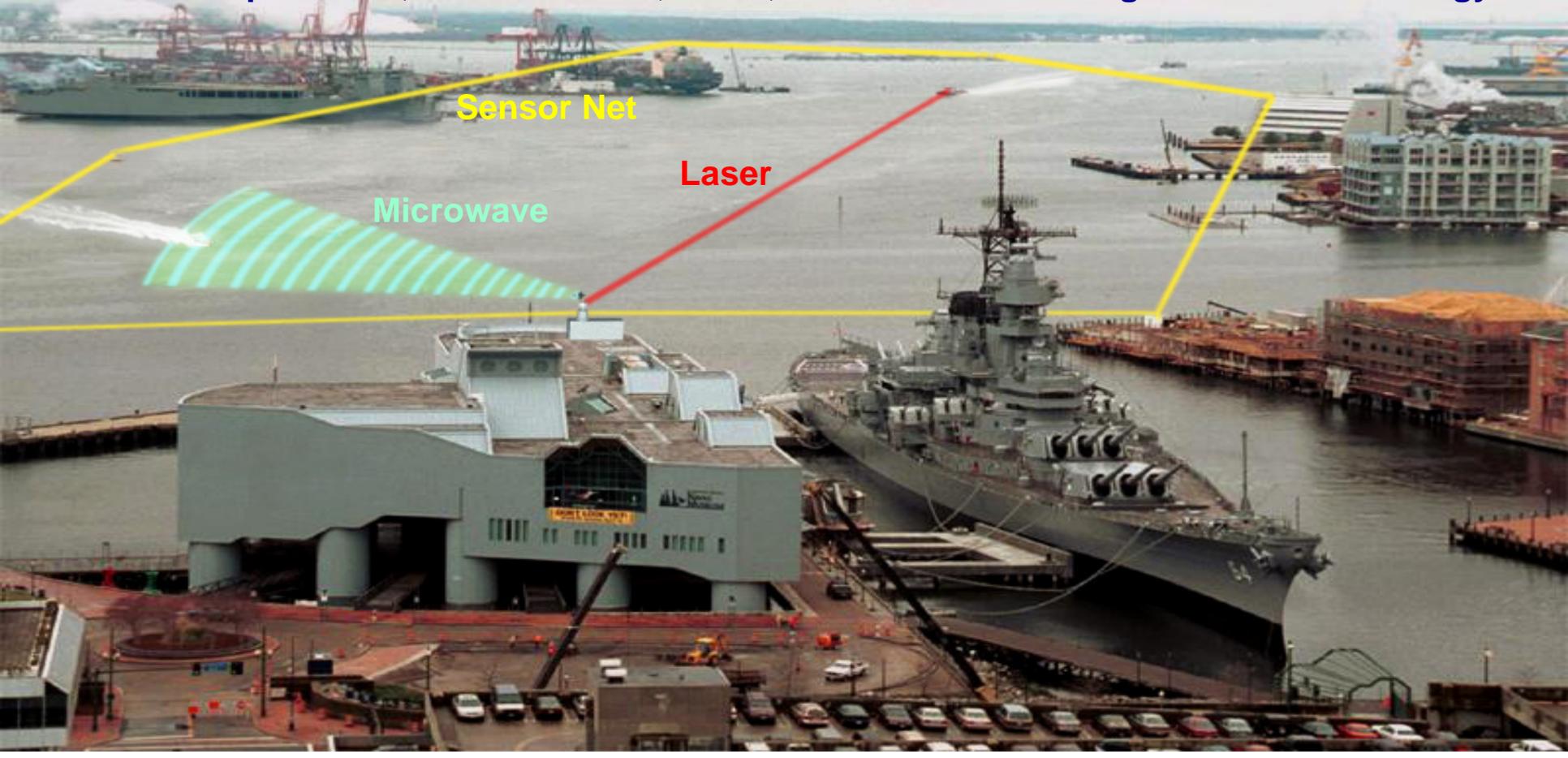
### Mobile ground DE systems are well suited for high value asset defense

