Network Centric Logistics
Managing Logistics in Dynamic Operations

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- How has the mission changed?
- What do we need to succeed?
- How does logistics fit into Network Centric Operations?
- What is Boeing doing related to Network Centric Operations?
- How do we integrate logistics into Network Centric Operations?
- Where is Boeing investing to implement Network Centric Logistics?

How has the Mission Changed?

- Dynamic and Not Well Defined
  - Constantly Moving, Possibly 100s of Miles
  - Hostile Environment
    - Terrain
    - Weather
    - Enemy Actions
- Logistics Needs Also Dynamic
  - Attrition
  - Variable Rate of Expenditure
  - Unplanned Maintenance Actions
- Initially Lacking Infrastructure to Execute
  - Need for Rapid Deployment
  - Affordability and Availability Issues

Keys to Success

- Situational Awareness / Understanding
- Timely and Effective Decision Making
- Timely and Effective Decision Execution

Network Centric Logistics

- A Critical Link in Network Centric Operations

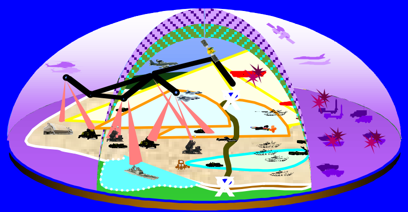
Boeing Investment in Network Centric Logistics

- Network Centric Operations
  - Common Open Architecture Standards
  - Future Combat Systems
  - Integrated Decision and Execution Network
  - IRAD Thrust Investment
  - Log Net
- Integrated Vehicle Health Management
- Supporting the Legacy Force
  - Mechanics Compass
  - Remote Service Center
  - Support Modeling and Simulation

Network Centric Operations

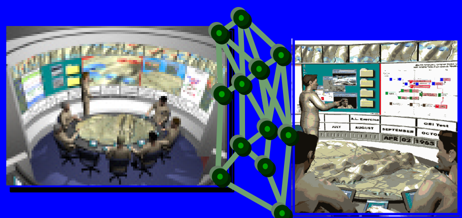
Network Centric Warfare

Three functional networks are required to prosecute any conflict



Kill Net

Log Net



Planning Net

- The Kill Net contains all the elements required to effectively employ combat power
- The Logistics Net includes the global logistics and sustainment elements in support of the Kill Net
- The Planning Net provides all strategic to campaign level planning functions to include worldwide data base access and fusion

Enabled by:

- Seamless wideband communications
- Integrated data systems
- Joint command and control

We are initiating the technical architecture work and demonstrating its value

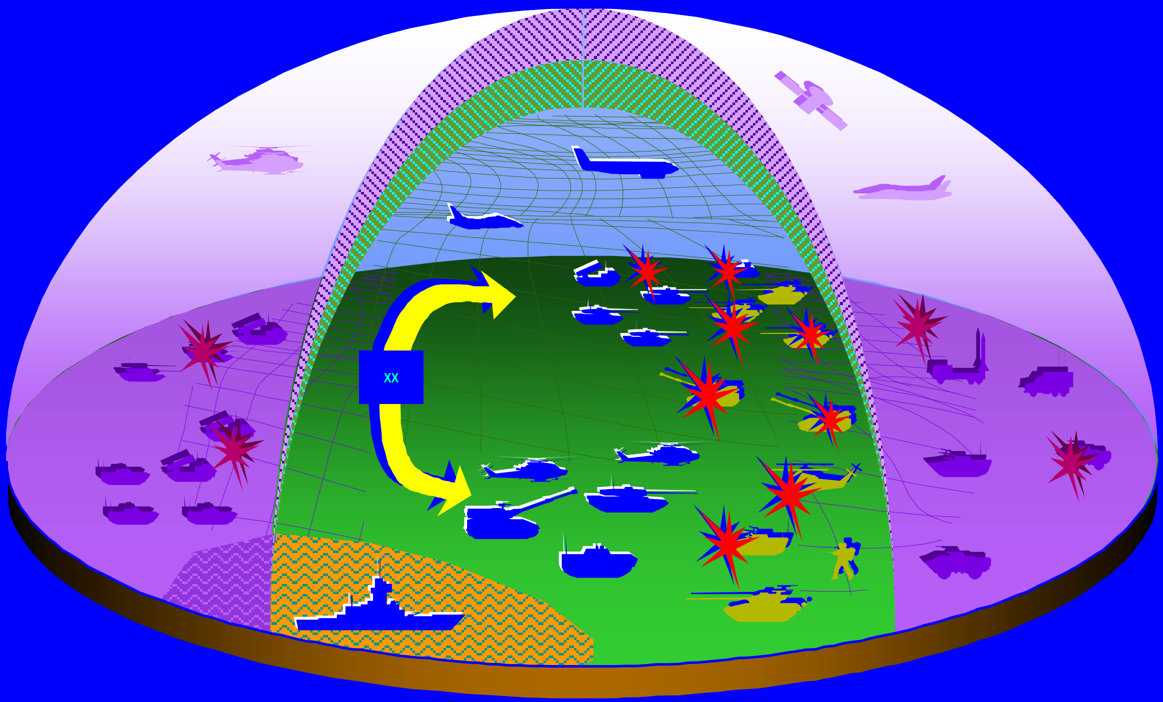
Comparing Two Approaches:

- Targeting the Means
  - Attrition-based
    - Focus on "Targets"
    - Military Objectives
    - Quantifiable Results
  - Indirect attack on will
  - War/Combat only
  - Deterrence
    - Threat of Pre-emption
    - Threat of Retaliation

- Targeting Will/ Behavior
  - Effects-based
    - Focus on "Actions"
    - Political Objectives
    - Non-linear Results
  - Direct attack on will
  - Peace, Crisis, War
  - Deterrence
    - Threat of unacceptable consequences

How do <u>we</u> use effects-based approach?

