IDA

Analytical Tools for Affordability Analysis

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IDA | What is "Affordability Analysis"?

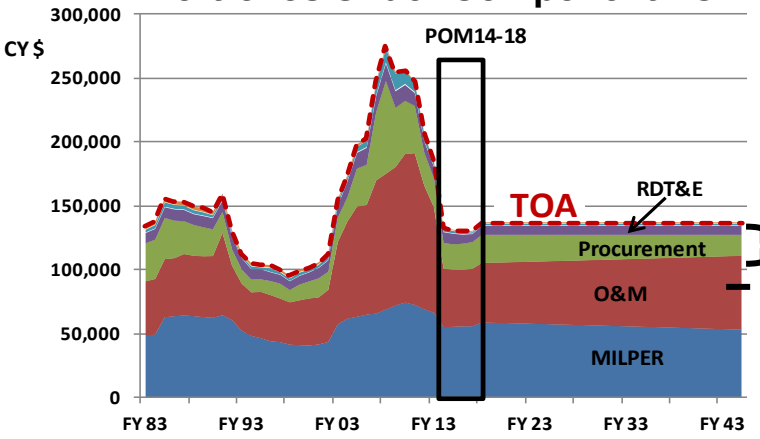
- Starting with 2010's "Better Buying Power" memorandum, OSD has issued policy requiring acquisition programs to present affordability analyses at Milestone reviews
- This requirement is now part of Department of Defense Instruction 5000.02
- The *Defense Acquisition Guidebook (DAG)* was updated in July 2013 to reflect the new requirement and provide guidance

IDA | Affordability Analysis Content

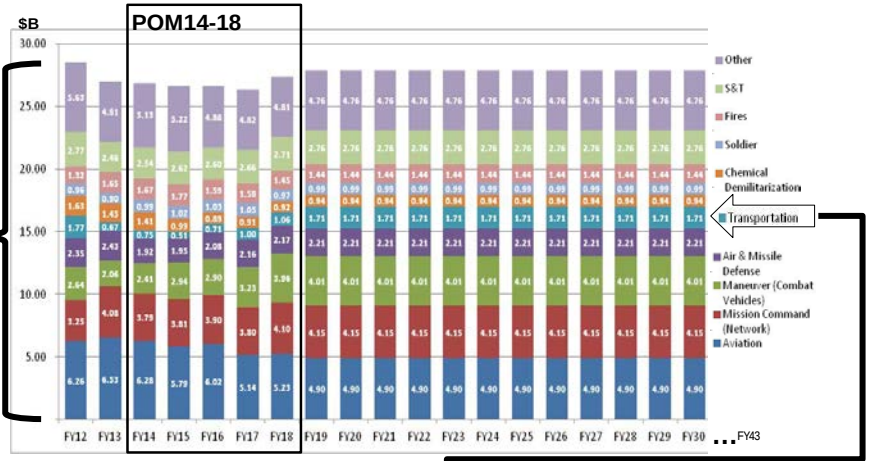
- Affordability Analysis shows each program's planned development and production costs over time, in the context of
  - The cost and schedules of the other programs in the relevant acquisition portfolio
  - The projected available funding over the life cycles of those programs
- This task is assigned to Service leadership
  - Not the program's responsibility
  - Should reflect Service long-term planning

IDA | Recommended Submission Formats (*DAG*)

