

# Enterprise Analysis and Cost Optimization System (EACOS)

***2006 Department of Defense  
Maintenance Symposium & Exhibition***

***“Modeling for Sustainment”  
Technical Breakout Session***

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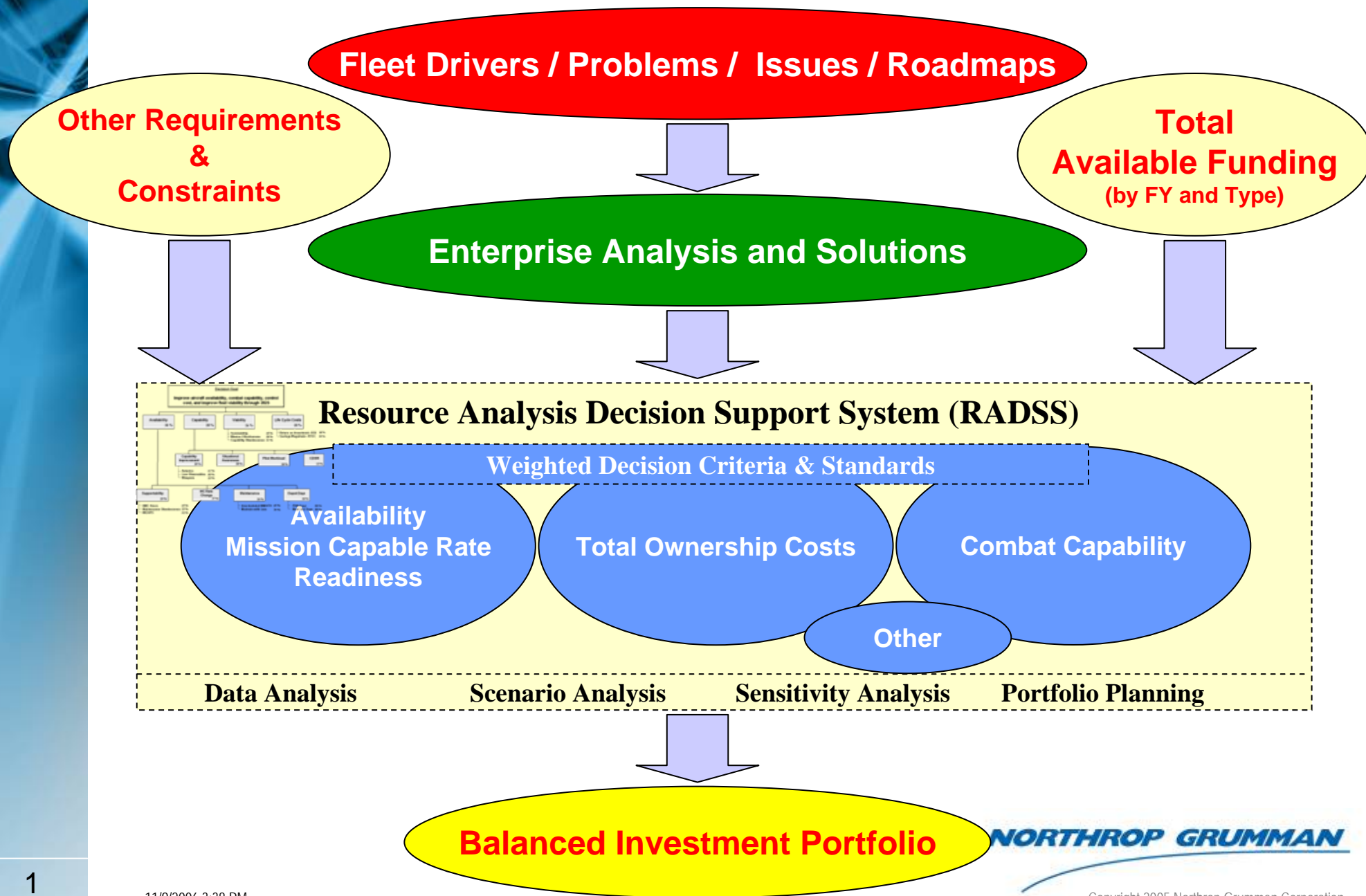
October 23, 2006

**Rob Thomson**  
Program Manager  
Aging Aircraft Programs  
Northrop Grumman Corporation

**Guy Engler**  
Program Manager  
Life Cycle Optimization  
Northrop Grumman Corporation

# The Essence of EACOS is "Life Cycle Optimization"

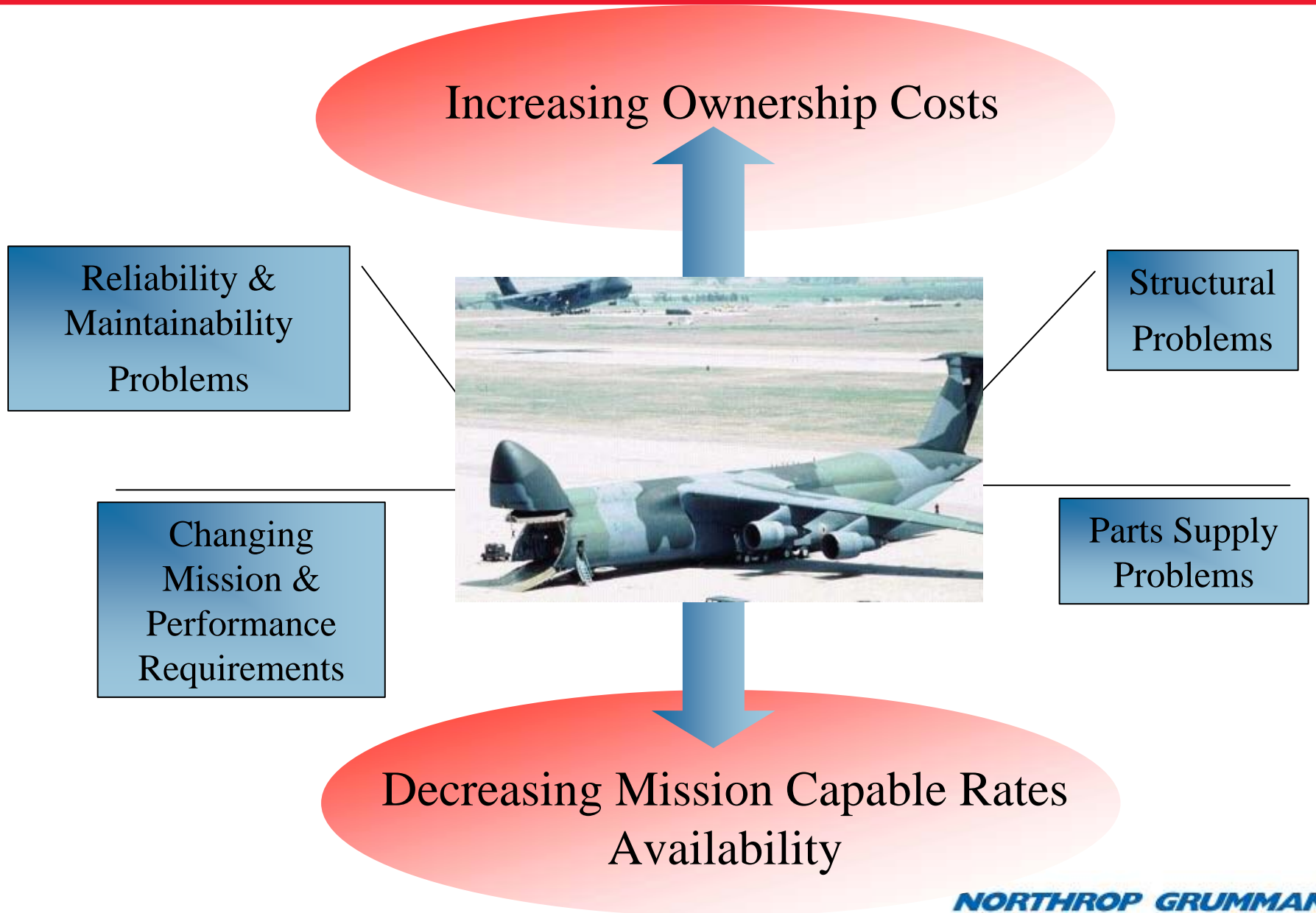
Achieving the Greatest Collective Benefits for the Fleet within Cost & Other Constraints



# EACOS Background

- **Objectives**
  - Identify drivers affecting fleet availability and system modernization / operating & support costs
  - Identify and model solutions, investment options, and scenarios that provide:
    - Optimized improvement in aircraft fleet availability
    - Optimized combat capabilities
    - Optimized approaches to modernization and sustainment
    - Optimized approaches to Fleet Viability
    - Reductions in total ownership cost
    - Best return on investment
  - Bottom line is to achieve the greatest collective benefits within constraints, thus realizing optimum investment strategies and an Optimized and Balanced Budget and Execution Portfolio for the fleet
- Northrop Grumman has completed EACOS implementations for the C-5, B-1B, A-10, F-16, & B-2 fleets, plus a Cross-Fleet Pilot Project