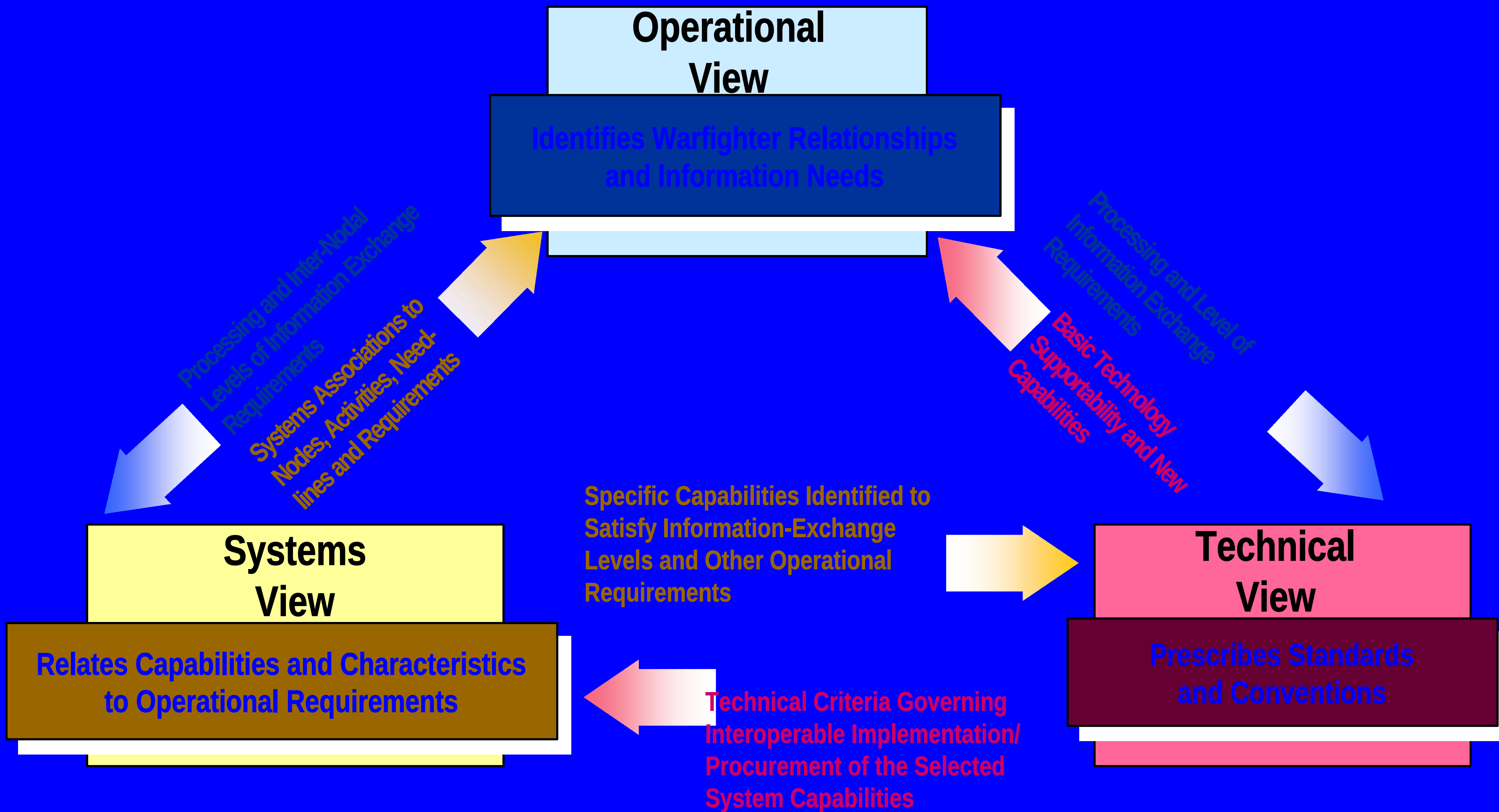
The Joint Battlespace Infosphere Is Our Information Management System



- Worldwide information source access
- Shared and managed information
- Improved data validity
- Controlled access to sensitive information
- Tools and services for info manipulation
- Tailored information to each user
- Common ontology, formats, and information structures
- Reduced duplication of information

Affordable Data Structures That Use Available Worldwide Databases and Information Fusion In Near Real Time

Joint Technical Architecture Framework

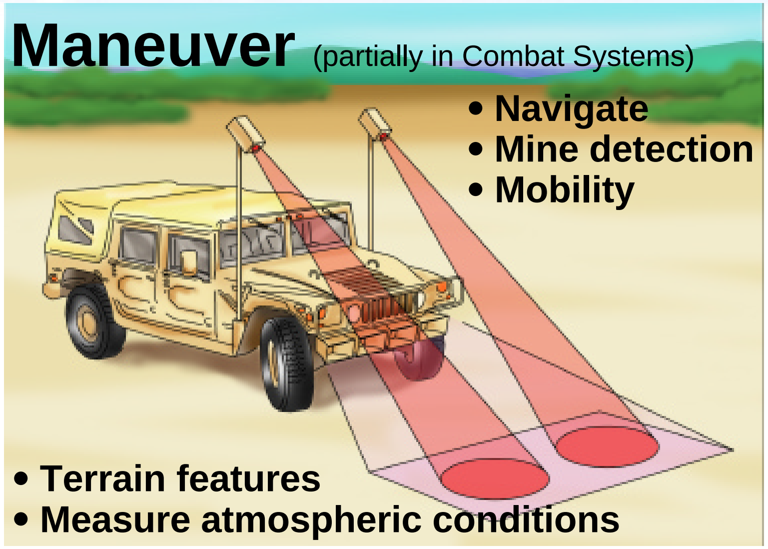


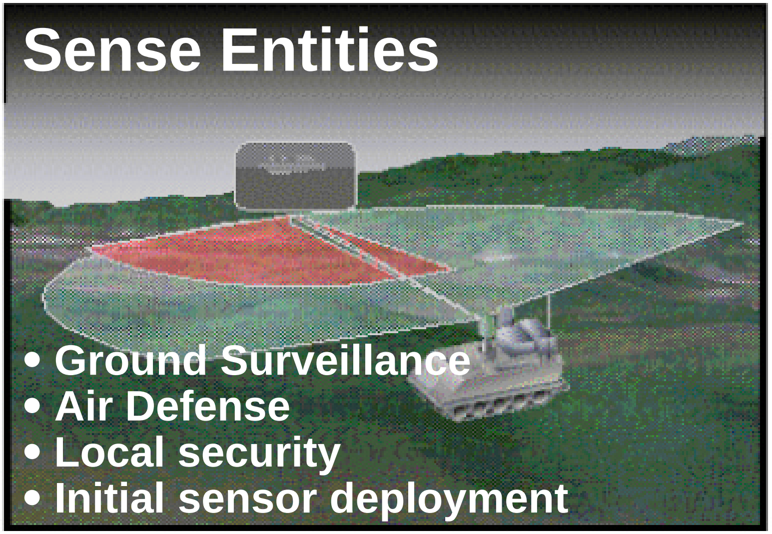
Source: " C4ISR Architectural Framework," Version 2.0, 18 Dec 1997


