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COTS Tech Refresh and Maintenance

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Virginia Stouffer

Logistics Management Institute
2000 Corporate Ridge
McLean, VA 22102
www.lmi.org

Technology Assessment

Problem Statement

¥ The FAA is increasingly using Commercial Off-The-Shelf (COTS) equipment in its air traffic systems automation, e.g.,

— STARS

— HOCSR

— DSR

— VSCS

¥ COTS equipment usually requires replacement or refreshment on a short time scale, shorter than the 20 year life-cycle the FAA enjoyed with custom-built systems

¥ What is the future maintenance and acquisition impact of this move to COTS?

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Answer

¥ We researched industry, FAA, and DoD experience and found that COTS equipment follows a very predictable life cycle pattern, described in phases:

| Version on market	Retail sale	Support	Upgradability
1	Product is the current "new" product	Manufacturer support often free of charge	N/A; product IS the upgrade
2	Still buyable	Manufacturer support available	HW easily upgradeable; SW makes automatic adjustments
3	Not Available	Not supported by manufacturer; contractor support may be available	HW requires new OS. SW (OS) requires some translation or bridge code to take an older application
4	Not Available	Support only from in-house staff or long-term contract, which may be broken	At some point, a new OS emerges, requiring re-coding to upgrade HW

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Definitions

¥ COTS: Any product offered for public sale

¥ Modified COTS: Any product offered for public sale that has been modified for the FAA; or for which the FAA is the only customer
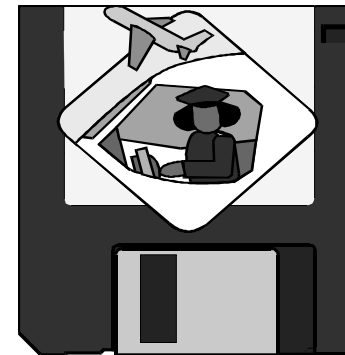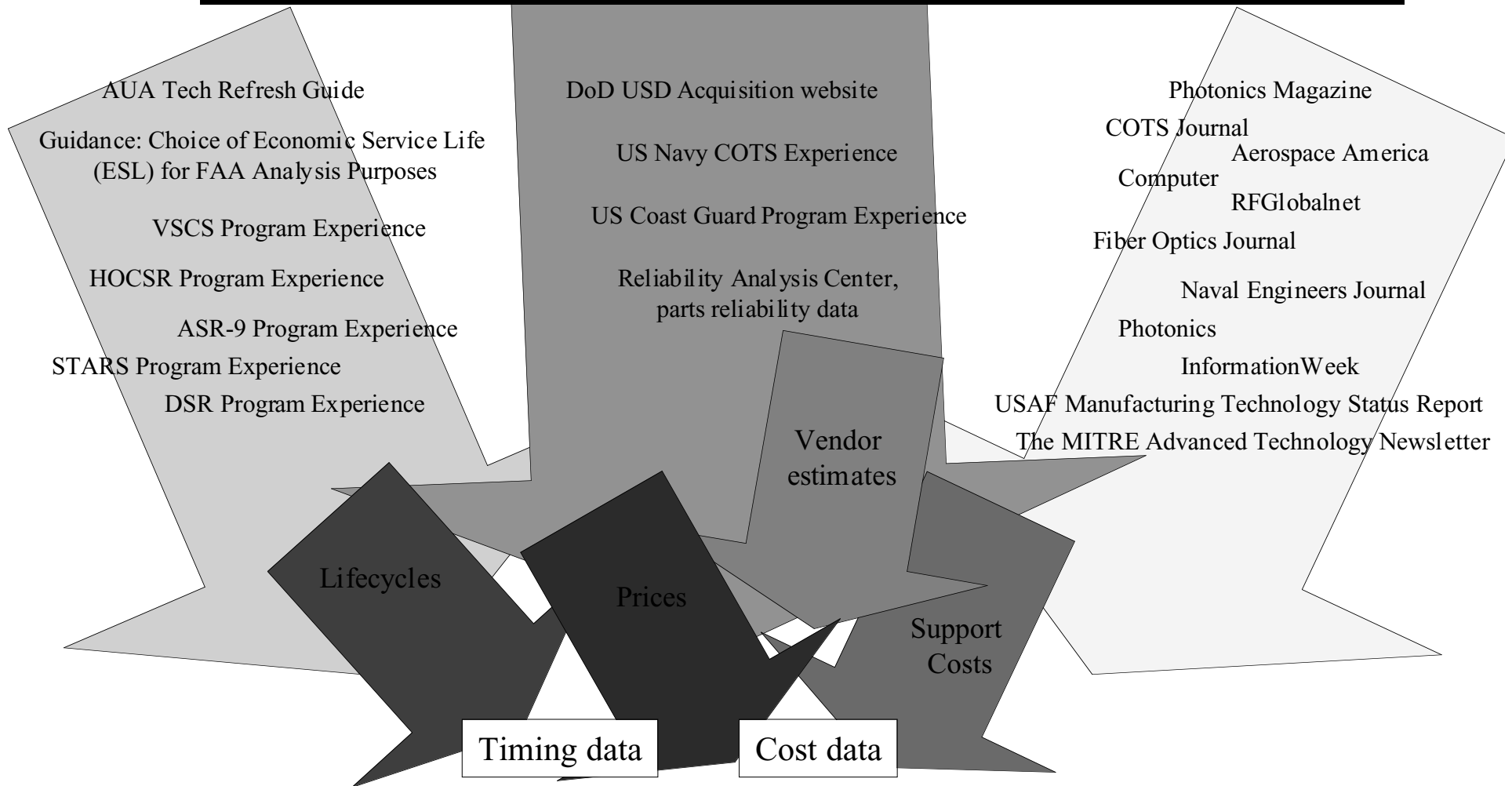
Hardware
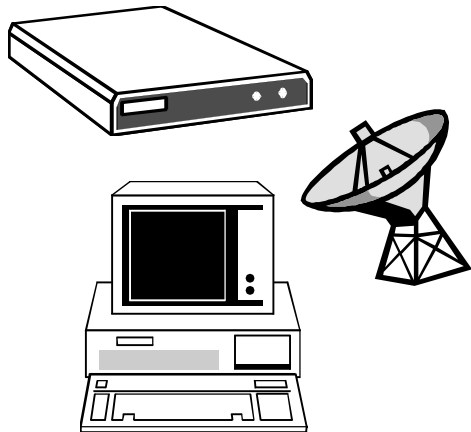
Software / Operating System
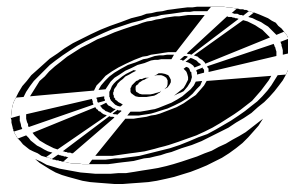
Application Software