# Complicating Factors



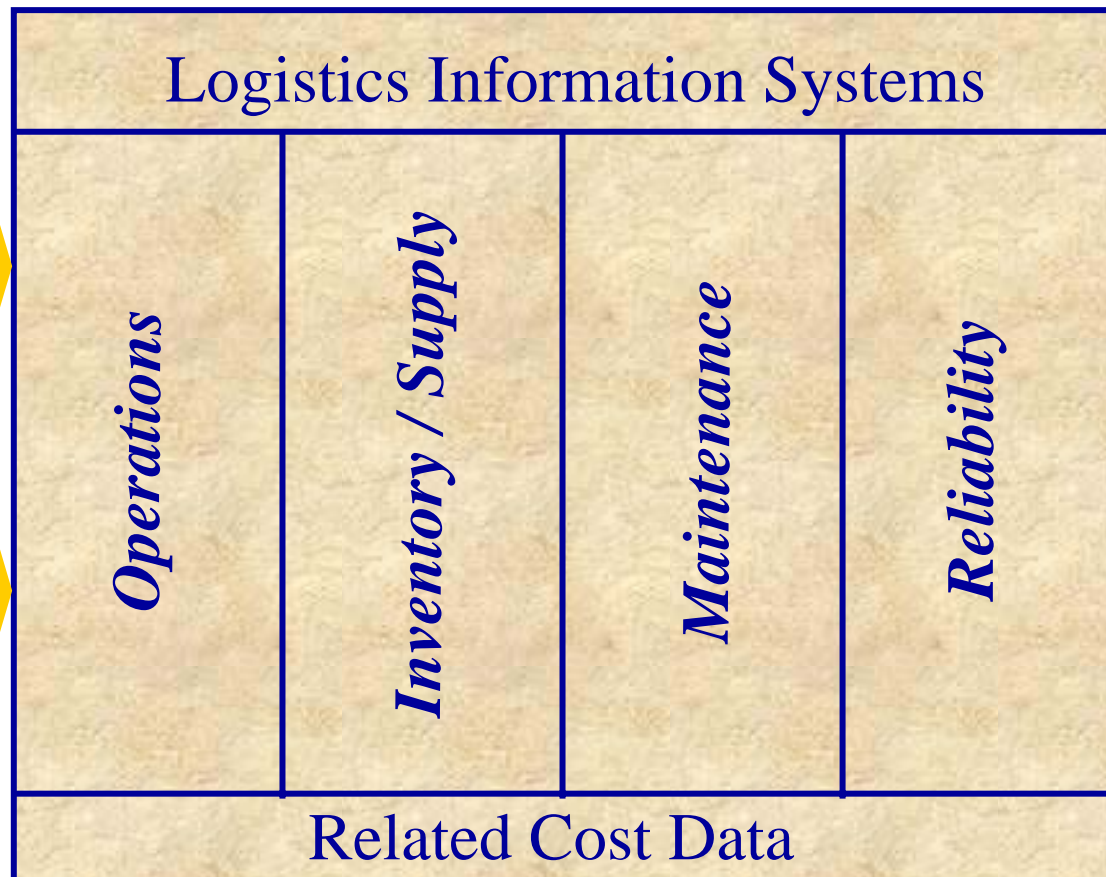
# The EACOS Approach

## What is it ?

Enterprise Analysis and Cost Optimization System

### WHAT IT DOES

- ✓ Baselines System
- ✓ Identifies necessary improvements
- ✓ Allows modeling & prediction of Improvements
- ✓ Optimizes Investments



System Design

Mission Profiles

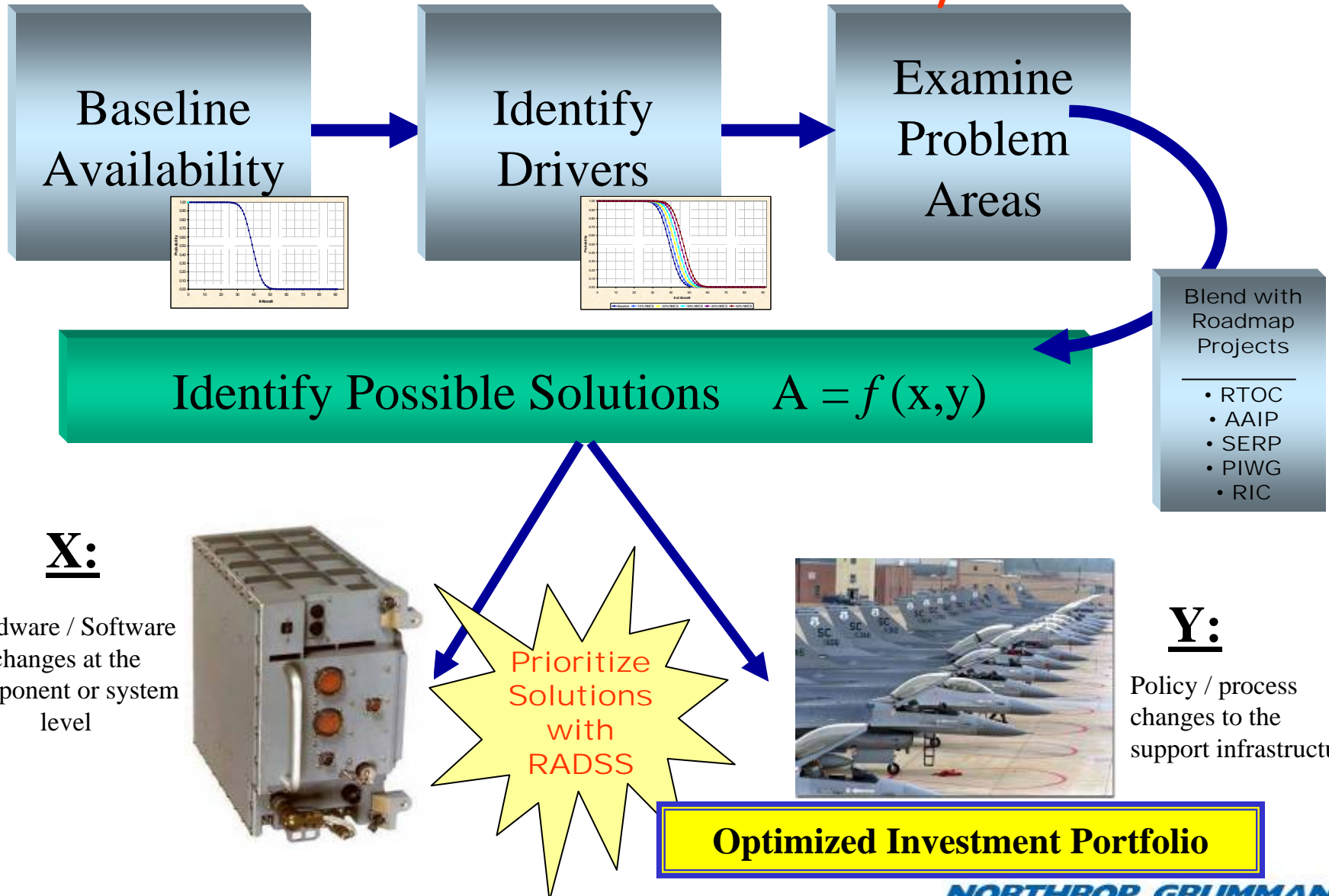
Improved Readiness / Availability

Reduced Total Cost of Ownership

**NORTHROP GRUMMAN**

# The EACOS Approach

*A Repeatable Process!*



# The EACOS Approach

## ■ Phase I: Enterprise Analysis

Baseline Fleet and Identify “Drivers & Solutions” (Investment Candidates):

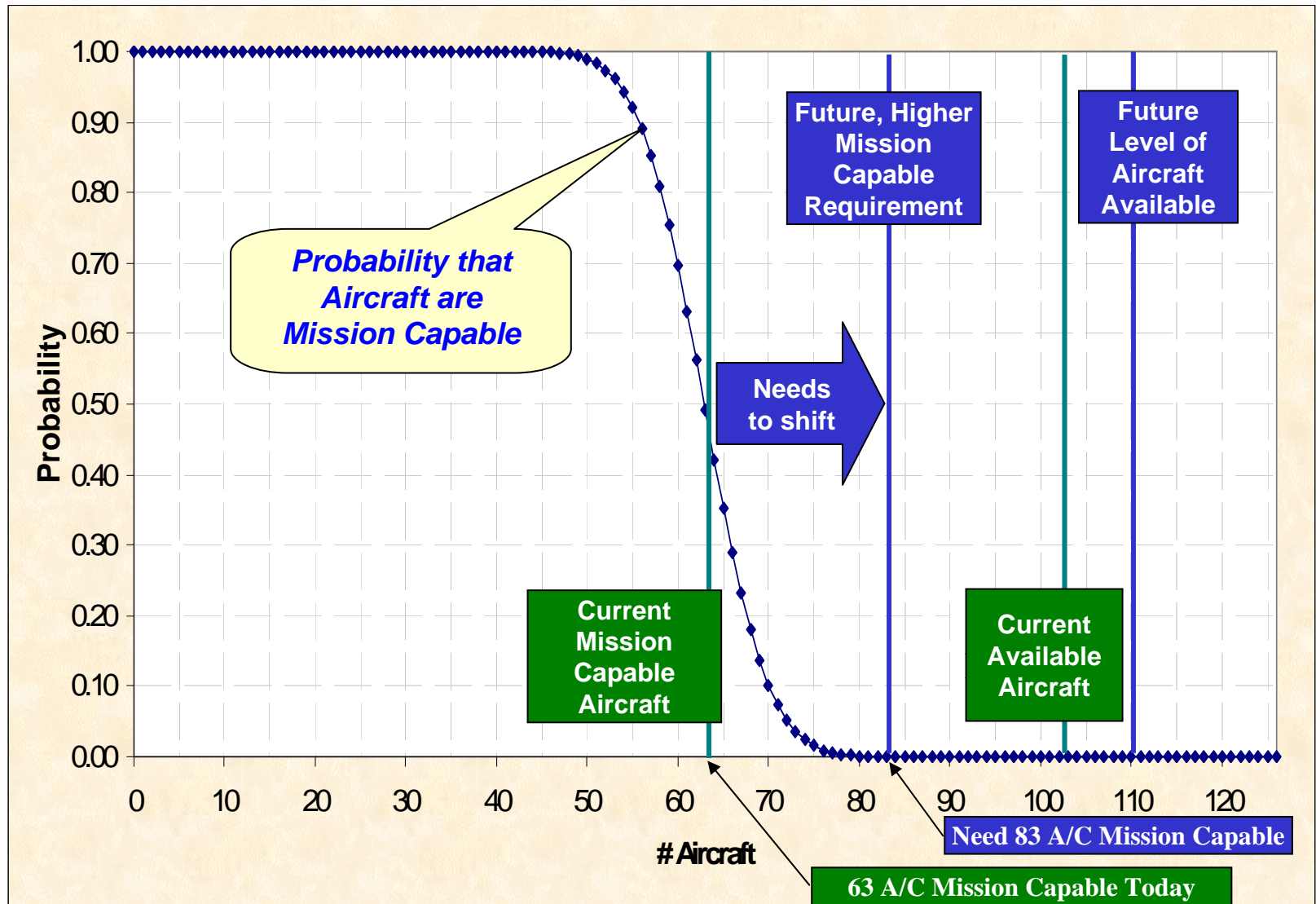
- Fleet Availability
  - Mission / Operations profile (Operations, Training, MC Rates, Flying Hours)
  - Reliability (Inherent Failures, Mission Aborts, Mean Time Between Failures)
  - Maintainability (Not Mission Capable Maintenance, Maintenance Manhours)
  - Supportability (Not Mission Capable Supply, Flow Days)
- Maintenance Concepts (Field, Depot, Phase, and Analytical Condition Inspections)
- Supply Concepts (Supply Chain Management, Defense Logistics Agency)