Future
Combat
Systems

Future Combat Systems

Sensor Tasks by Domain



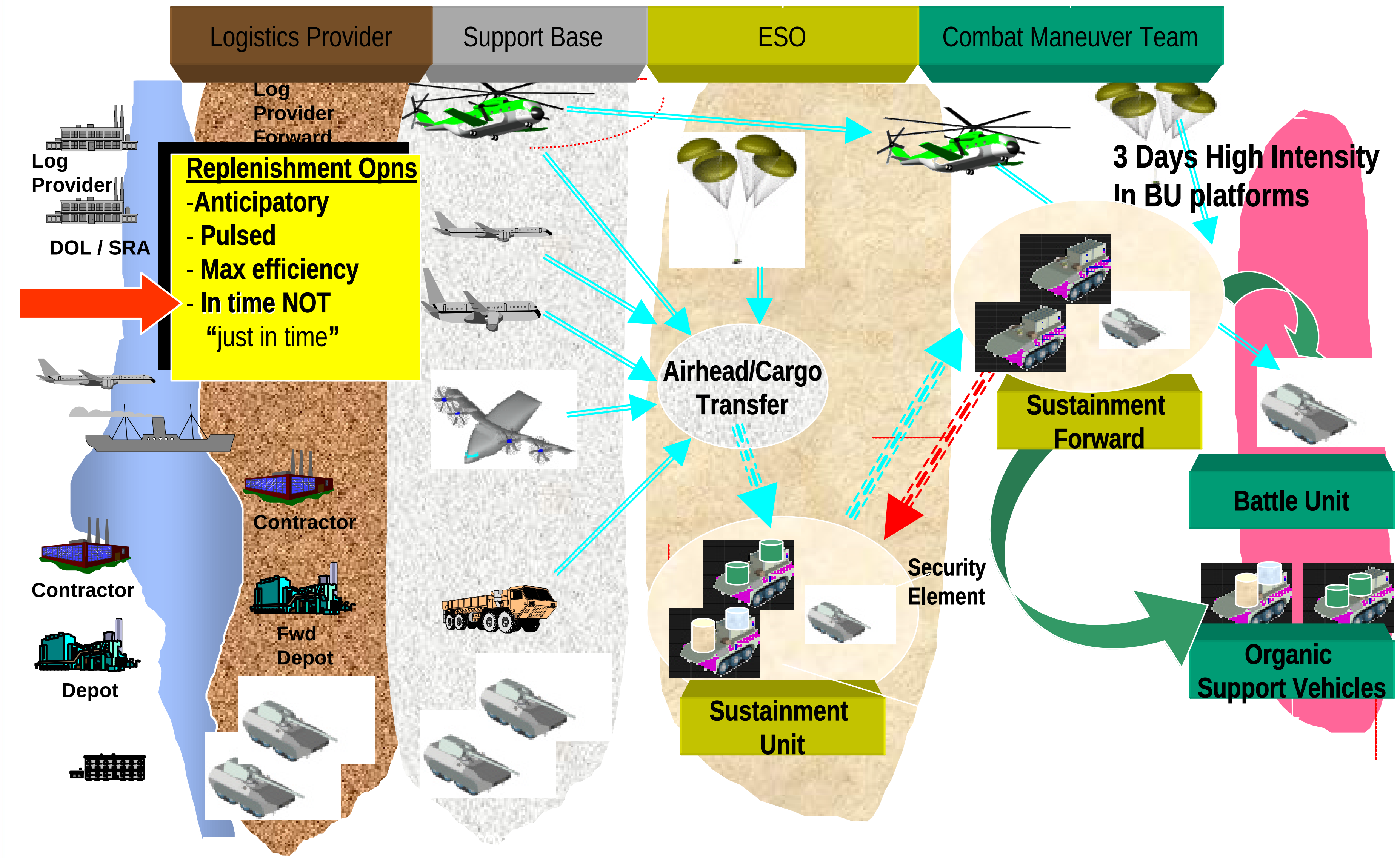


Survive (partially in Combat Systems)

Logistics networked in every domain

Future Combat Systems

Logistic Support Concept



Log Net

BM/CC

Joint
Battlespace
Infosphere

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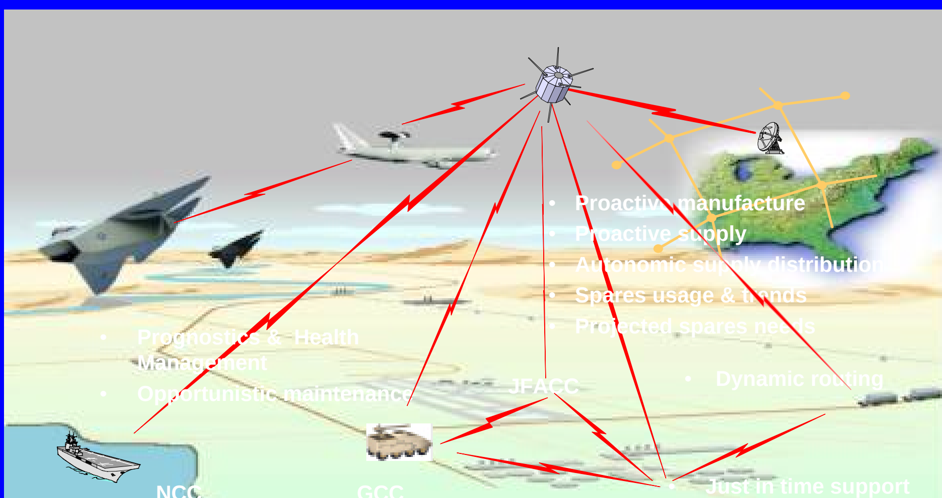

Joint Logistics
Capability

Global
Communications

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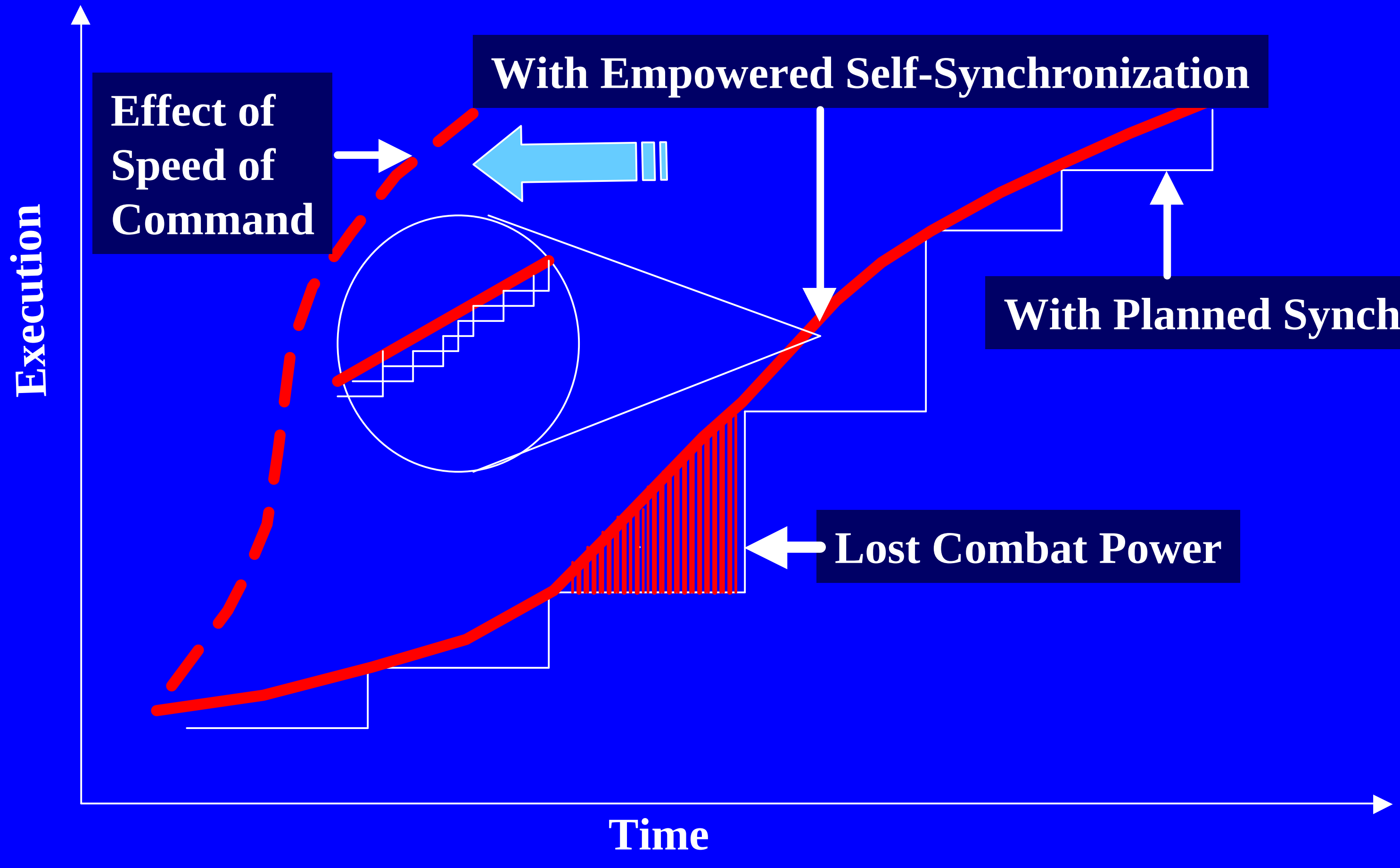
Log Net is the result of the total integration of logistics C2, communications and information

What does “Network Centric” Buy Us?