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Rules of Thumb

¥ AUA Guide:

— Each phase is 18 months long

— Phase 1: Commercially available, with new product support

— Phase 2: Follow-on release is out; support limited

— Phase 3: OS is now 3 releases ago; possible to get independent contract support

— Phase 4: Support unavailable anywhere at any price

¥ Alterations based on FAA program experience: PAMRI, VSCS, HOCSR, STARS

— Phases vary in length

— OS license fees apply

— HW O&M and OS license fees face cost increases of 20% per year

— Components reach an absolute physical end of life

¥ Supplement with industry rules of thumb, other data

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Data Sources

AUA Tech Refresh Guide

Guidance: Choice of Economic Service Life
(ESL) for FAA Analysis Purposes

VSCS Program Experience

HOCSR Program Experience

ASR-9 Program Experience

STARS Program Experience

DSR Program Experience

DoD USD Acquisition website

US Navy COTS Experience

US Coast Guard Program Experience

Reliability Analysis Center,
parts reliability data

Photonics Magazine

COTS Journal

Aerospace America

Computer

RFGlobalnet

Fiber Optics Journal

Naval Engineers Journal

Photonics

InformationWeek

USAF Manufacturing Technology Status Report

The MITRE Advanced Technology Newsletter

Vendor
estimates

Lifecycles

Prices

Support
Costs

Timing data

Cost data

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Turning Data into Algorithms

Collect data → Derive rules of thumb → Codify rules of thumb into working CERs → Simplify working CERs into FAA-wide CERs