## ■ Phase II: Cost Optimization System

- Define Decision Goal
- Identify and Weight Decision Criteria and Standards (to generate “Benefit Scores”)
- Evaluate Investment Candidates (Phase I Analysis, Roadmaps, etc.)
  - Analyze Data (Show Stoppers, Correlations, Constraints)
  - Identify Global and Boolean Constraints (for Linear Program optimization)
- Load Data into Resource Allocation Decision Support System (RADSS)
  - Run RADSS to generate Benefit Priorities and Benefit-to-Cost ratios
  - Conduct Sensitivity and Scenario Analysis
- Select Optimum Solution Set to achieve greatest collective Benefits vs. Constraints

# Fleet Availability Baseline & Required Improvements

## Mathematically Modeling the Effects of Investments



# Monthly Status of an "Average Aircraft"

EACOS identifies "Drivers" to Fleet Availability and Ownership Costs

EACOS then models "Solutions" to all "Drivers" (including related Investment Costs) and Predictive Results

Day	62.4% MC Rate						
1	Mission Capable 15.1	Fully Mission Capable 9.7	Flying Time 1.64 days				
2							
3							
4							
5							
6							
7							
8							
9							
10							
11	Partially Mission Capable 5.4	PMCB 2.7	9.6 Sorties per Month *****				
12				PMCM 1.5	39.4 Hours per Month *****		
13						PMCS 1.2	4.1 Hours per Sortie
14							
15							
16	Not Mission Capable 9.1	NMC Maintenance 4.8	NMCMS .7				
17				NMC Both 2.4	NMCBS 1.7		
18						NMC Supply 1.9	NMCBSU .7
19							
20		NMC Supply 1.9	NMC Supply 1.9	NMC Supply 1.9			
21							
22							
23							
24							
25							
26	Depot 5.8						
27							
28							
29							
30							

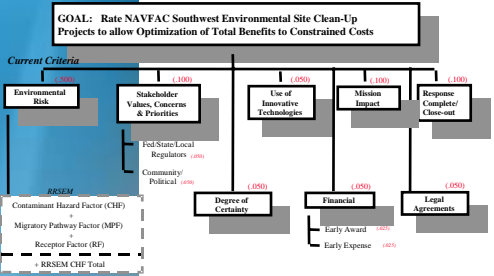
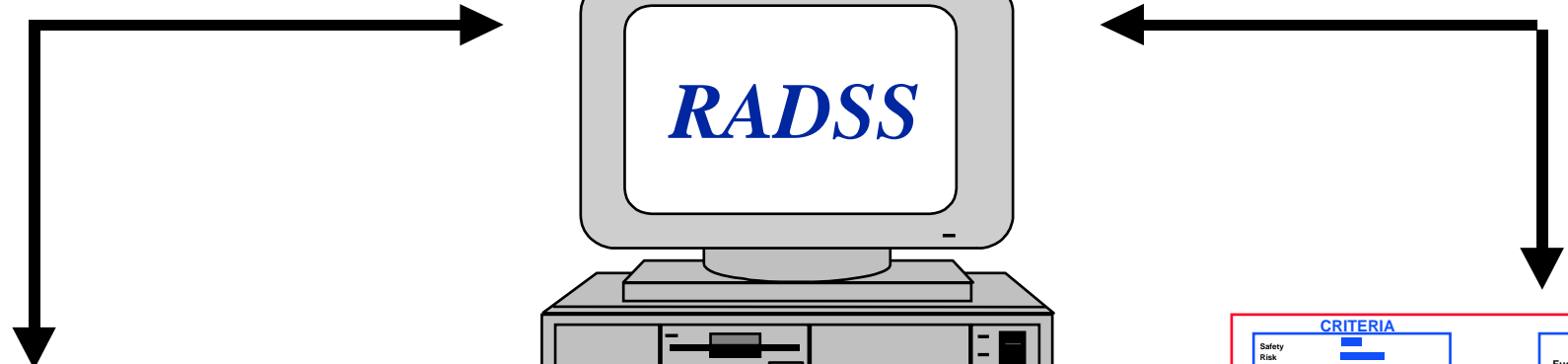
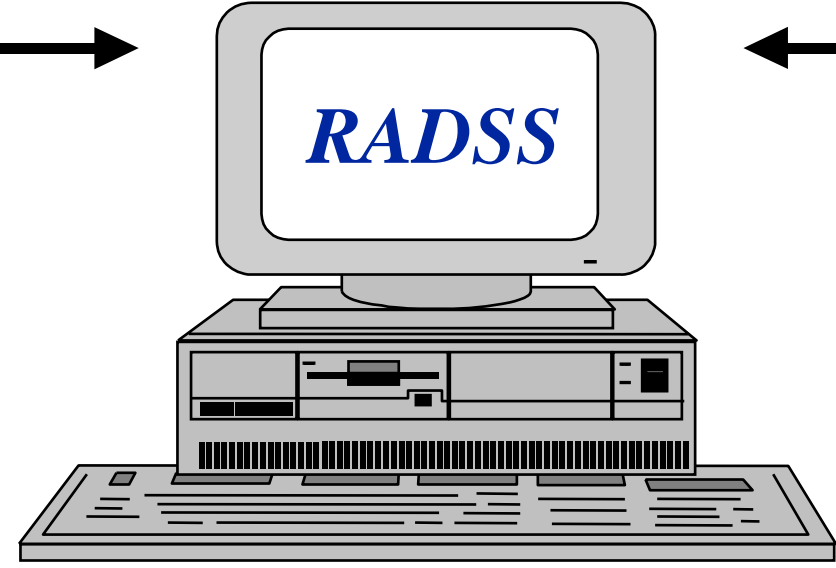
# Sample of Hundreds of "Drivers" and "Solutions"