New Sciences and Warfare
VADM A.K. Cebrowski 9/21/98

Integrated Decision and Execution Network

- Derived from initial effort to structure an architecture for Integrated Air and Missile Defense (IAMD)
- Initial simulation results show
  - Increased robustness and an average of up to 50% more kills in a cruise missile defense scenarios with legacy forces
  - 70% increase in kills in a land combat scenario with legacy forces
  - Order of magnitude increase in effectiveness for new forces designed for this approach

Integrated Vehicle Health Management

IVHM Maturity Levels

- **Informed Maintenance – Ability to perform maintenance based on component / subsystem condition and operational requirements, to automate flight certification, and to monitor and manage / schedule maintenance resources.**

- ***Level 5 Prognostics* – Can you predict component/subsystem failure and perform maintenance on condition or demand? Integration with controls?**

- ***Level 4 Advanced Diagnostics* – Can tell a component is degrading prior to failure? Are anomalies, intermittents, single event upsets detected, data captured, correlated to operational context? Minimal CNDs?**

- ***Level 3 Integrated System Architecture* – Does the system hardware and software architecture provide the data and resources for IVHM given the operational, support and safety requirements? Can you easily update the IVHM system? Does a closed loop process support maturation?**

- ***Level 2 Integrated Diagnostics* – Can the root cause of a failure be traced across subsystems? Are diagnostic analysis and design an integral part of the system engineering process? Data and analysis models shared/reused?**

- ***Level 1 Built In Test (BIT)* – Is faulty vs acceptable performance based on a defined discrete threshold?**

BIT

PHM

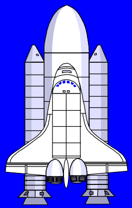
- **False alarm reduction *(this is our prime thrust - a must for autonomic logistics)***
  - **Alert/confirm - whenever practical**
    - ***Confirm suspected faults with independent observations***
  - **"Real-timely" fault confirmation**
    - ***Confirm the fault shortly after it is suspected . . . while conditions are similar***
  - **Resolve multiple consequences of a single fault (done on 777)**
    - ***One fault = one maintenance action***
- **pHM for most systems is "little p, big HM"**
  - ***Emphasize Health Management* to ensure that graceful degradation and reconfiguration inherent to the design *achieve Opportunistic Maintenance***
  - **Prognostics enhances safety**
  - **Apply structured process using PrognostiCalc to develop cost effective prognostics**
  - **Operational Maintenance Program (OMP) isolates PHM changes from OFP**

On Condition / Opportunistic Maintenance
Maximizes SGR While Minimizing Maintenance Costs

Application Focus Areas

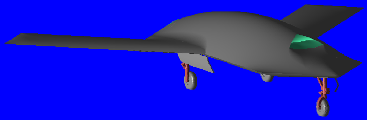
- **Propulsion**
  - Turbine Engine
  - Rocket Engine





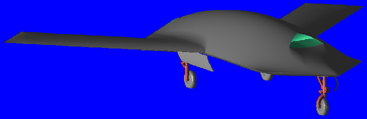
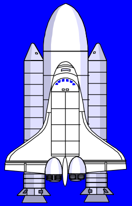

- **Gear Trains and Drive Shafts**

- **Actuation**
  - Hydraulic
  - Electromechanical




- **Electrical/Arc Fault/Wiring**

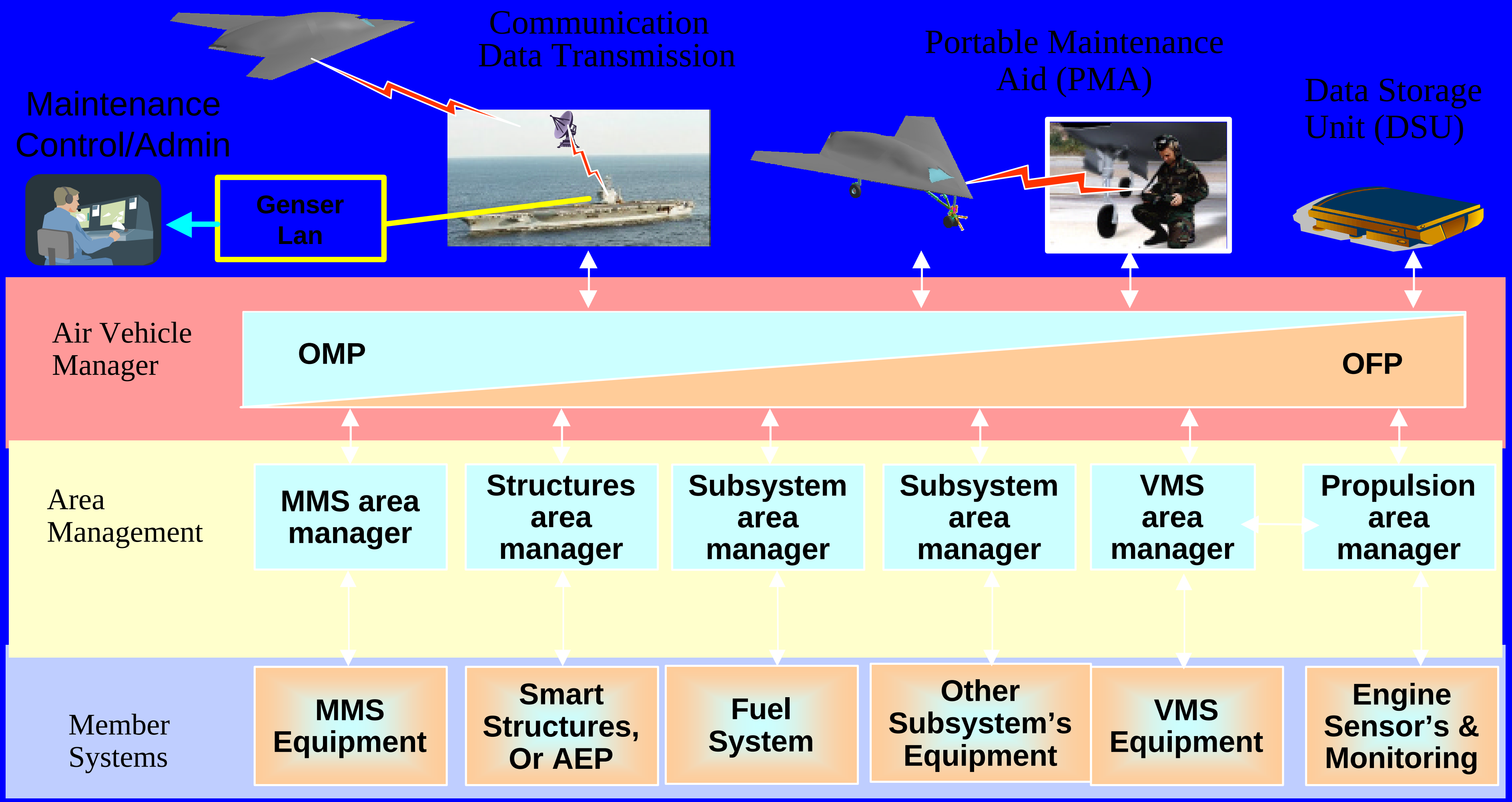
- **Utility Systems**
  - Fuel Valves/Pumps
  - Landing Gear, ECS