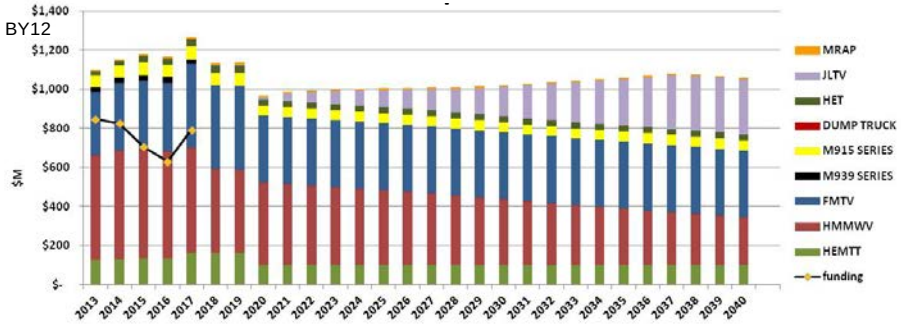
All Portfolios Under Component TOA



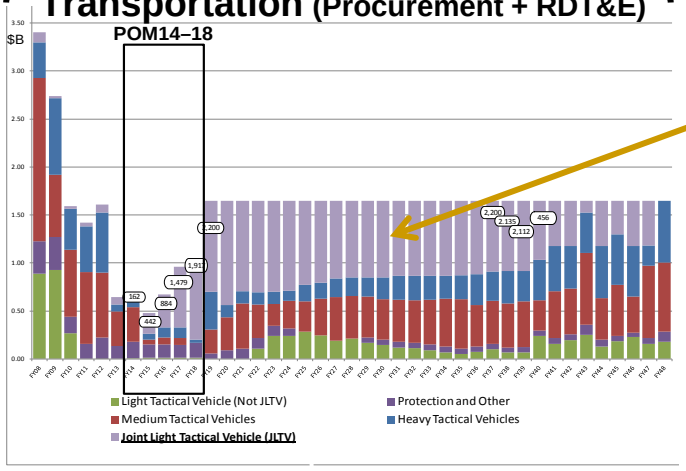
Procurement + RDT&E Portfolios



TWV Portion of O&M



Transportation (Procurement + RDT&E)



New System Total Lifecycle Costs (total reserved profile)

IDA | What Tools do Affordability Analysts Need?

- Reconcile inconsistent submissions
- Predict annual costs for alternative plans
- Estimate the consequences of various possible funding levels
- Assess affordability risk
  - For the portfolio
  - For each program

IDA | Reconciliation of Inconsistencies

- Which programs are in the portfolio?
- How much total funding is available?
- How much of that total will each program get year by year?
- How many units will that buy?

If Service plans or estimates have changed, need to be able to propagate those changes to other portfolios as well

Estimated Cost of Alternative Plans

- If the current plan is

Fiscal Year	2015	2016	2017	2018	2019	2020	2021
Quantity	20	40	50	50	50	50	20
Cost	1502.8	2331.1	2581.0	2403.9	2291.9	2210.7	883.8

...then what would the annual costs be if instead we do

Fiscal Year	2015	2016	2017	2018	2019	2020	2021	2022
Quantity	10	30	40	40	40	40	40	40
Cost	?	?	?	?	?	?	?	?

This is a hard problem.

Why Is It Hard?

- Cost progress (aka “learning curves”)
- Fixed costs at contractor and program levels
- Nonrecurring and non-end-item costs
- Production rate effects and incentives
- Causal ambiguity in historical data
  - Schedule changes cause cost changes
  - Cost changes also cause schedule changes
  - Technical / management issues can cause both

Competing Theories and Models

- Fixed/Variable apportioning (e.g., Balut et al.)
  - Plant capacity varies with workload
  - Program share of fixed costs is proportional to variable costs, some of which have learning
- Cobb-Douglas production function (Womer)
  - Unit cost as a function of learning and rate
- Learning with forgetting (Benkard)
  - Learning depreciates over time
- Discretionary capital investment (Rogerson)

IDA | Estimated Impact of Change in Budget

- If there isn't enough money in the budget to do what we had planned, what happens?
  - Programs stretch – lower production rates
  - If necessary, some may be canceled
- In order to predict the impact of a given schedule, we need a heuristic that can estimate how the portfolio manager would react to the new budget
  - Requires costing ability described above
  - Should also work for unexpected surplus funds

- Affordability is often treated as a yes/no question, but reality is messier
  - Cost estimates are uncertain
  - Program outcomes are uncertain
  - Budgets are uncertain
  - Service priorities change over time
  - New programs start
- The question of interest is not "*Is this program affordable?*", but rather "*What is likely to happen if this is the plan?*"

- Sensitivity analysis
  - Vary one input at a time, see what happens
  - Does not directly answer “What is likely?”
- Monte Carlo estimation
  - Vary all uncertain inputs according to user-specified probability distributions
  - Analyze the distribution of outcomes
  - Requires credible driving distributions for many parameters and program characteristics

IDA | Analyst Support Tool Notional Design

- Organize programs into portfolios
  - Multiple alternative ways to partition the world
- Coordinate across multiple data sources
  - SAR / DAES / PB / POM
  - Individual program affordability analysis submissions
- Perform what-if and sensitivity analyses
  - Alternative schedules
  - Alternative budgets
  - Revised cost estimates
  - New programs

Current Status: Software

- APASS: the Acquisition Portfolio Affordability Support System
  - Web application
  - SQL Server database
  - Migrating to D3 graphics from Google API
- Data from multiple (conflicting) sources, organized by *portfolio sets* for analysis at the portfolio level
- To date, MDAP and pre-MDAP data only