Rules of Thumb

FAA Program Data
HOCSR
VSCS
PAMRI
ASR-9
DSR
STARS

DOD & Industry Data

Working CERS

Individual Program Models
PAMRI
HOCSR
VSCS

Computers
General CERs

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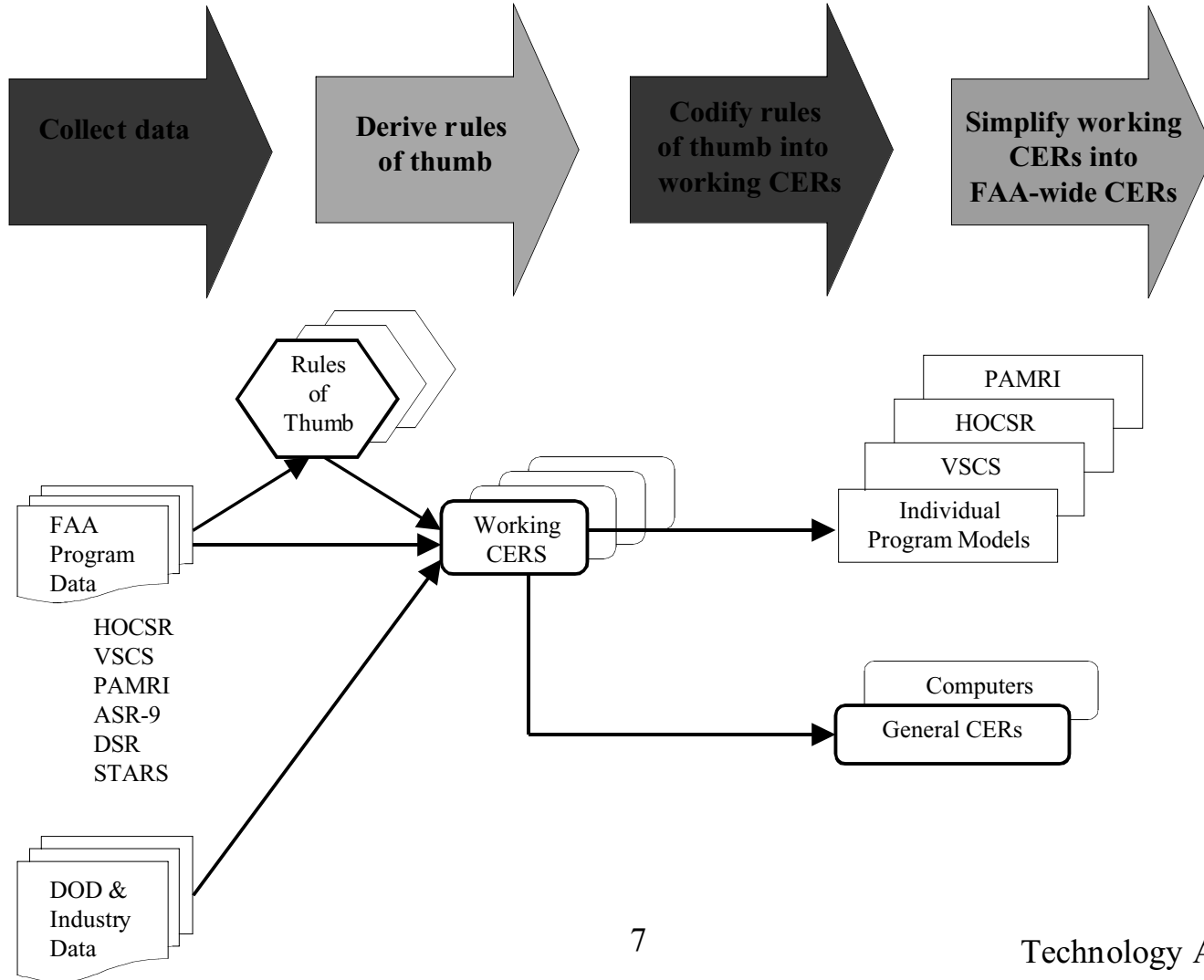
List of Equipment