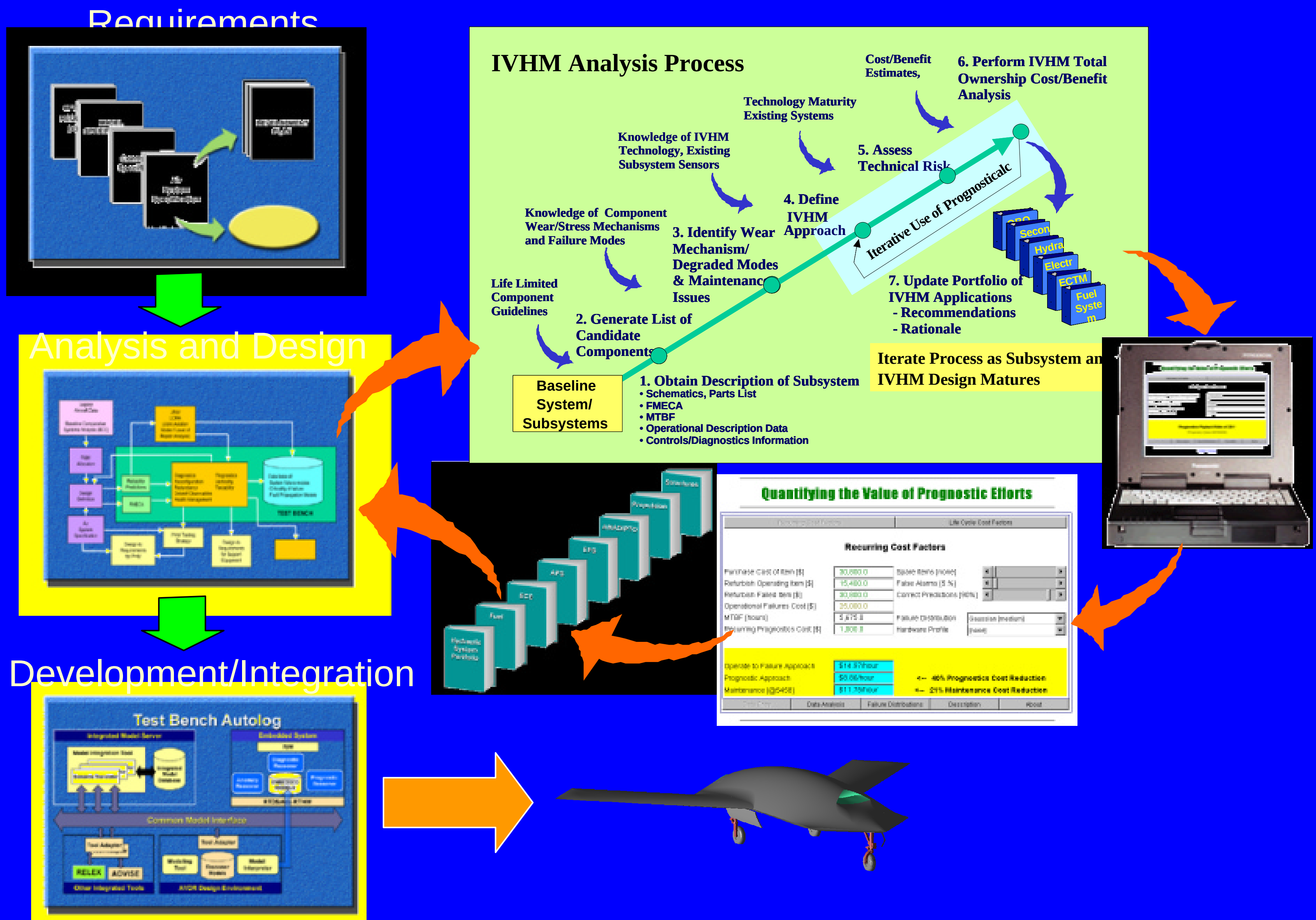

- **Structures/Corrosion**


- **Avionics (All)**

Generic IVHM Functional Hierarchy

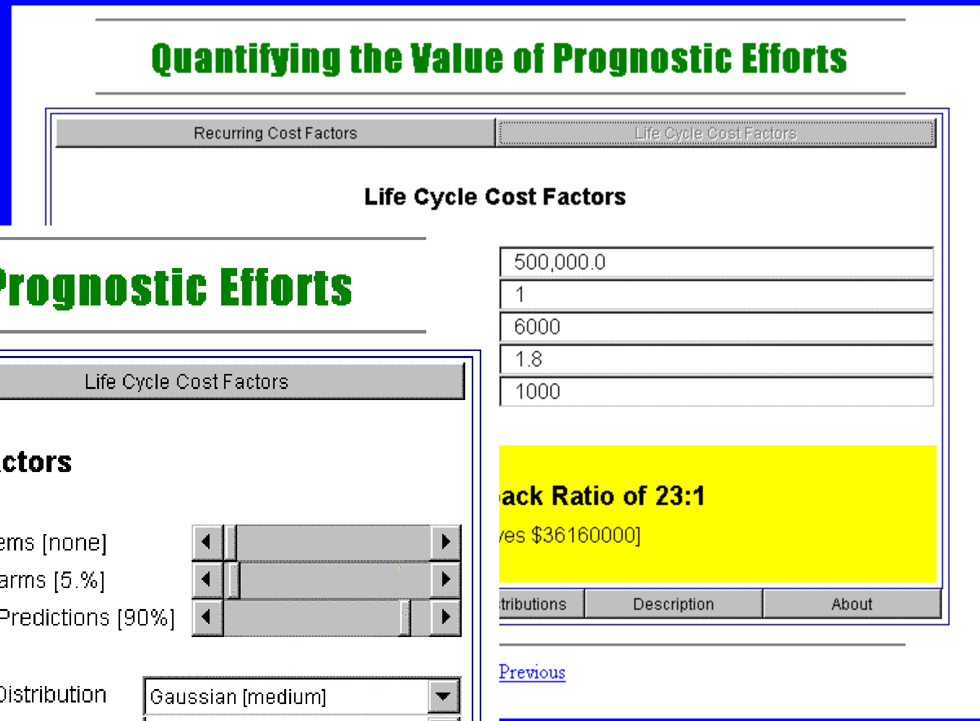


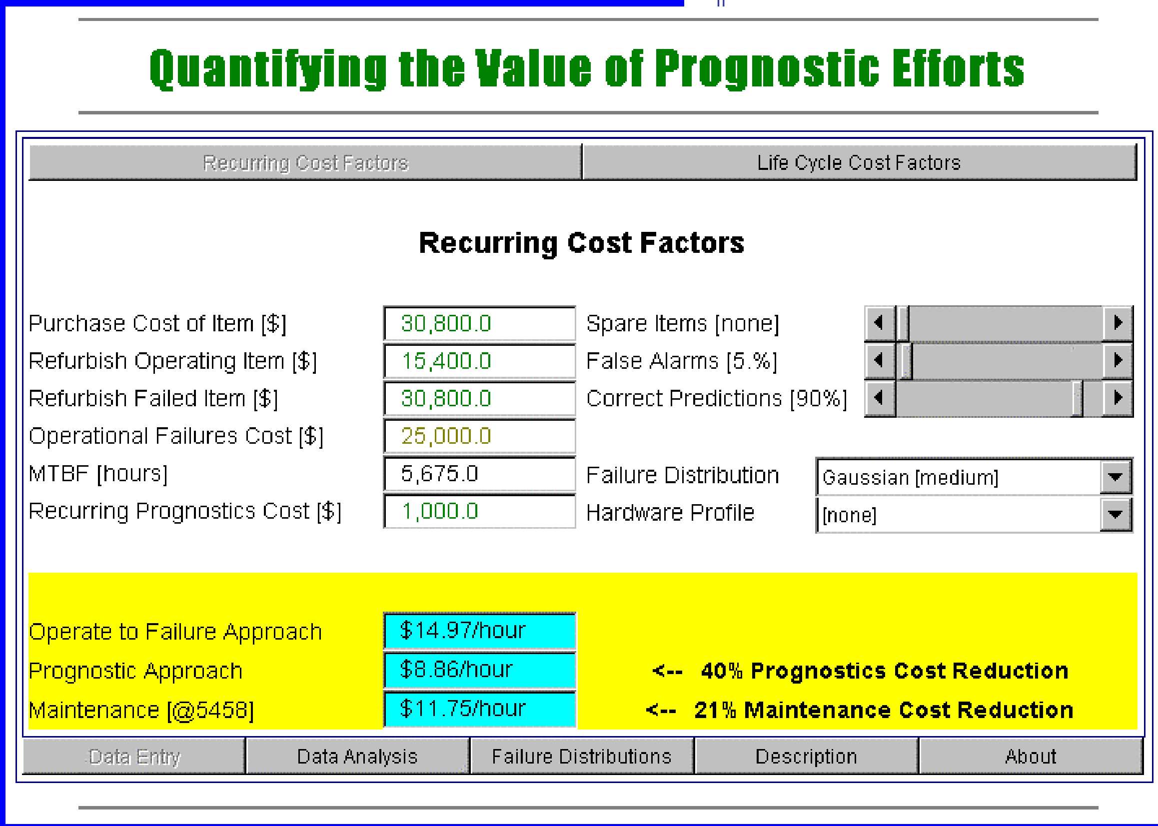
IVHM Begins with Sound Requirements

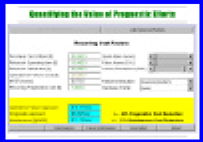


Prognosticalc Tool

PC Web Based
Tool written in Java







Prognosticost – Extended Prognosticalc And Integrated Diagnostic Analysis

PrognostiCost Version Beta 1.2 Feb 27, 2002 - Airplane/System/Economic Inputs

Study Title:	
ATA:	
Analayst Name:	

AIRPLANE / SYSTEM / ECONOMIC FACTORS DETAILED INPUT SECTION

AIRPLANE LEVEL INPUTS	UNITS	BASELINE	ALTERNATE	SOURCE(S) FOR BASELINE	SOURCE(S) FOR ALTERNATE
1. Airplane Program					
2. Airplane Fleet Size					
3. Average Number of Flights per Ye					
4. Average Flight Hours per Flight					
5. Average Delay Cost per Delay Ho					
6. Average Cancellation Cost per C					
7. Average Air Turnback Cost per T					
8. Average Diversion Cost per Dive					
9. Out of Service Cost per Day					
10. Lbs Fuel Burned / Flight Hour / Lb					
SYSTEM LEVEL INPUTS					
11. System Name					
12. Year of Delivery of the System					
13. System Acquisition Cost, Base Y					
14 Increase in System Acquisition C					
15 System Support Equipment Cost,					
16 System Initial Training Cost, Base					
17 Length of System Life in Years (1-					
ECONOMIC FACTORS (REQUI					
18 Average Fuel Inflation Rate Beyo					
19 Average Non-fuel Inflation Rate E					
20 Insurance Factor (Normally Zero					
21 Minimum Attractive Rate of Retu					
22 Spares Holding Factor					
23 Maintenance Labor Burden Facto					