EACOS MODEL INPUT							
IN-PUT #	CANDIDATE	Candidate	Problem Description	Potential Solutions	Source		
2003 Top Drivers	1 11DBJ Trailing Edge Wedge	Active	#1 NMC	mx practices	mx practices	REMIS	
	2 74HAO LA	Control Unit	Active	Mod of L	ed Inventory	IFFCC M	ete by DS
	3 74JBO Co	Recorder	Active	Part mov		Depot re	expansion.
	4 46AAO Let	(Assem bly)	Active	High NMC	primarily to cracking.	Part of H	
	5 14NAC RID	bly	Active	Aging filg		Identify	analysis.
	6 14CEA Let		Active	Aging filg		Identify	analysis.
	7 46AAA At	er)	Active	Aging filg		Comple	og-Up.
	8 14NBO Sla	ments	Active	Age of s	x	Convert	n to steel
	9 11AFB Cet	s	Active	Increas in	deployments	Injection	process
	10 23KAO Th	Assem bly)	Active	Modular	ugh	Part of t	ent Upgrade.
	11 75AAO GU		Active	NMCM a	2003 due to ops tempo		
	12 41CAO Ca		Active	Operatin	NMCM time.		
	13 44CFO Ma	gator P anel	Active	High NMC	Ns, high MMH		
	14 46DAD Inte	mponents	Active	NMCM in	decreasing field experie		
	15 14NAO Let	er	Active	Age of s	x	Convert	n to steel
	16 13CAF NV	hit	Active	NMCM a			
	17 55DK0 Ele		Active	Large Inc			
	18 23DCA Ma		Active	Deterioti	Ns, MMH, INH, MTBF-1		
	19 14CEC Rik	gator	Active	Aging filg		Identify	analysis.
	20 46DAA FUL	ndicator	Active	Steady s	2003 NMCM and MMH		
	21 41AAO En	anel	Active	Deterioti	Ns, MMH, INH, MTBF-1		
	22 51CAC Re	or ARU-2B/A	Active	NMCS n			
	23 46AD0 FU		Active	Significa	e		
	24 51DAO Ce	iter	Active	Needs m	A-10 Modernization Plan	EMD co	on funding.
	25 14LCA Spee	Speed Brake Actuator ET	Active	Large incre	in turn and interent failures for 2003.		
Phase I EA	26 Flight Test	craft	Active	Avg of 5	pliot's schedule	Flight te	home statio
	27 Establish a	C apability	Active	A/C cann	quires decling	Establis	Phase I EA
	28 Depot Dedi		Active	A/C mx t	om floor to tow	Establis	ctr's support
	29 Tackey Tap		Active	Some st	engthy cure times	Tackey ta	(GUA, 1017
	30 UR ASSI De		Active	Some de	ures NRTS	Use der	cedures
	31 Wheel Pod	nd 8 Leaks	Active	Fuel leak	areas	Conside	channel seal
	32 A-10 PDM		Active	A/C life e	complex phase	Conside	pleted
33 RCM Analy	rol System	Active	Flight co	ted during phase	Use AM	ses's shortfalls	
A-10 Roadmap / Right Plan	34 EGI and GA	rod Funded Ins	Underway	Navigation	A-10 fleet	Embed	M for A-10 fle
	35 Fire Contro	d EMD, Prod)	Underway	High NMC		IFFCC S	W, Rel Wirt
	36 Suite 2 (EM		Underway	CDU upg		CDU up	
	37 Counterme	nded Installs)	Underway	Defensiv	irements	240 airc	t for mod
	38 Suite 3 Pre	Spiral 1)	Active	Requires	DAW/MMCD	Upgrade	ata bus
	39 Suite 3 PE	ral 2)	Active	Op capa	In ADR	Upgrade	ink
	40 Suite 3 PE	3010 shortfalls)	Active	Reqs fo		Adds di	dia bomb, B
	41 Suite 4 Mail	Prod Funded)	Active	Maintens		Mainten	
	42 TE MS/AD R		Active	Reliabilit	and ADR	Fleet re	nding
	43 Fire Handle	& Prod Funded)	Active				
	44 C ADC (Unf		Active	Obsoles	cers	Re-engi	
	45 HUD R & M	d Unf Prod)	Active	Not IIRP		Fund pri	ppgrade
	46 Technology		Active	Rqmts fo	ic, Sys on Chip	Integrat	tem on chip
47 GATM (Mod	ND & Prod)	Active	Mode S	will be req'd	Upgrade		
48 OBOGS (U		Active	Current x	onboard LOX	Implem	more loltter	
49 Com et Pod	Prod)	Active	Ops cap	CM	Provides	verage	
50 Propulsion	(Unf Prod)	Active	Negative	mb in current ops	Re-engi	loltter by 10	
51 Suite 5 Sof	ed)	Active	Form 37		Implem	didates	
52 Suite 5 Avic	ed)	Active	Digital M	ADI, RADALT etc.	Integrat	al map etc.	
53 Suite 6 Sof		Active	Form 37		Implem	didates	
54 Suite 7 Sof		Active	Form 37		Implem	didates	
55 Suite 7 Avic		Active	Require	tic foam, HMD etc	Integrat	MD etc.	
56 Suite 8 Sof		Active	Form 37		Implem	didates	

# EACOS Phase II: Investment Optimization

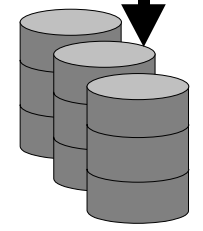
## Resource Allocation Decision Support System

*A Complete, User-Friendly, Integrated "Portfolio Planning and Management System"*

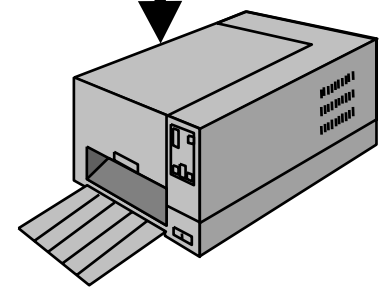


**Customized AHP Decision Model (s)**

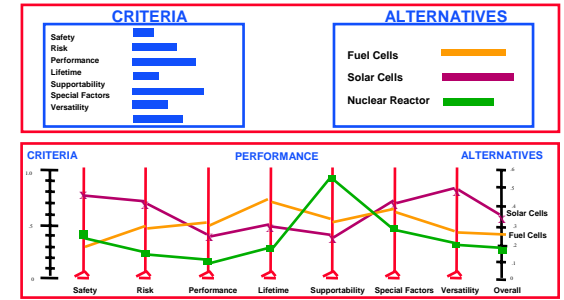
**Windows Database Management (M/S Access)**



**Data Bases**



**Reports and Graphics**



**Powerful Optimization Program & Sensitivity Analysis**

*Enhanced Analysis and Decisions*



# Broad Range of RADSS Applications

Resource Allocation Decision Support System

Model Projects Scenarios Admin Help Exit

DEPARTMENT OF DEFENSE  
UNITED STATES OF AMERICA

DEFENSE MAPPING AGENCY  
UNITED STATES OF AMERICA

Decision Support Environment

Version 1.51

NORTHROP GRUMMAN  
Information Technology

Resource Allocation Decision Support System  
RADSS 2000  
for  
A-10 EACOS

Resource Allocation Decision Support System

Model ARs Scenarios Admin Help

AGT

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Environmental Resource Allocation Decision Support System  
(Remediation Module)

Resource Allocation Decision Support System  
RADSS 2000  
for  
Parts Obsolescence Management Decisions  
DEMONSTRATION MODEL  
for  
Air Force Materiel Parts Obsolescence Management Tools Initiative

NORTHROP GRUMMAN  
Information Technology

on Decision Support System  
ADSS 2000  
for

US Army Corps of Engineers

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Meeting Today's Business Challenges Through Applied Information Technology

Resource Allocation Decision Support System

Tailored to Individual Customer Requirements

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Information Technology

Resource Allocation Decision Support System  
RADSS 2000  
for  
B-1B Fleet Availability

NREL  
ADVANCED VEHICLE SYSTEMS

Resource Allocation Decision Support System

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Portfolio Planning and Management System

Texas Instruments

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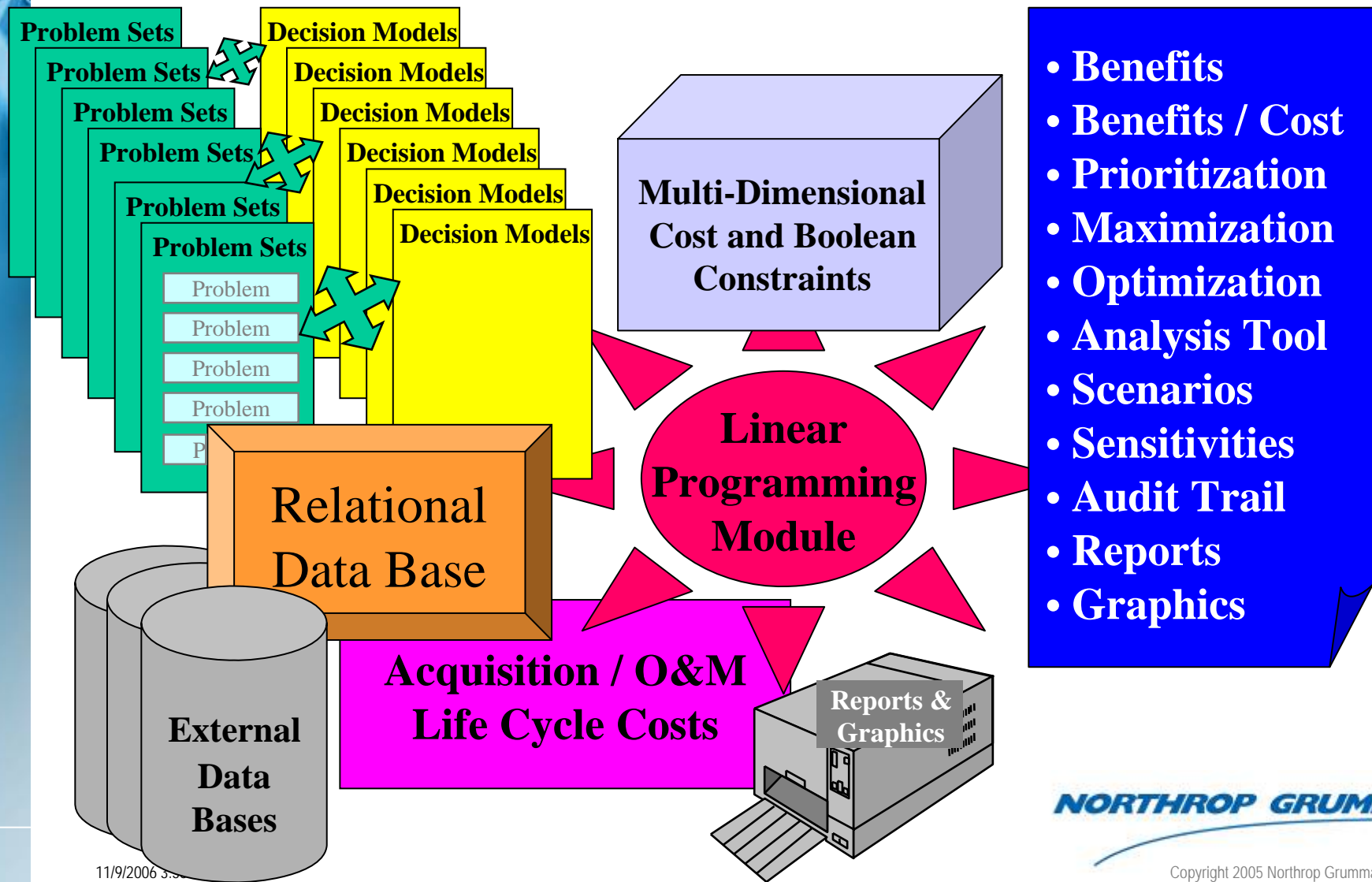
Resource Allocation Decision Support System  
RADSS 2000  
for  
T-1A TRAINING SYSTEM

NORTHROP GRUMMAN  
Information Technology

Resource Allocation Decision Support System  
RADSS 2000  
for  
B-1B Fleet Availability