Computers - mainframes	Hubs	4 port desktop 10 Base T
Computers - Unix		8 port desktop 10 Base T
PC servers -high		10/12 port 10 Base T
PC servers - medium		PCMCIA lan card
PC servers - low		4 port desktop 100Base T
Basic PC		8 port desktop 100Base T
computer peripherals in general		10/12 port 100Base T
computer disk drive		reserved for higher speed
computer head	RAIDs	minimum: RAID 1, 45 GB
computer hard drive		reserved for bigger RAID
computer memory		Level 7, small sz
computer track ball		RAID level 7
Displays summary	Racks	high end - w/ ac
commercial big screen GB		high - w/doors
CRT display, GF		med
LED display		low - metal shelves
LED, alphanum display	UPS	low end - 6 minutes for PC
liquid crystal		30 min for server
20x20 high density	Printer	laser printer/fast dot matrix
Radar	Telecomm	
communications antenna		20x20 PBX
Lans fiber per 10K-ft, <10K ft segments		Ring Generator
IP router	Telecom Test Equip	
Crypto router		Transmission Impairment Meas. Test Set, analog
Mulitprotocol router		Transmission Impairment Meas. Test Set, digital
Voice data router		Signaling Analyzers, analog
8-slot router		Signaling Analyzers, digital
8-slot w/ tunnel switch		Oscilloscope, analog
ethernet router		Oscilloscope, digital
Cisco 13 slot		A/D Converter, 4 wire
KVM; 4 port		Liftcart
KVM; 6 port		

Firmware
   burn new cards
   burn repeat cards
Software
   Sunsoft C++ Workshop
SLOC cost
   ADA
   C
   Jovial
   Fortran
   Cobol

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Equipment Variables

COTS/CAS system
Lifetime (hrs)
Failure rate E6
Initial hardware cost
Initial hardware support cost
Initial bridge hardware sppt cost
Bridge HW sppt cost growth rate
Initial software cost
Initial software support cost
Second software sppt cost
2nd SW sppt growth rate
Program cost %
Time Profile in Years
End of Hardware Market Life
End of Hardware Service Life
End of Hardware Phys Life
End of Software (Op Sys) Market Life
End of Software (Op Sys) Svc life
Unable to mod SW due entropy
SLEP cost
EOL
Probability of failure after EOL

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Model Basics

SW OS
license&
maint.
costs

HW
O&M
costs

SLEP

Refresh
Cost at
each point
in time

Replace HW, SW; rewrite appl.

Replace HW; transport application SW

Replace all, plus
need an
emulation

Time period	0 begin	1 End of Market Life HW	2 End of Service Life HW	4 End of Market Life SW (OS)	5 End of Service Life SW (OS)	n End of Physical Life HW