- Embassies, DoD/DoE installations, etc.
- HEL and HPM integration for range of responses, combined effects
- Highly integrated sensing and acquisition, tracking and pointing (ATP) subsystems are required

# HACSAW Concept Fits NLD Needs

## High-value Area Control Surveillance And Weapon System

- Portable integrated Laser/Microwave/Sensor defense system for high value assets and areas - Ports, base camps, embassies, sensitive sites
- Laser and Microwave Weapons Element for non-lethal & lethal effects
- Integrated active/passive Sensor System for Fire Control and BMC4I
- Ultra-precision, instantaneous, silent, invisible attack using available technology



# Boeing Performed Detailed Mission Analysis for ATL Same Needs To Be Done For Other NLD Applications

**ATL Supports Amphibious Operations**

North Korea (Eastern Coastline)

Cruise Missile Velocity: Mach 1.0

Tactical Laser Dwell Time

Sec	1.0	1.7	2.5	6.0
Letter	a	b	c	d

20 16 12 8  
Range (km)

Boeing Proprietary

**Amphibious Assault**

**Special Ops**

**Ultra-Precision Silent Warfare**

**Defense Against Land Attack Cruise Missiles**

9.50 Kilometers

1:30

45

1:57

0 5 10 15 20  
Kilometers

**Defense Against Land Attack Cruise Missiles**

**ATL Self-Defense North Korea KS-1**

CLOUD LAYER 5,000 TO 7,000 FEET