# RADSS™ Architecture

*"Portfolio Planning via Decision Modeling"*



- Benefits
- Benefits / Cost
- Prioritization
- Maximization
- Optimization
- Analysis Tool
- Scenarios
- Sensitivities
- Audit Trail
- Reports
- Graphics

# Criteria, Constraints, and Rules

- **RADSS supports both Qualitative and Quantitative Decision Criteria and Standards**
- **RADSS supports multiple Constraints**
  - **Global** (Total or annual budgets)
  - **Category** (On classifications)
  - **Minimum or maximum** (Cost or resource levels)
  - **Additive** (The more stringent constraint takes precedence)
- **RADSS supports Boolean Rules**
  - **Include** (Alternatives are funded regardless of their cost or benefit)
  - **Exclude** (Alternatives are not funded regardless of their cost or benefit)
  - **Linked** (Dependent alternatives are linked to independent alternatives)
  - **One or None** (Only one alternative of a group – or none – are funded)
  - **All or None** (Either all alternatives in a group – or none -- are funded)

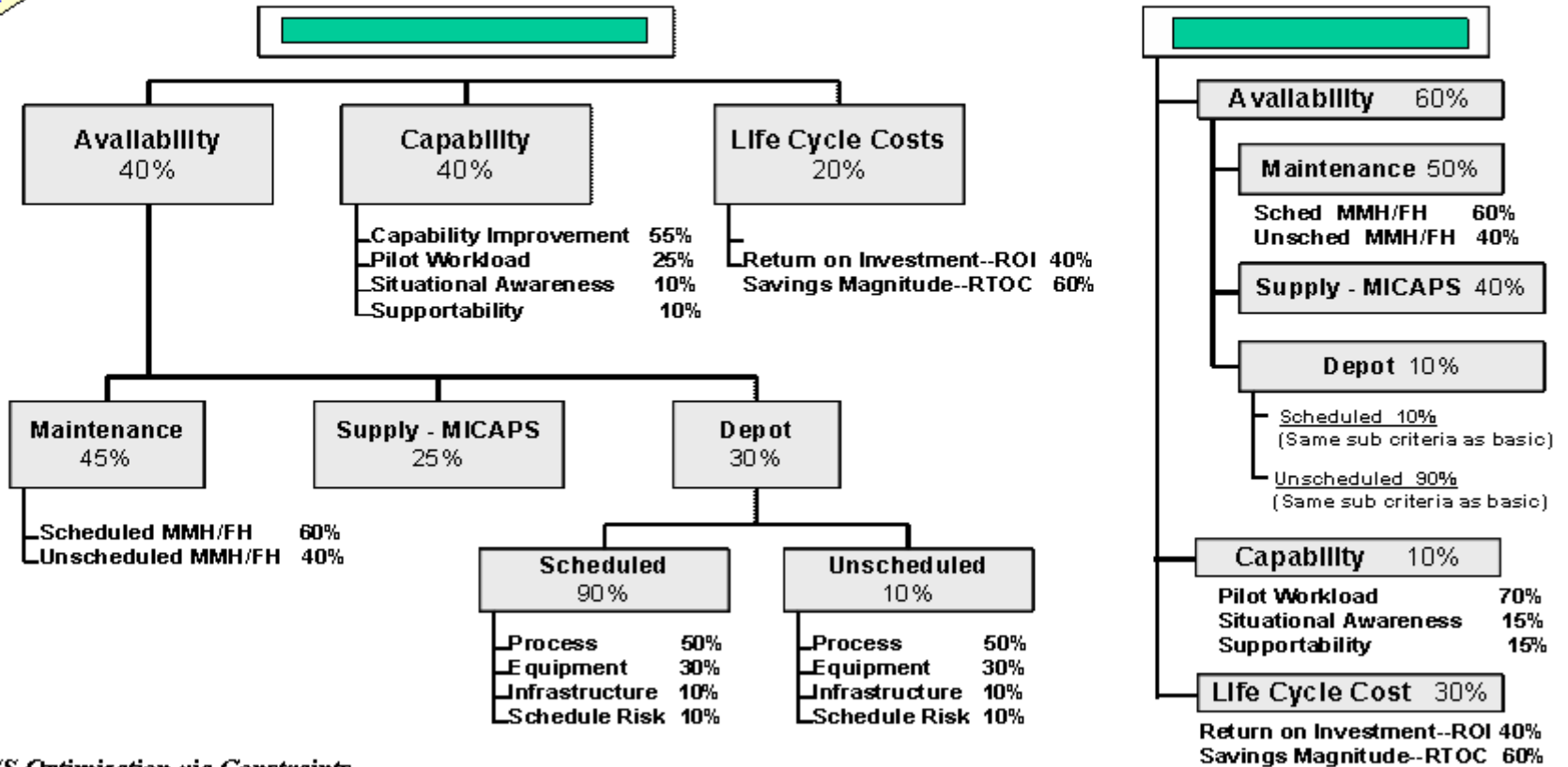
# Sample EACOS Decision Model

Generates "Benefits Score" for each "Solution"

## EACOS Decision Model

Approach B

**Decision Goal**  
Increase aircraft availability and mission capability while minimizing cost



### RADSS Optimization via Constraints

Max Funding per Block

(or by 3600, 3400, 3010)