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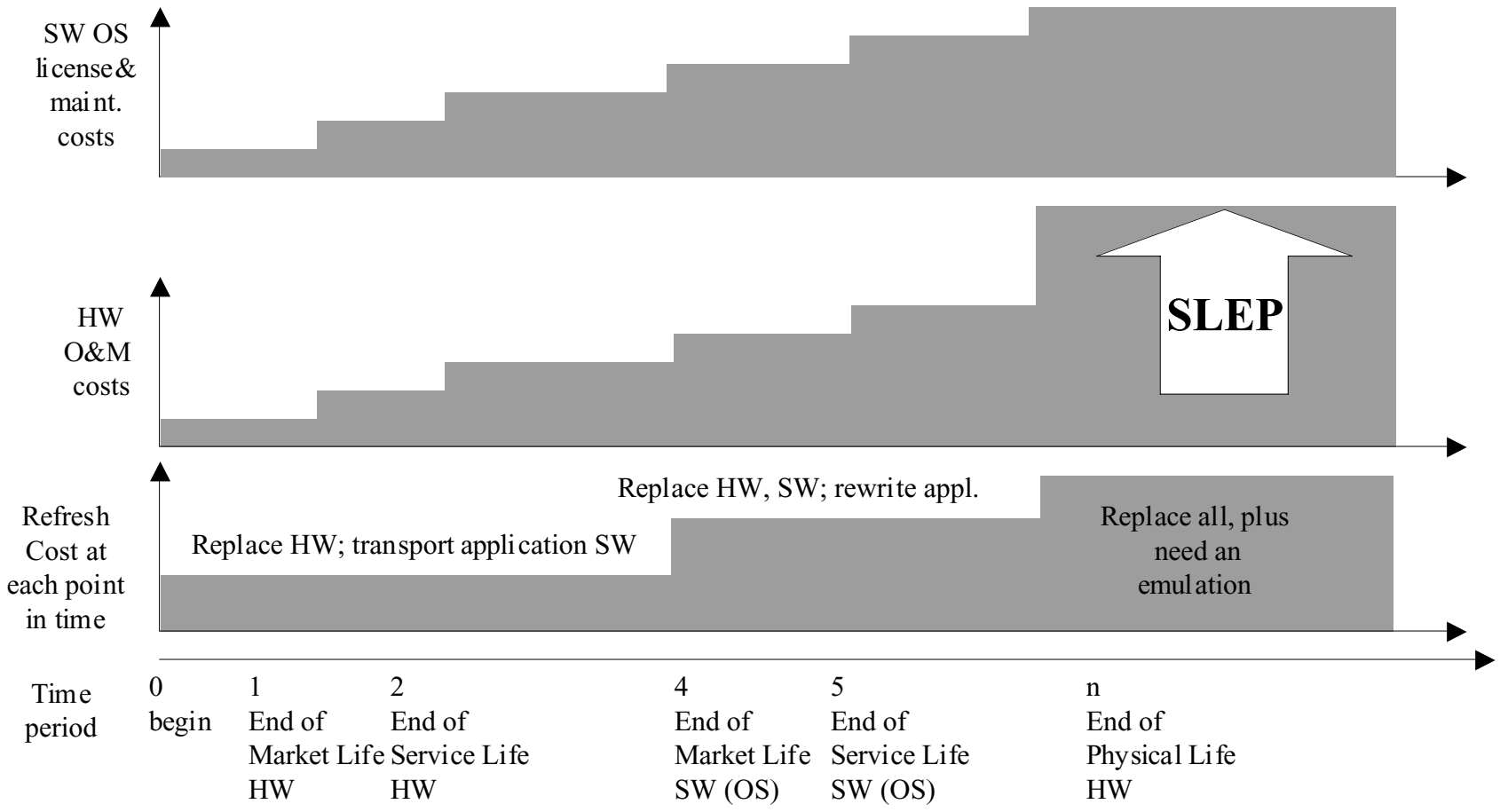
Overall Model Capabilities

¥ Provides a single model and interface to plan and estimate the costs of tech refresh

¥ Supports budget alternatives analysis

¥ Supports FAA-wide tech refresh cost estimating

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COST ESTIMATING USER INTERFACE

Programs

Select Program to Refresh

- ○ VSCS
- ○ HOCSR
- ⦿ PAMRI
- ○ Make inputs now

You MUST press "Calculate Now" AFTER entering all your inputs, to run the model.

[Calculate Now]

First Refresh Cycle

Field Refresh in year (1-10) [6] ▲▼

(See profiles for hints)

Regular Refresh

Refresh every x years:

- ○ 3 years
- ⦿ 5 years
- ○ 7 years
- ○ 10 years

- ○ Never

[Go To Budget GUI]

BUDGET ALTERNATIVES USER INTERFACE

Program being analyzed:

[PAMRI]

Amount F&E needed ($K): [$ 4,092]

[Return to varying TR parameters]

F&E Budget

Tech Refresh F&E Budget profile   All dollars are in Year 2000 constant dollars

- ○ 33%-33%-33%
- ⦿ 10%-20%-40%-30%
- ○ Analyze the budget I've entered below
  [enter your budget below, then check button]

Year	1	2	3	4	5	6	7	8	9	10	TOTAL
$K	$0	$0	$409	$818	$1,637	$1,228	$0	$0	$0	$0	$4,092

No error messages.