24 Direct Labor Rate per Hour					
25 Fuel Cost per Gallon, Base Year					

BOEING PrognostiC

PrognostiCost Version Beta 1.2 Feb 27, 2002 - Cost By LRU Outputs

Study Title: Trade Study
Analyst Name: Rhodes, Stephen C.

BASELINE	LRU 1	LRU 2	LRU 3	Totals
Part Description	computer	Valve	Actuator	
Maintenance Approach Operating + Spares Life Cycle Cost NPV - 20 Years	Operate To Failure	Scheduled MTBO= 6000	Operate To Failure	
Fuel	$106,634	$120,582	$120,582	$347,798
Line Maintenance	$22,848	$57,047	$39,573	$119,467
Planned Maintenance	$12,567	$0	$12,567	$25,134
Shop Maintenance	$393,937	$1,873,681	$190,186	$2,457,804
Scheduled Interruption	$1,432,553	$292,971	$68,827	$1,794,351
Spares	$1,036,691	$755,920	$215,977	$2,008,588
Expendable Material	$0	$0	$0	$0
Recurring Prognostics				$0
Total	$3,005,230	$3,100,201	$647,712	$6,753,143

ALTERNATE	LRU 1	LRU 2	LRU 3	Totals
Part Description	Computer	Valve	Actuator	
Maintenance Approach Operating + Spares Life Cycle Cost NPV - 20 Years	Operate To Failure	Prognostics	Prognostics	
Fuel	$106,634	$125,231	$120,582	$352,447
Line Maintenance	$19,054	$67,616	$27,724	$114,394
Planned Maintenance	$12,567	$12,567	$2,922	$28,056
Shop Maintenance	$301,753	$1,938,204	$165,370	$2,405,328
Scheduled Interruption	$159,318	$265,001	$114,882	$539,201
Spares	$809,915	$950,300	$174,942	$1,935,156
Expendable Material	$0	$0	$0	$0
Recurring Prognostics				$0
Total	$1,409,241	$3,378,249	$616,086	$5,403,576

PrognostiCost Version Beta 1.2 Feb 27, 2002

BOEING

Supporting Legacy Systems

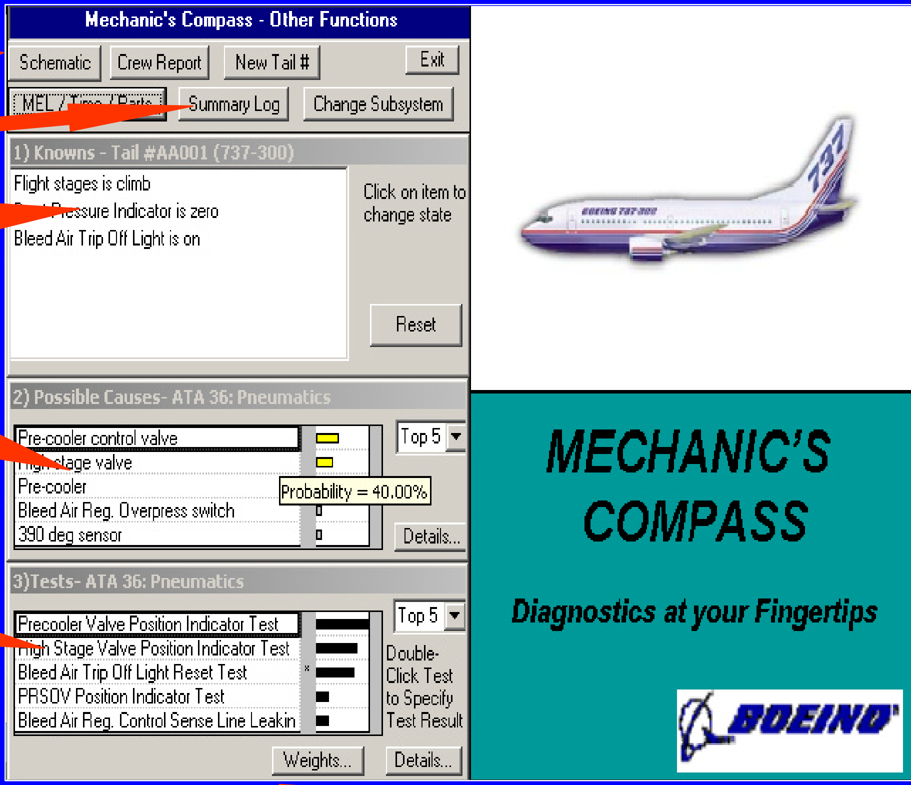
Description of Ground Diagnostic System
(Mechanic's Compass)