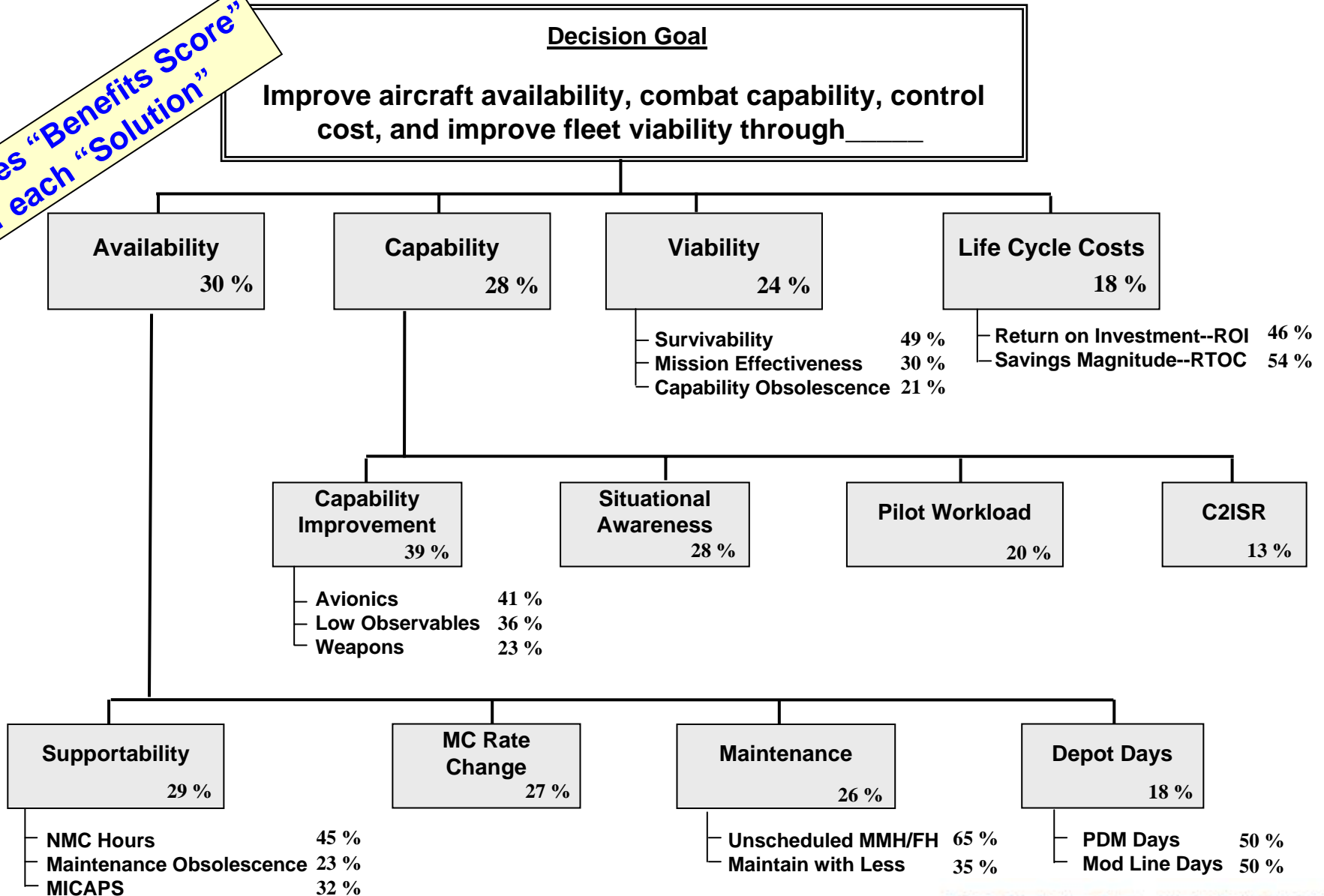
Min Funding per Block



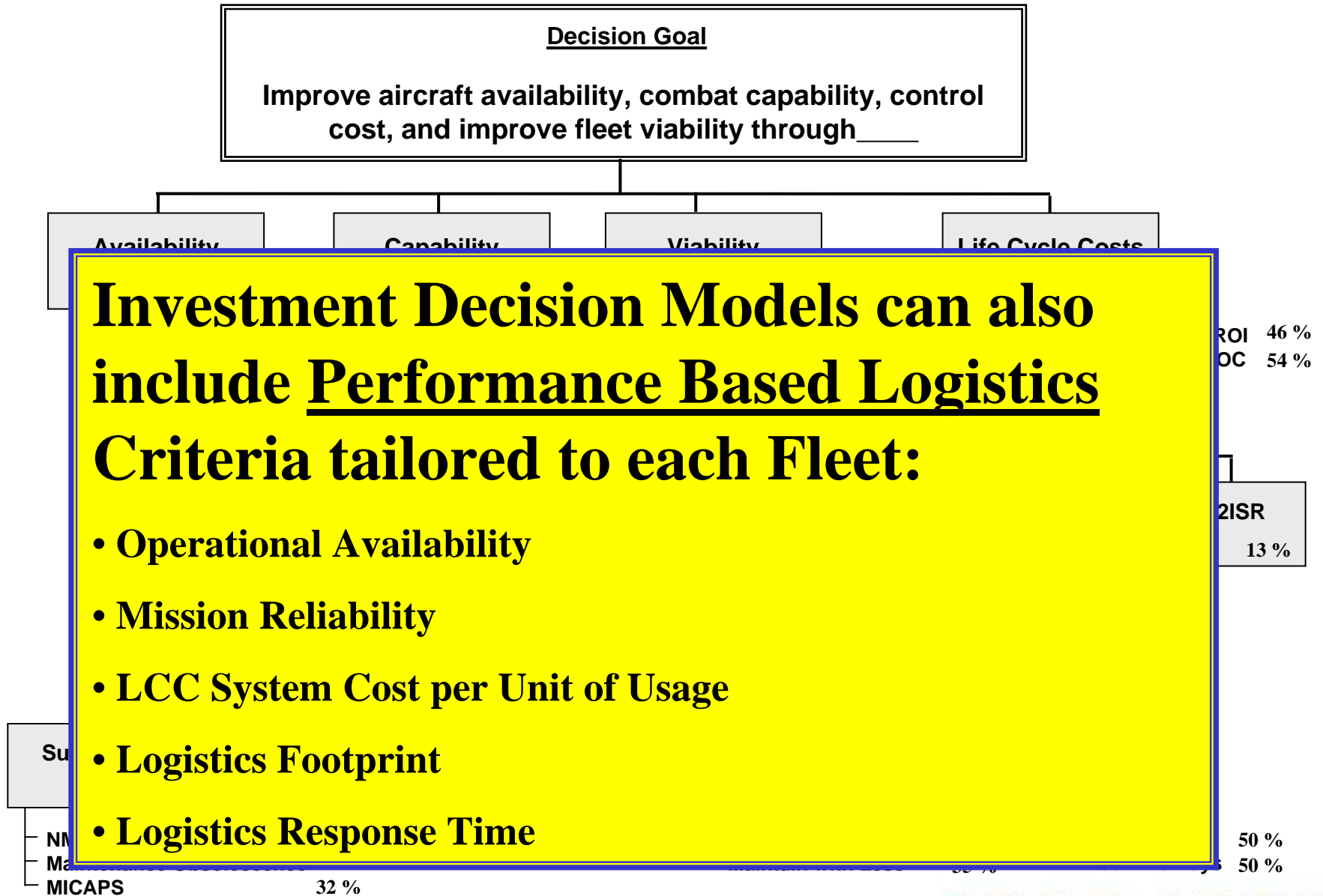
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# Sample EACOS Decision Model

Generates "Benefits Score" for each "Solution"

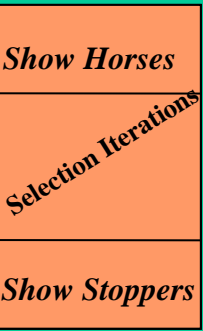
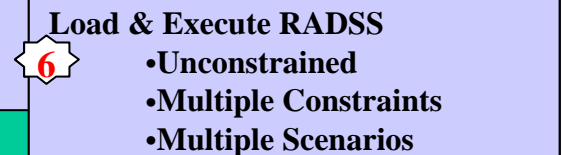
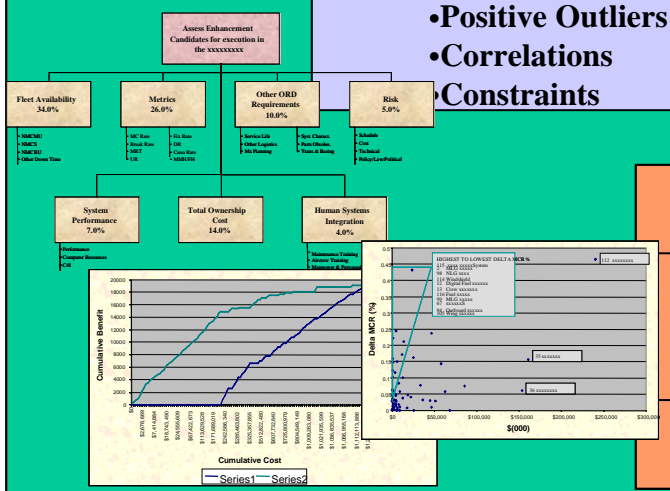
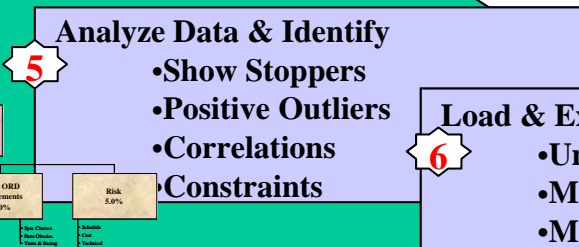
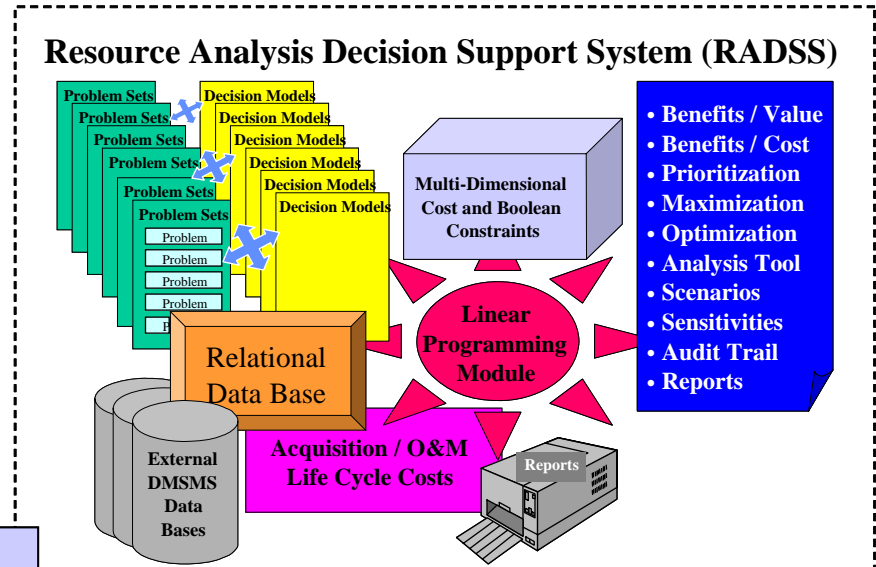
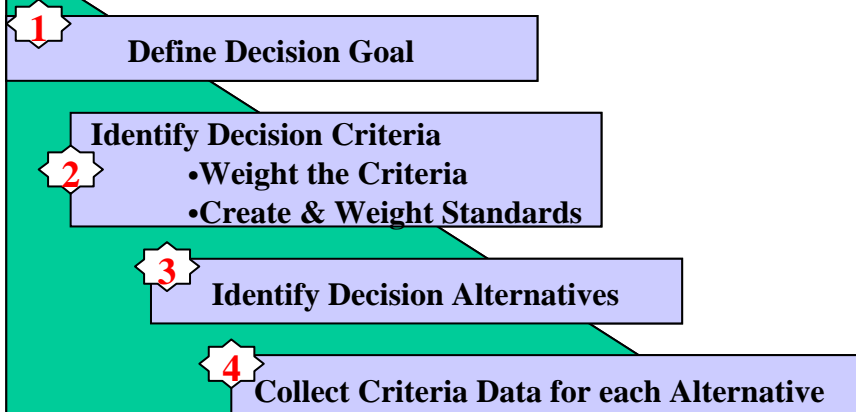