TERRAIN ELEVATION

KS-1 Minimum Engagement Altitude

10K 9K 8K 7K 6K 5K 4K 3K 2K 1K 0 Mean Sea Level

17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

**Self-Defense Against SAMs (Escort Mission)**

**Naval Choke Point Scenario Effective Against Salvo Cruise Missile Attack**

Cruise Missile Velocity: Mach 2.0

ATL at 13 kft

0 20 km

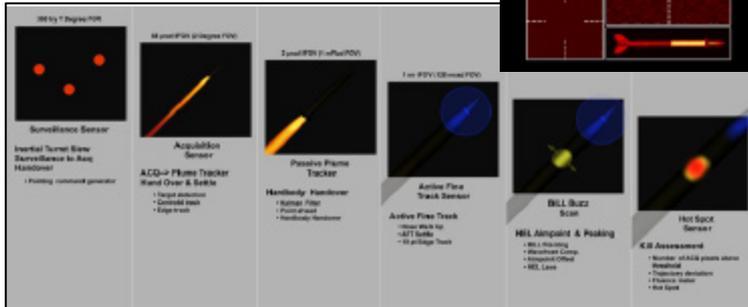
Boeing Proprietary

**Anti-Ship Missile Force Defense**

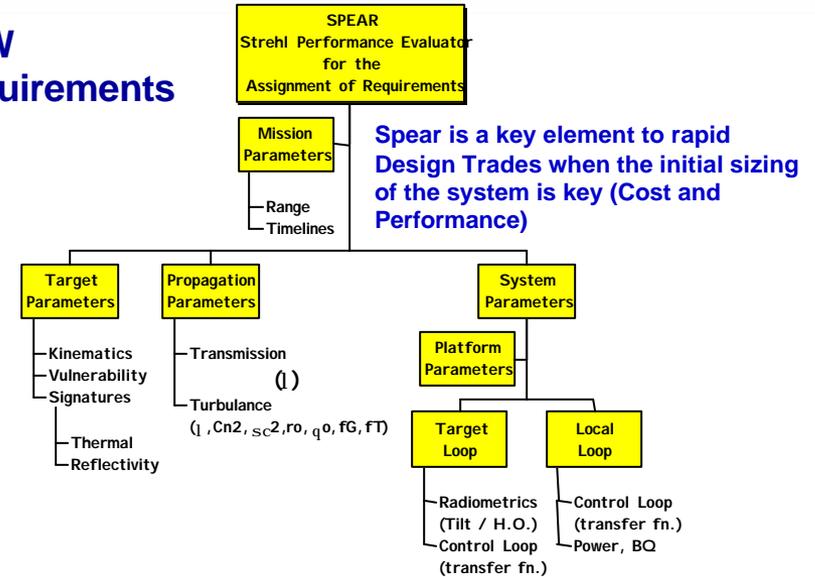
**Ballistic Threats Above the Horizon**

# Validated DE System Level Tools Can Be Applied to Emerging NLW/NLD Needs

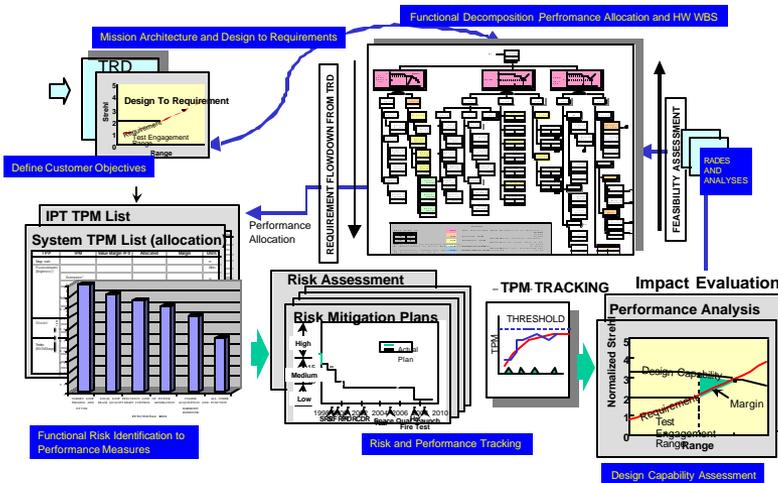
## ATP/Control System & Sensors



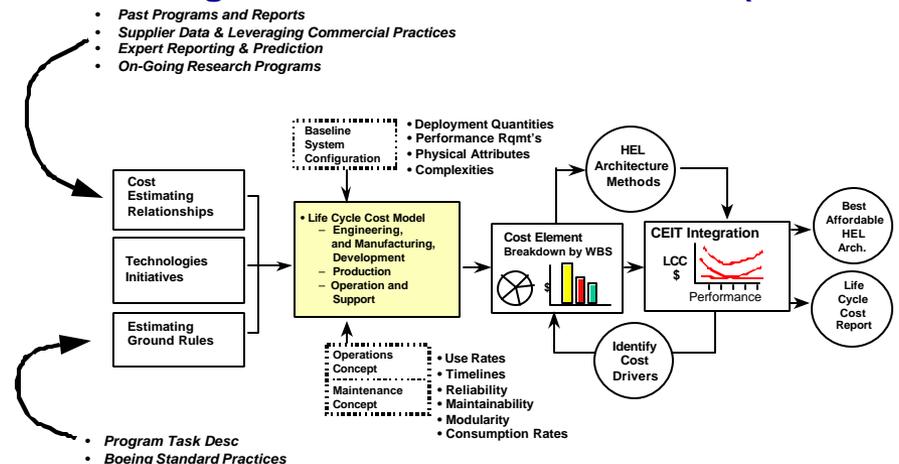
## DEW Requirements



## Integrated System Risk Assessment



## CEIT - Integrated Cost and Performance (Parametric)



# Summary



- **Boeing believes in DE systems for multiple mission applications**
  - **Missile defense, strike, NLW**
- **Non-lethal applications are natural for DE due to intrinsic characteristics**
  - **Ultra-precision, variable lethality, unobtrusive**
- **DE system engineering is needed for NLD**
  - **Requires experienced people, validated tools**
- **Current DoD programs, e.g., ATL can be leveraged for NLD**