A Boeing Commercial maintenance decision-support tool that

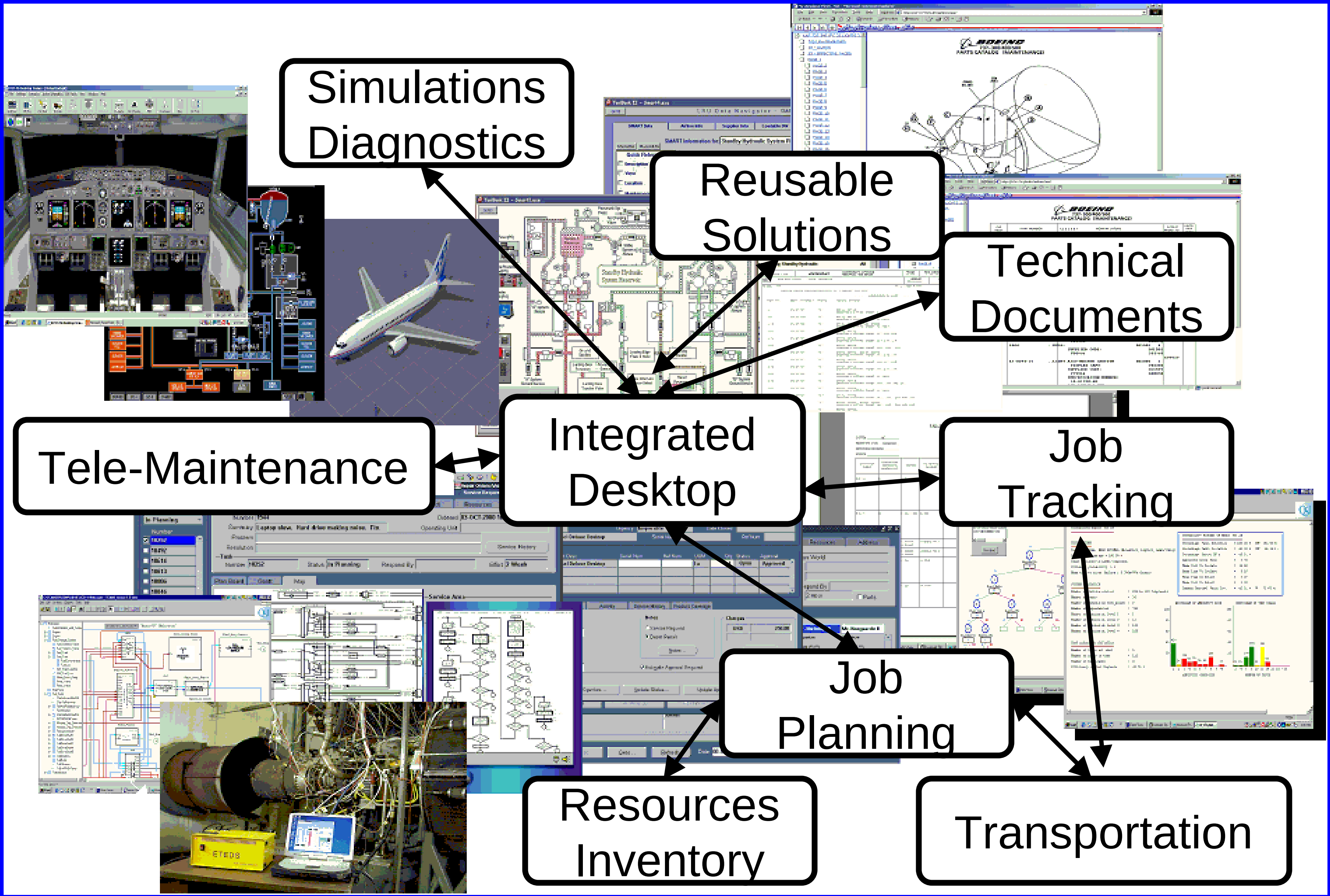
- Uses a probabilistic Bayesian network diagnostic engine
- Integrates engineering system-design knowledge and mechanic cause-and-effect knowledge with component reliability data

Features

- Links causes to system schematics
- Summarizes diagnostic session
- Summarizes known observations
- Prioritizes most probable causes
- Recommends subsequent tests actions to disambiguate causes, based on:
  - Test information content
  - Cost to perform test
  - Time to perform test
- Links to Portable Maintenance Aid in context (AMM, FIM)