# Sample PBL Decision Model Application



# EACOS Phase II: Investment Optimization Process

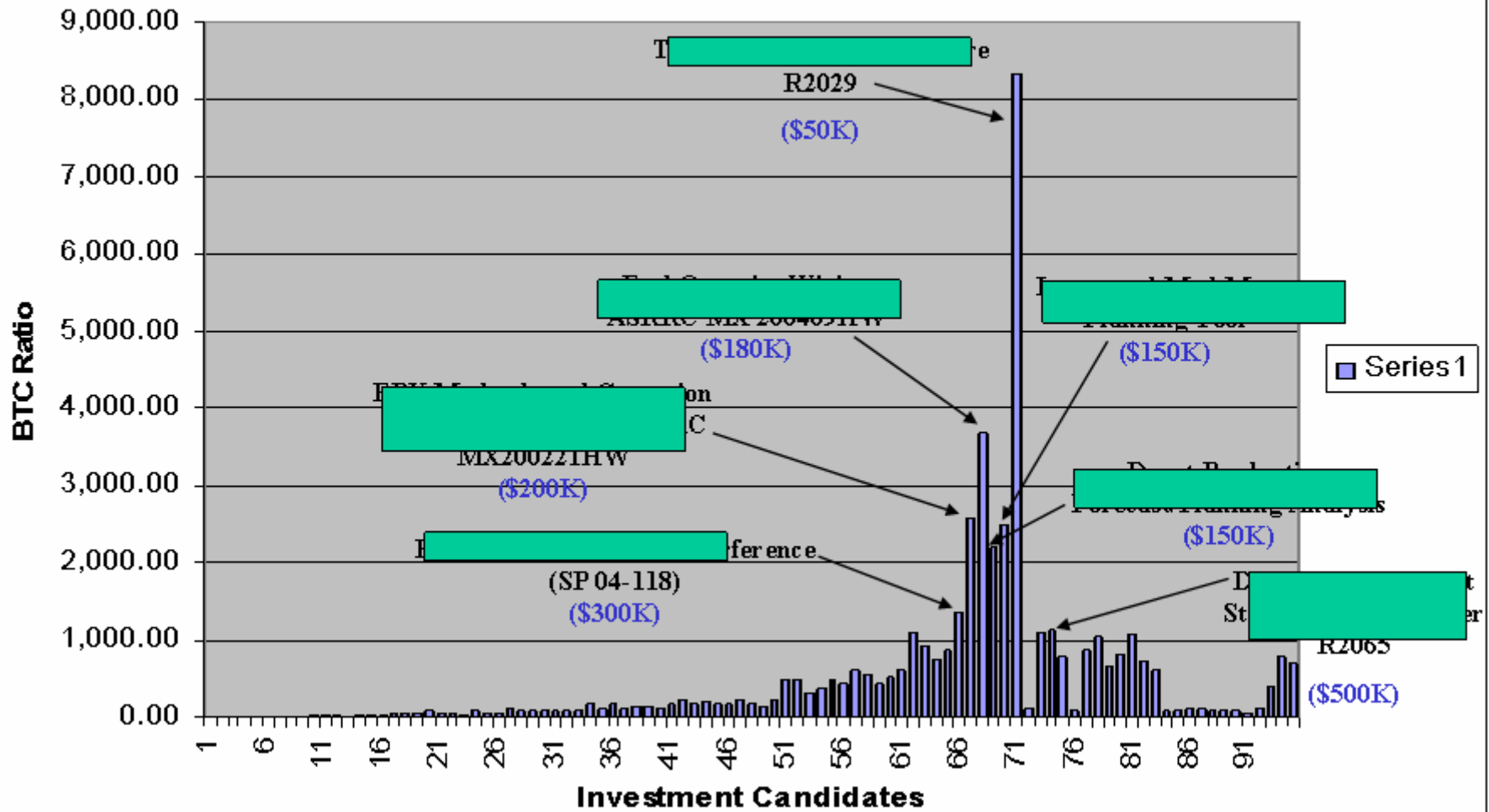
## RADSS Decision Process



# EACOS RADSS Run – Benefit to Cost

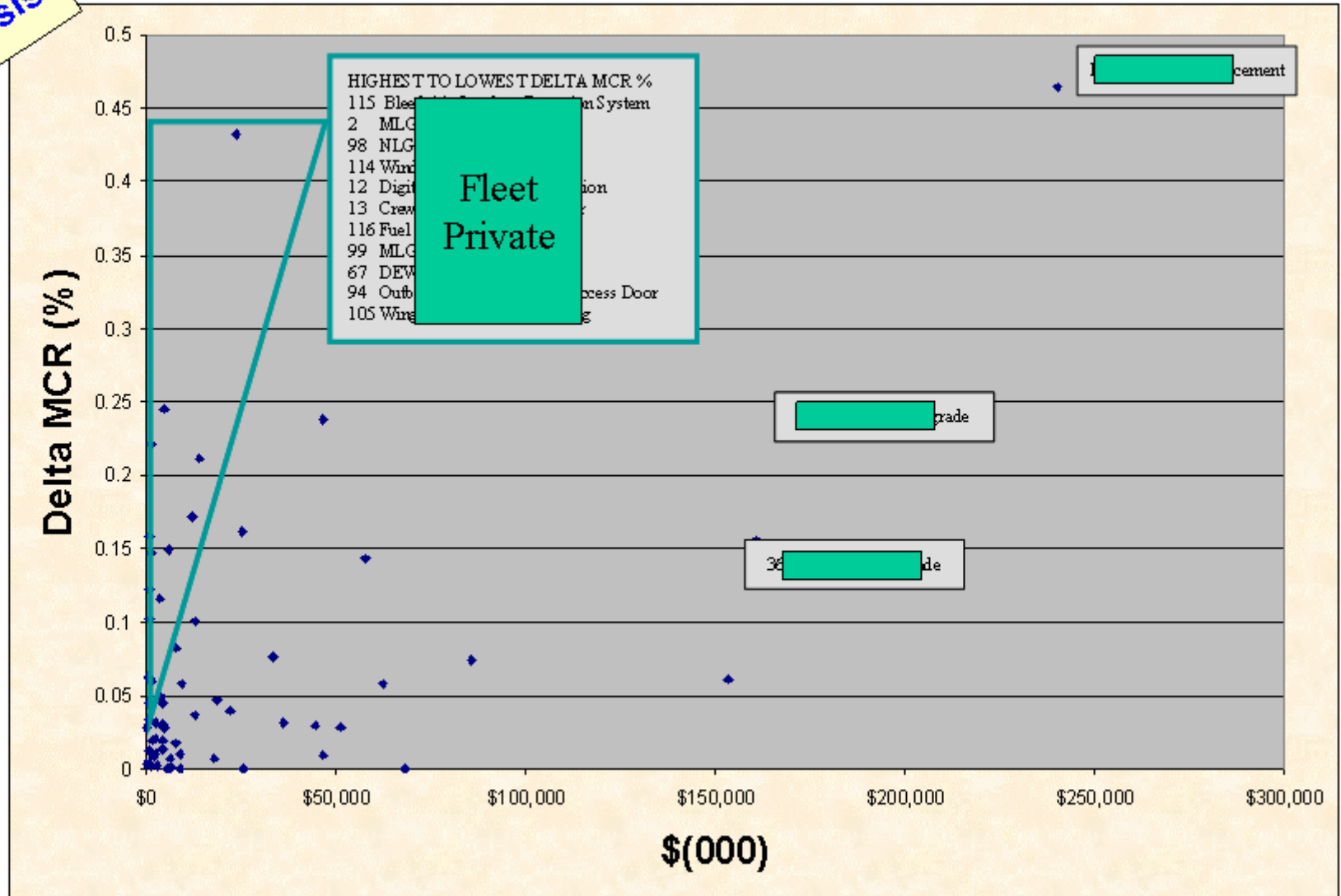
All Investment Candidates

Run #3 Benefit-to-Cost Ratios



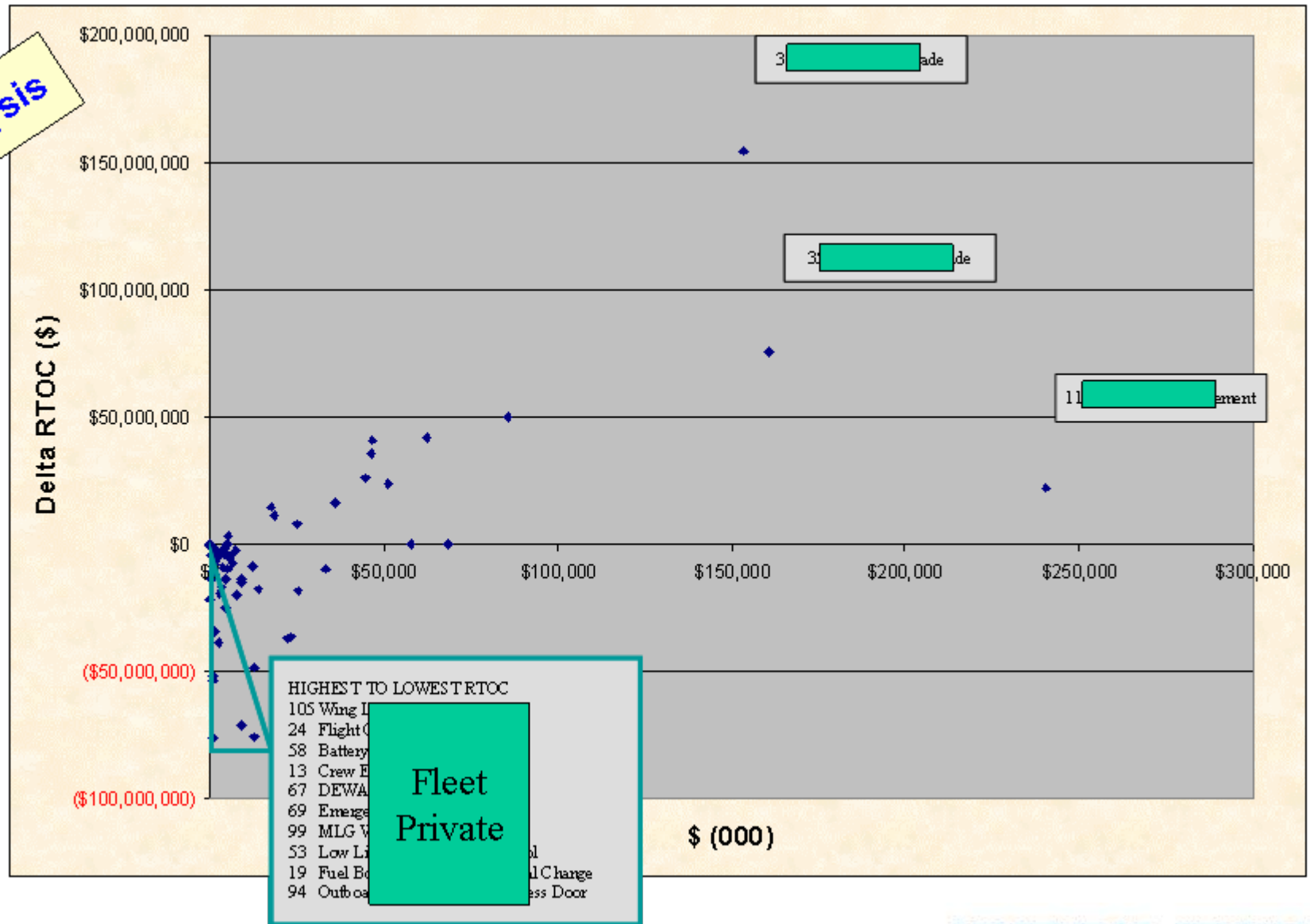
# Delta Mission Capable Rate vs. Cost

Data Analysis



# Delta RTOC versus Cost

Data Analysis



# Scenario #9 - Medium Cost Boolean Rules

- Selected “High-Contribution” candidates for “Automatic” Funding

- A003 - [REDACTED]
- A004 - [REDACTED]
- FA006 - [REDACTED]
- A012 - [REDACTED]