Model Budget Capabilities

¥ Allows input of actual funding streams

¥ Compares funding stream to funding requirements and implements schedule slips if funding falls below requirements

¥ Forecasts increased maintenance costs as a result of schedule slips

¥ Forecasts system-wide tech refresh costs over the next 20+ years
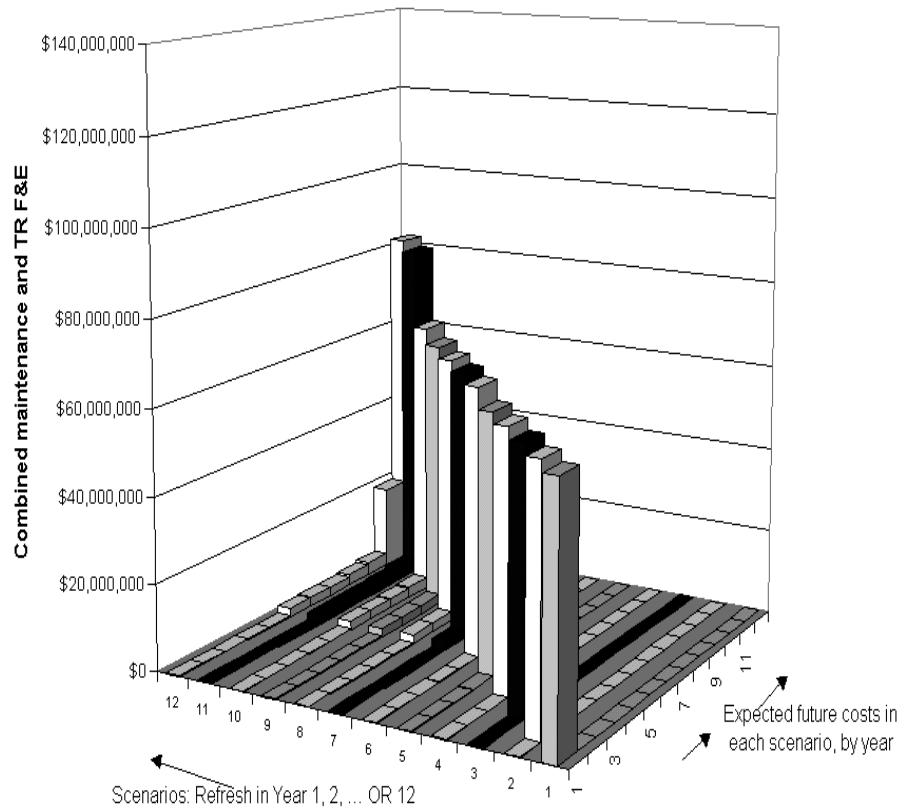
Model Cost Estimating Capabilities

¥ Estimates program cost of tech refresh

— Program costs increase as refresh date is pushed further into the future

¥ Performs default budget estimating for cost estimators unwilling to specify a budget

¥ Estimates maintenance burden of refreshable systems

— O&M increases as systems age

¥ Models systems or subsystems

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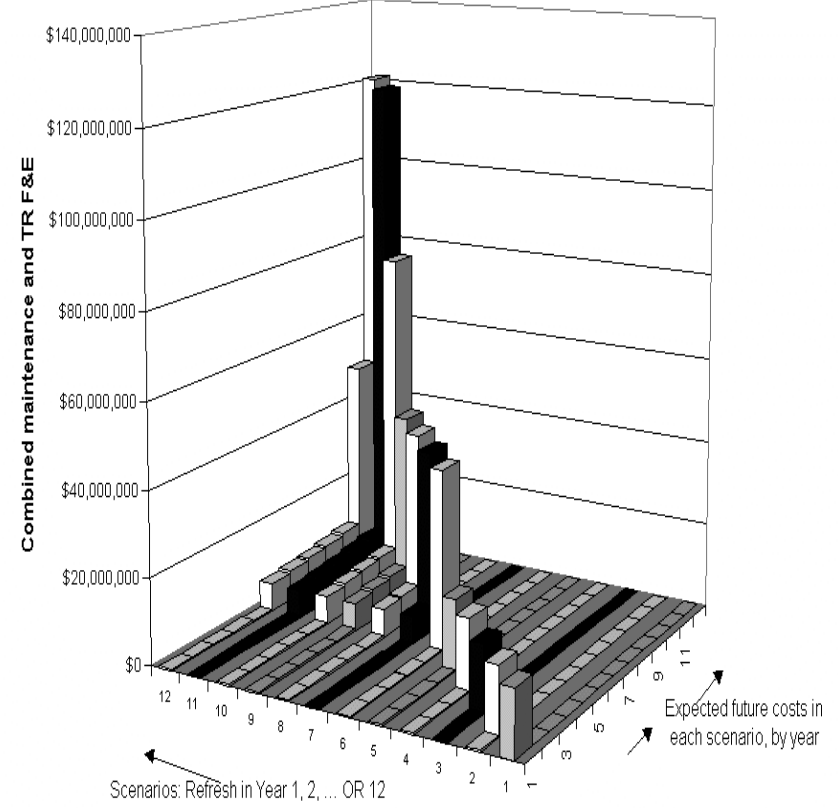
Essential Capabilities of the Model for the FAA