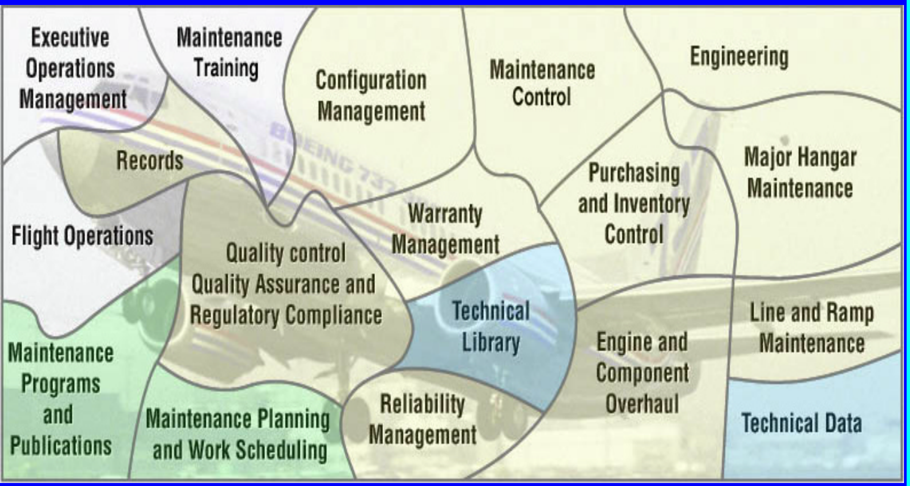


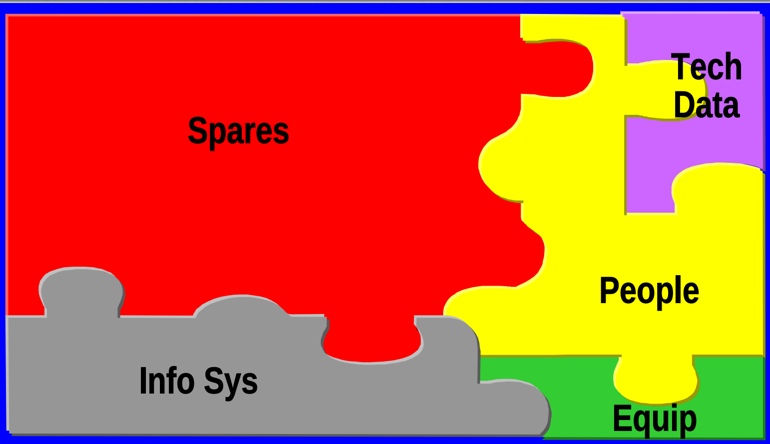
Remote Service Center Architecture

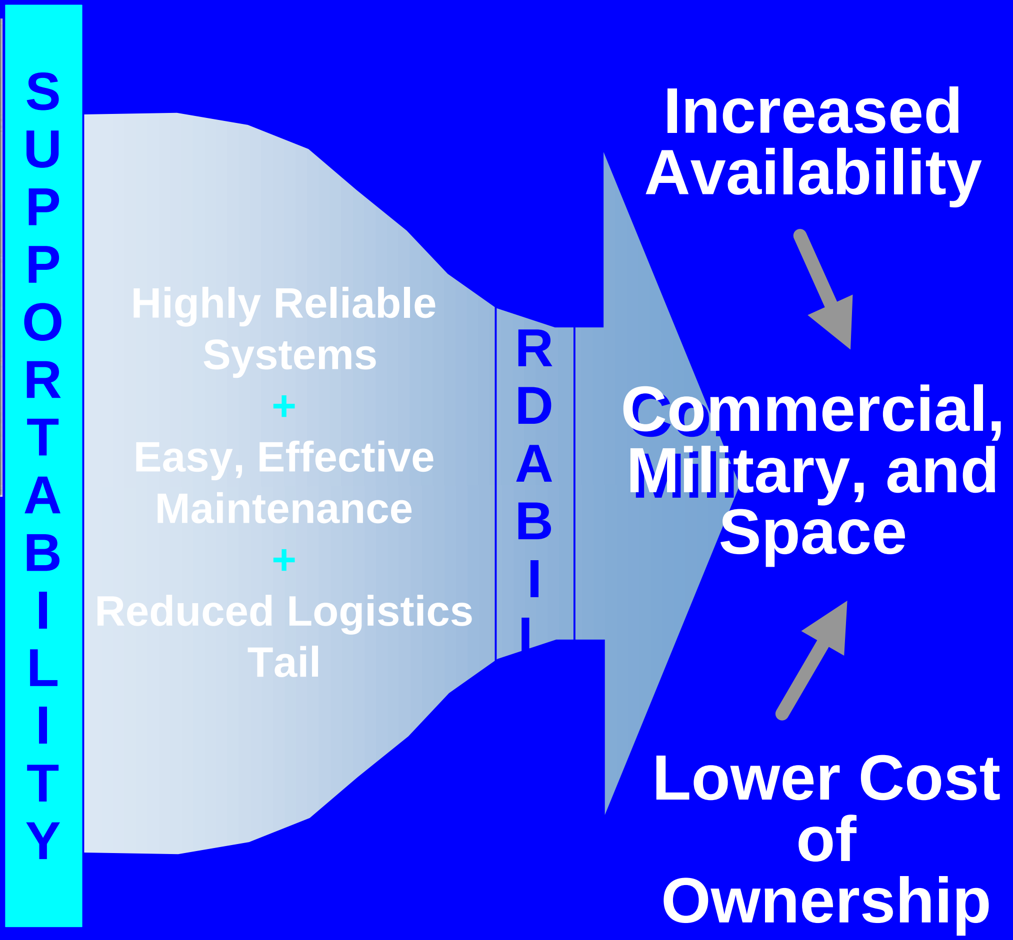


History

The Support MS&A Goal

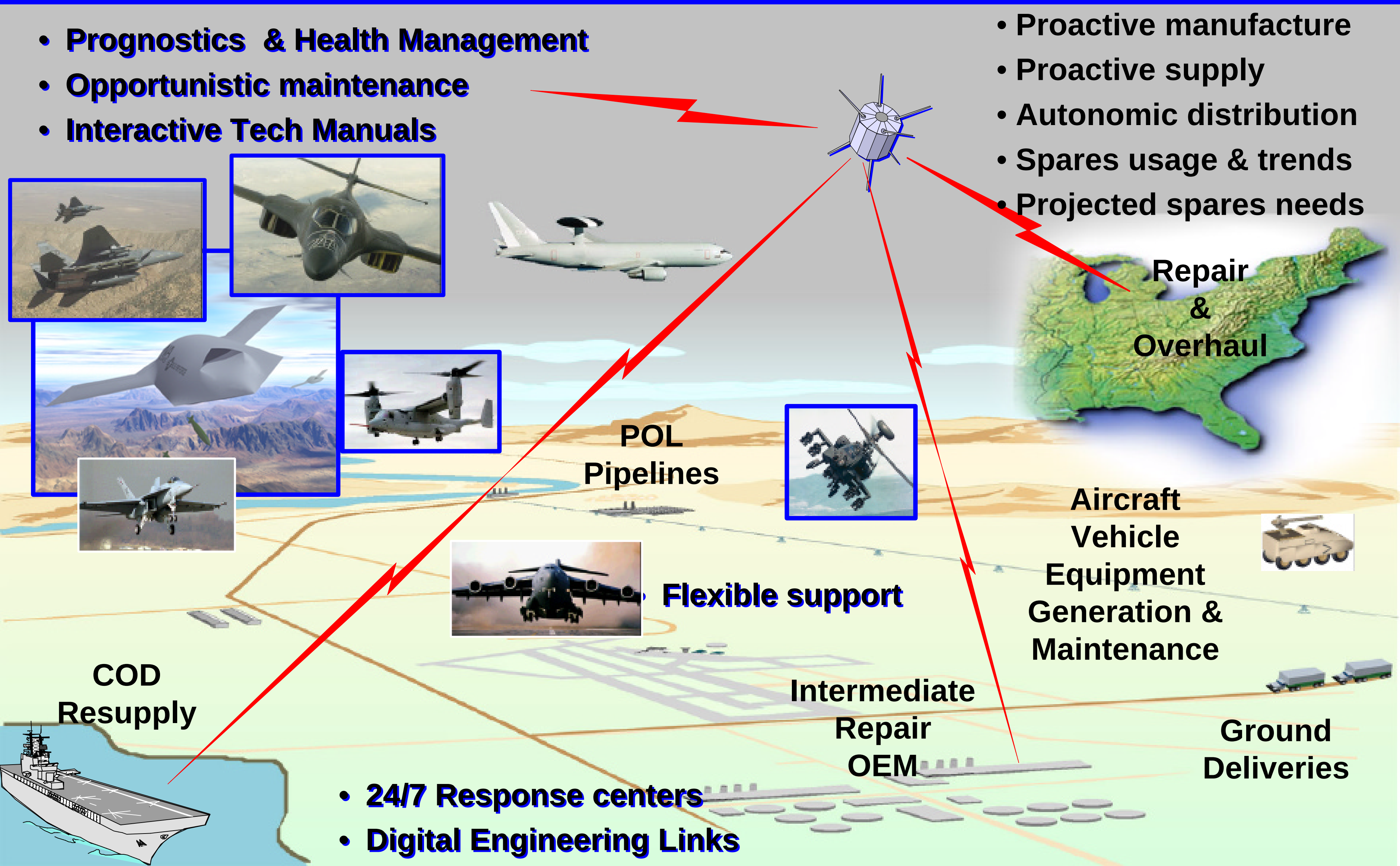






Capability to measure and prioritize technologies and initiatives across the Support spectrum

Support Modeling Environment
Support Concept Strategy



Making it Work

- Government Industry Partnering
  - Tailoring Commercial Architectures
  - Open Systems Design
  - Non-traditional Business Models

- Logistics
  - Incorporated into the Overall System Design
  - Flexible, Using the Pipeline as the Staging Area
  - Enabled by Information and Processes