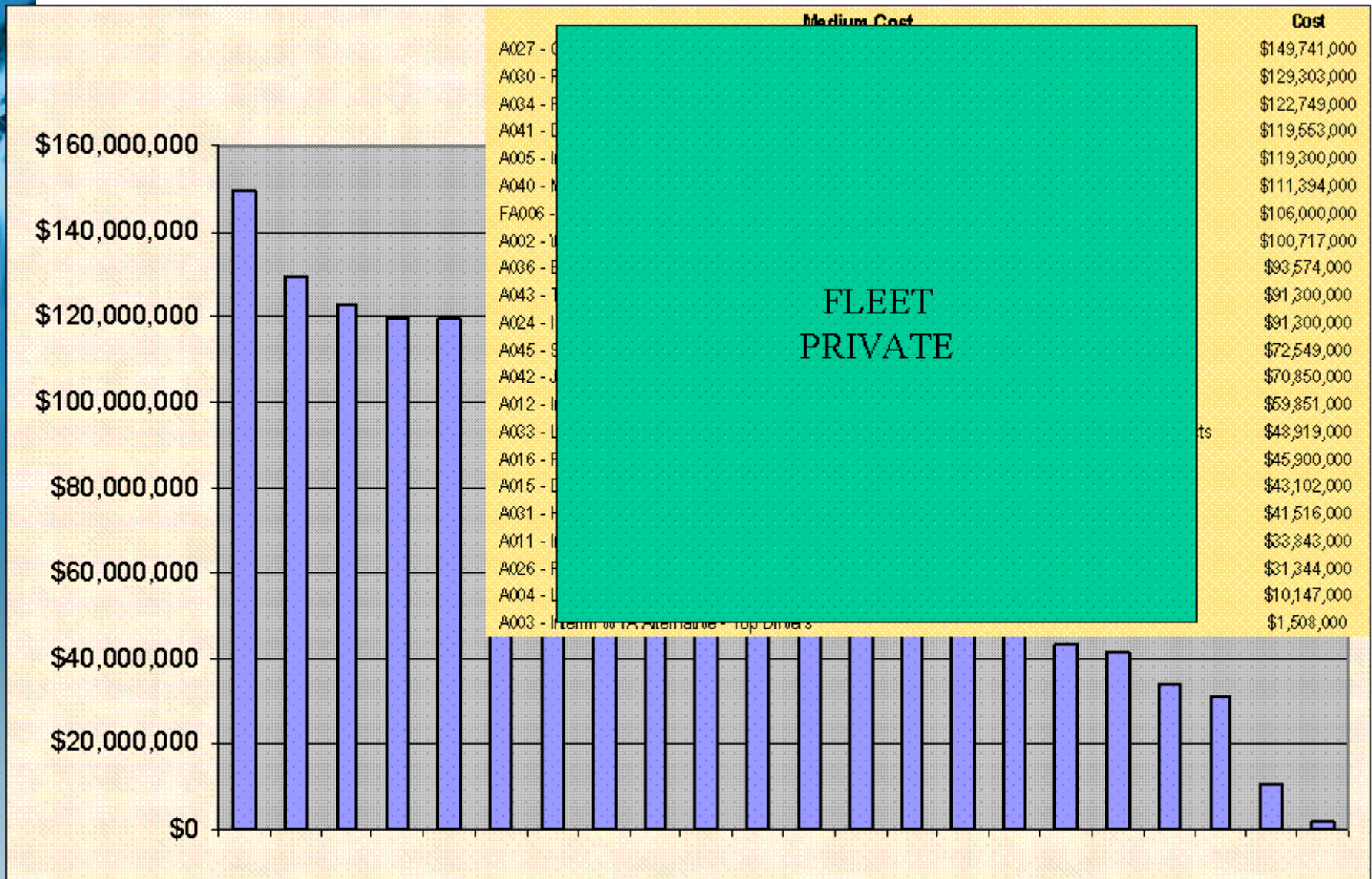
- Linked Candidates

- A003 - [REDACTED]
- A004 - [REDACTED]

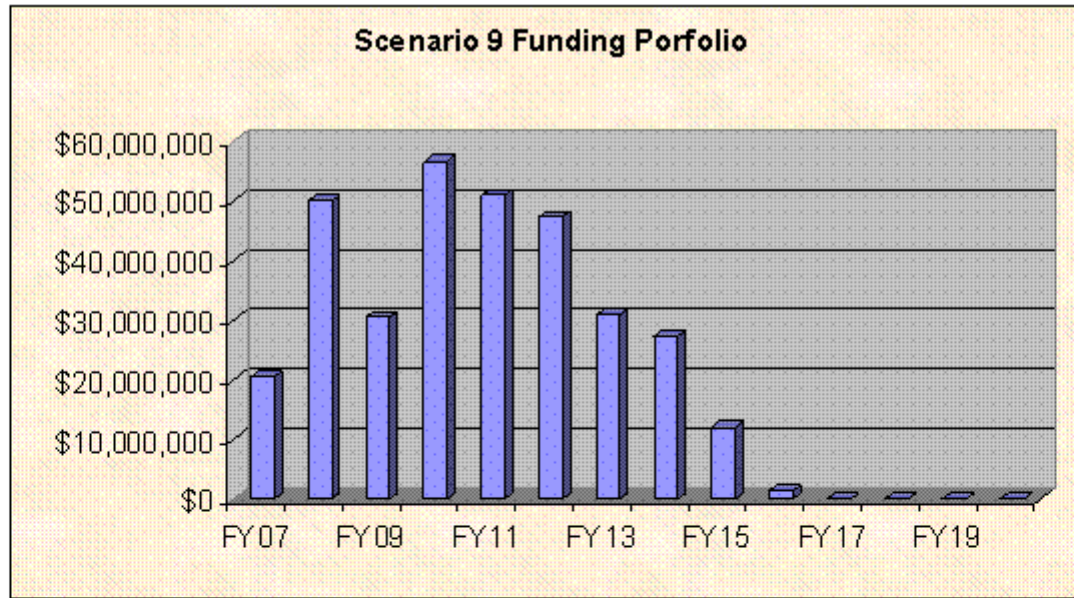
- “One-or-None” Groups

- A002 - [REDACTED]
- A003 - [REDACTED]
- A005 - [REDACTED]

# Medium Cost Alternatives (\$25M - \$200M)



# Cumulative Effects of Funding Scenario #9



CANDIDATES	MC Rate	NMC Hours	Unscheduled MMH/FH	RTOC	Total (\$)
A00	5.47%	-6,883	-6,687	\$ (2.0)	\$ 1,508,000
A00	7.29%	-9,177	-8,916	\$ 7.5	\$ 10,147,000
A00	1.73%	-2,173	-6,473	\$ (3.1)	\$ 106,000,000
A01	1.23%	-1,547	-1,321	\$ (23.3)	\$ 33,843,000
A01	4.92%	-6,187	-4,401	\$ (73.2)	\$ 59,851,000
A01	0.10%	-120	-89	\$ 54.2	\$ 43,102,000
A02	0.00%	0	0	\$ 31.4	\$ 31,344,000
A03	0.00%	0	0	\$ 159.7	\$ 41,516,000
<b>Total Cumulative Effects of Scenario #9</b>	<b>20.73%</b>	<b>-26,086</b>	<b>-27,887</b>	<b>\$ 151</b>	<b>\$ 327,311,000</b>

**20% Funding Scenario –  
Funds 8 Candidates for \$327M**

# Predictive Nature of Funded Scenario(s)

- Funding of a single Investment Candidate will result in calculated changes to the metrics contained in the EACOS Fleet Decision Model, i.e., deltas to:
  - Availability / Mission Capable Rate
  - Scheduled / Unscheduled Maintenance Manhours
  - MICAPs
  - Capability
  - Life Cycle Cost
  - Depot Flow Time
  - Other Metrics applicable to the customized fleet decision model
- Modeling and funding of a group of Investment Candidates within a specified scenario will result in a cumulative delta change to fleet MC Rate, RTOC, etc.

# Benefits of the EACOS Process

- Complements / Enhances Current Decision Processes
- Rigorous Enterprise Analysis and RADSS Approach is highly Effective
- Allows Modeling & Better Differentiation & Prioritization
- Enhances Marginal Returns on Complex Decisions
- Increases Total Benefits within Constrained Budgets
- Collectively Achieves Greater ROI

**Optimized & Balanced  
Budget and  
Execution Portfolio**

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# Summary

- **The RADSS modeling tool simplifies and optimizes complex investment decisions**
  - Considers decision criteria of all Stakeholders
  - Considers a wide-variety of constraints
  - Considers sensitivity and scenario analysis
  - Results in multiple, customized Investment Portfolios
- **EACOS has broad applications across the Services**
  - All aging systems can benefit from the baselines and EACOS predictive assessments to help *support modernization & end-to-end sustainment investment decisions*
  - All DoD processes (supply, maintenance, depot, operations) can benefit from EACOS principles & tools
  - Special initiatives can benefit, e.g., Modeling for Performance Based Logistics (PBL) and Aircraft Availability Improvement Program (AAIP)