¥ Present inability to forecast tech refresh requirements

   —baseline breaches

   —re-baselining

   —budget alternatives on the move

¥ Model has already shown how one refresh project should be expedited over another due to more quickly rising costs

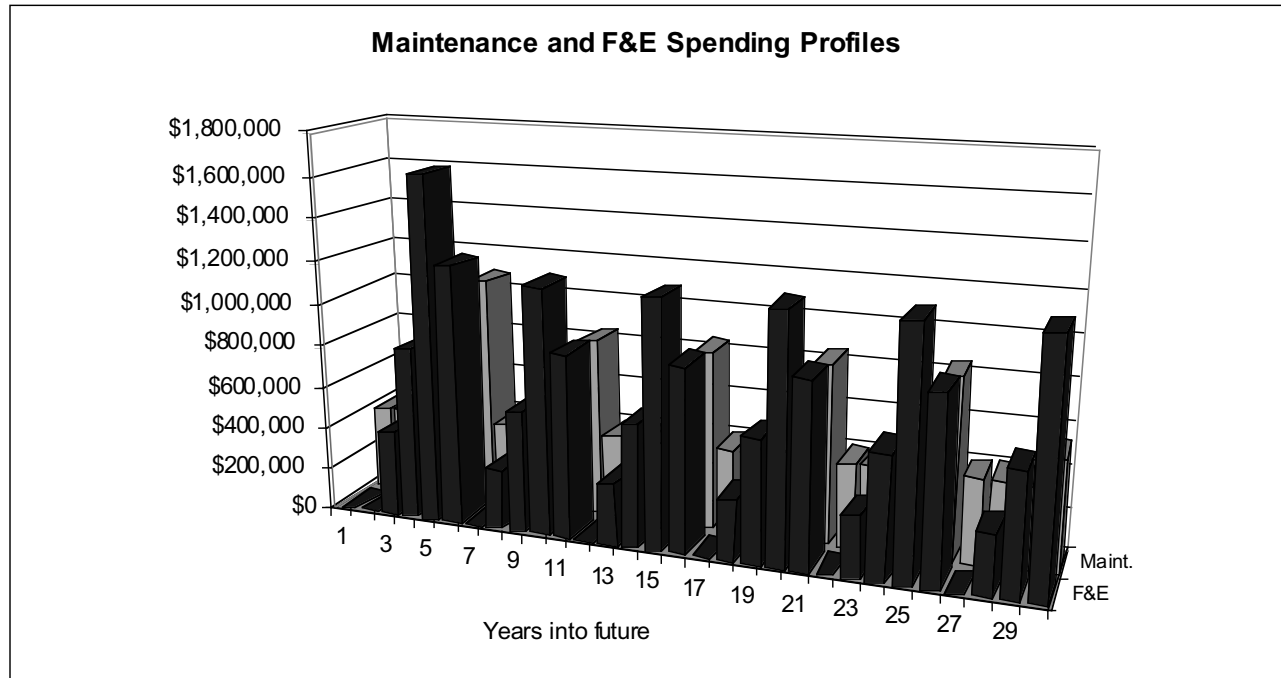# Strategic TR Planning:
Comparisons enabled by Model
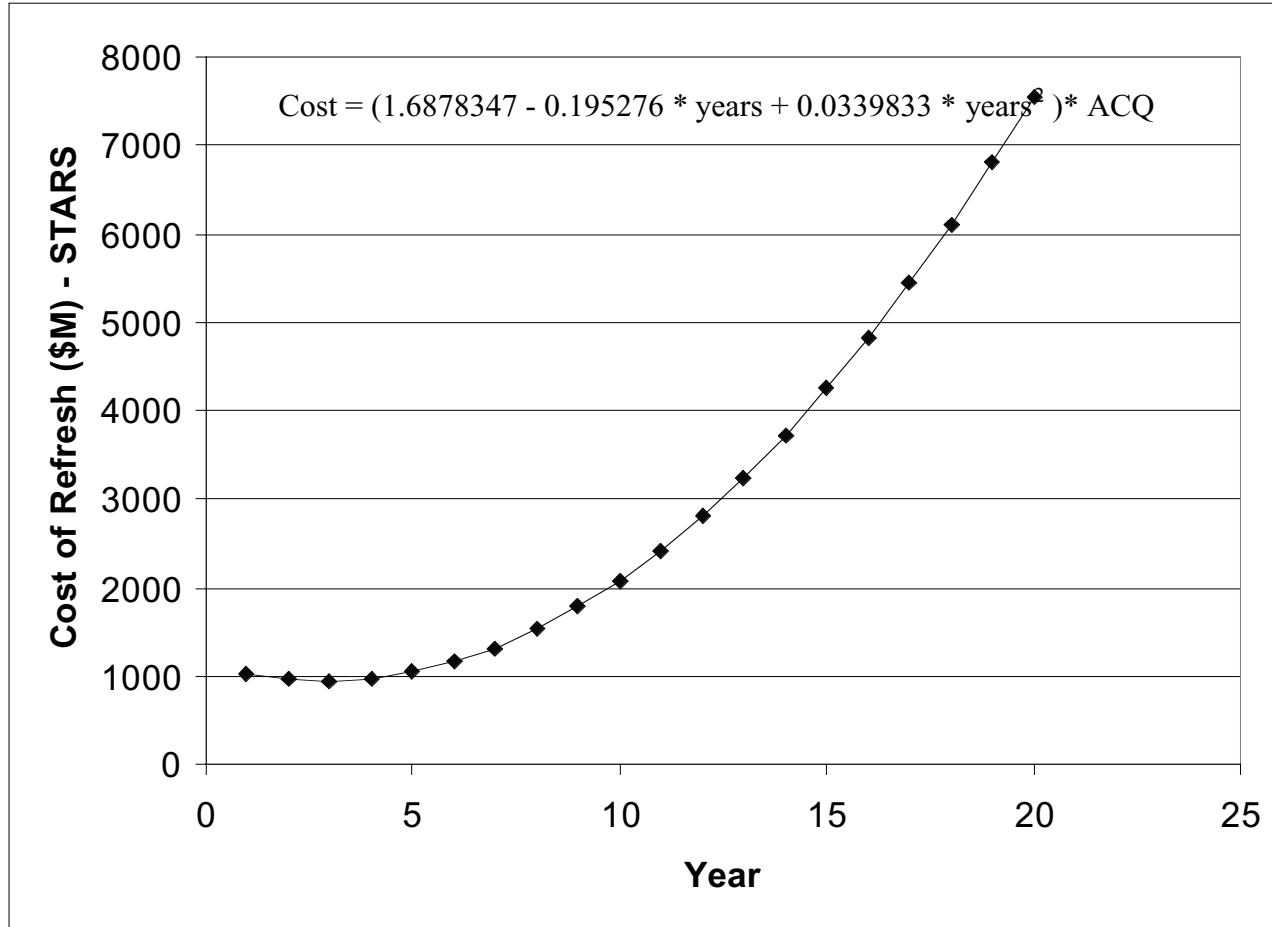
Project A: Refresh costs are fairly constant

Project B: Better to refresh sooner

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Maintenance Burden Forecast

Maintenance and F&E Spending Profiles

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Computing CER Applied

$$Cost = (1.6878347 - 0.195276 * years + 0.0339833 * years^2)* ACQ$$

Note: original acquisition cost of STARS assumed to be $1,327 M.

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FAA CER Areas

Computing - Accomplished in Phase I

Areas to Add

Communications (networks)

Displays

Radar

Communication sensors

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