IDA | A Portfolio Set

Acquisition Portfolio Analysis Support System

Home / Army / Equipment

Dollars

- Then-Year Dollars
- Base Year: 2013

Show

- By Budget Category
- Equipment Portfolio Set
- Affordability Portfolio Set

Categories

- RDT&E
- Procurement
- O&M
- MILCON

Years to Show

Start Year:
Earliest: 1995
End year:
Latest: 2034

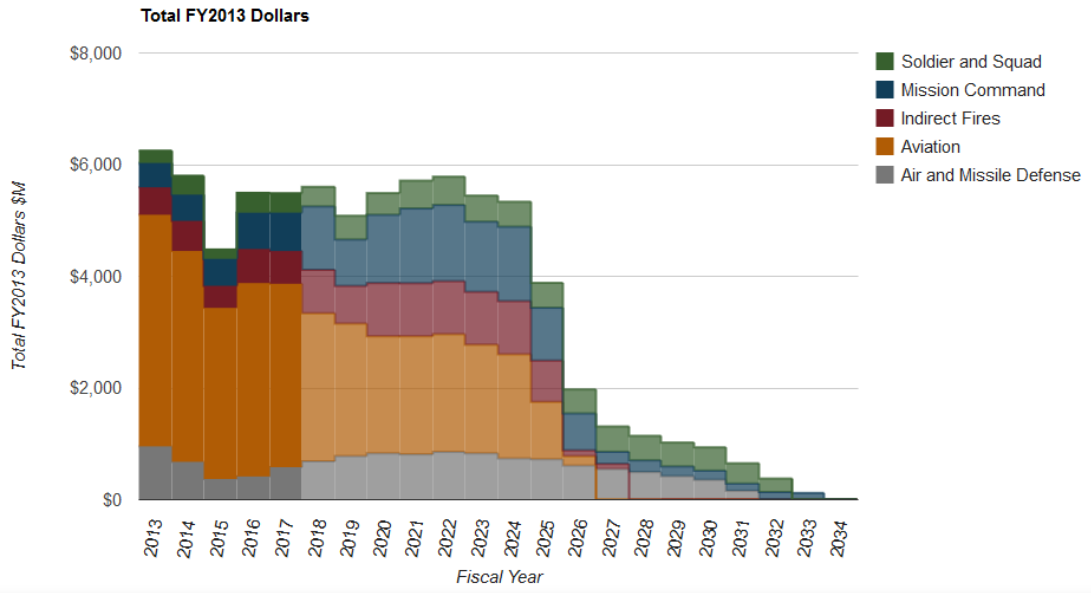
Max Dollars:

Show Actuals

Source: SAR: 2013-12-25

Service: Army
Portfolio Set: Equipment
Source: SAR: 2013-12-25

Chart Type ▾ Data ▾ Workspace: Projections ▾ Reload



IDA | A Portfolio with Budget

Acquisition Portfolio Analysis Support System

Dollars

- ○ Then-Year Dollars
- ◉ Base Year: 2013

Show

- ○ By Budget Category
- ◉ Equipment Portfolio Set
- ○ Affordability Portfolio Set

Categories

- ☐ RDT&E
- ☑ Procurement
- ☐ O&M
- ☐ MILCON

Years to Show

Start Year:
Earliest: 1995
End year:
Latest: 2026

Max Dollars:

☐ Show Actuals

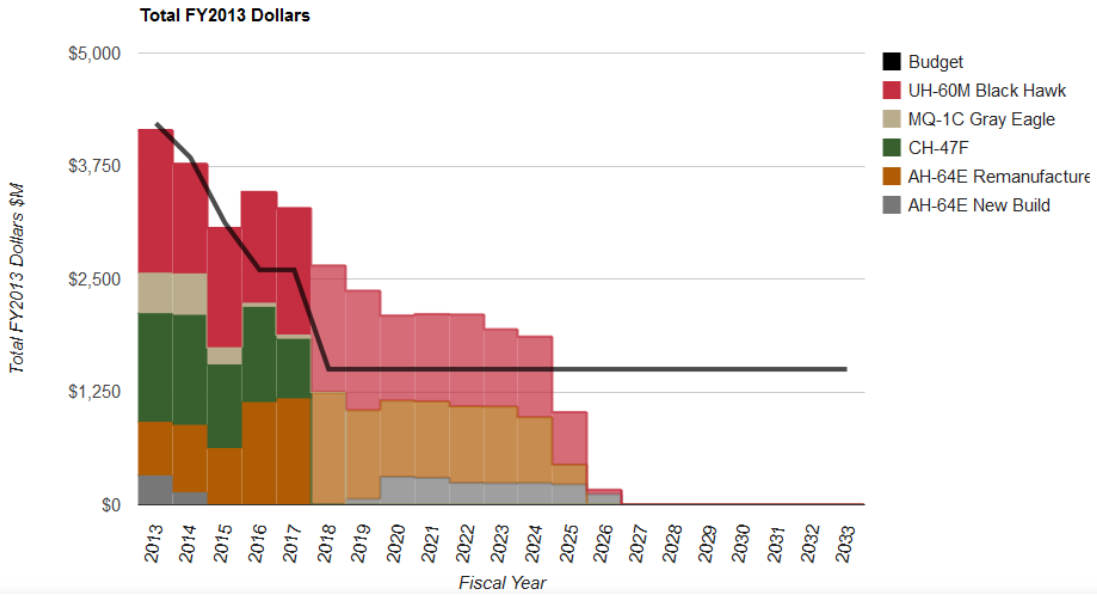
Include

- ☑ Budget
- ☐ Fit to budget

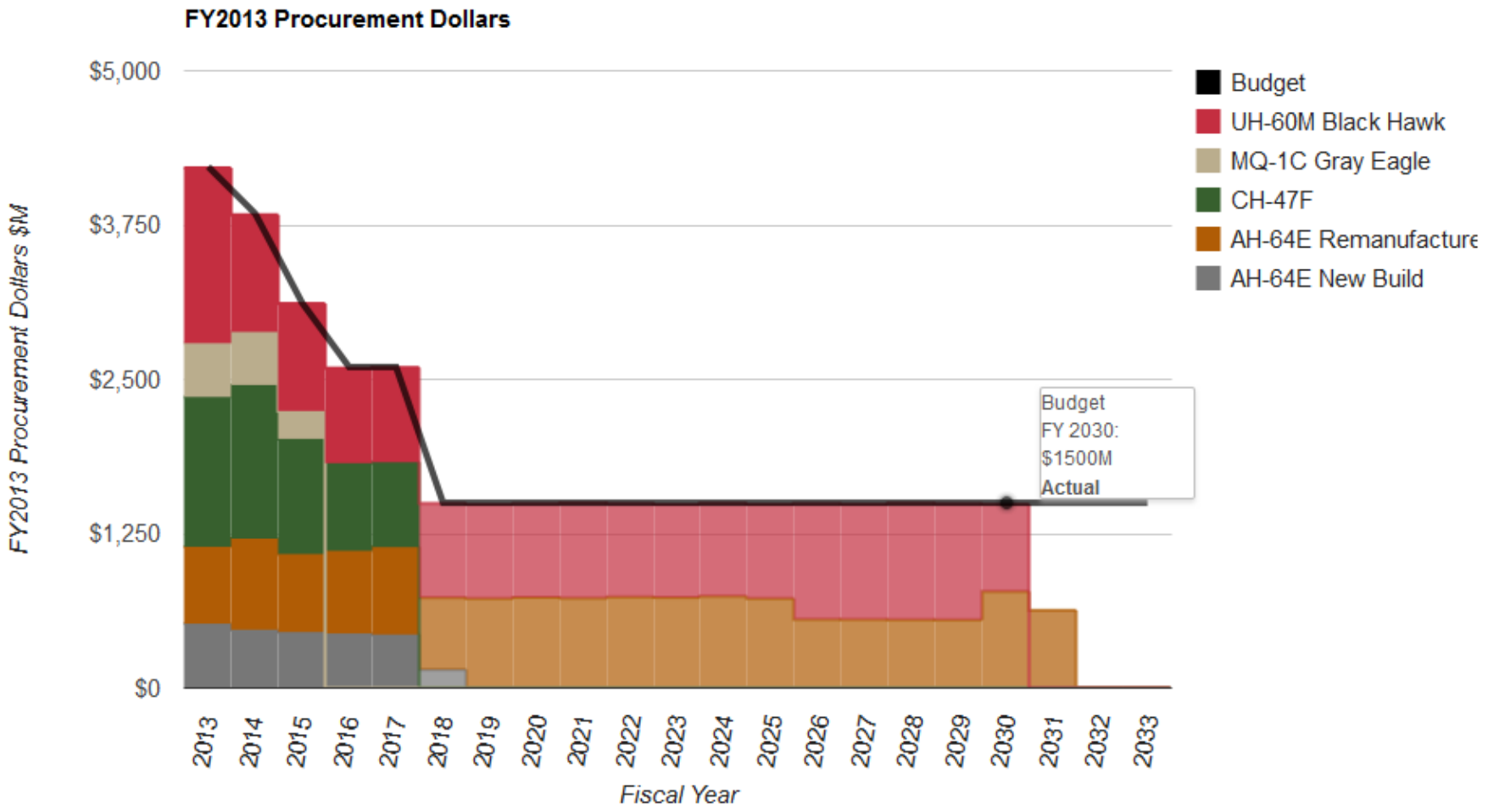
Source: SAR: 2013-12-25

Service: Army
Portfolio Set: Equipment
Portfolio: Aviation
Source: SAR: 2013-12-25

Chart Type ▾ Data ▾ Workspace: Projections ▾ Reload



IDA | Results of Fitting to Budget



IDA | Summary

- We are developing software tools to support Affordability Analysis (and oversight of Affordability Analysis)
- The current focus is on near-term ability to view and compare disparate data sources and alternative scenarios
  - Spot discrepancies
  - Produce reconciled views
  - Provide “what if?” assessment of alternatives
- Secondary focus on estimating the impact on portfolios of alternative budgets

IDA

BACKUP

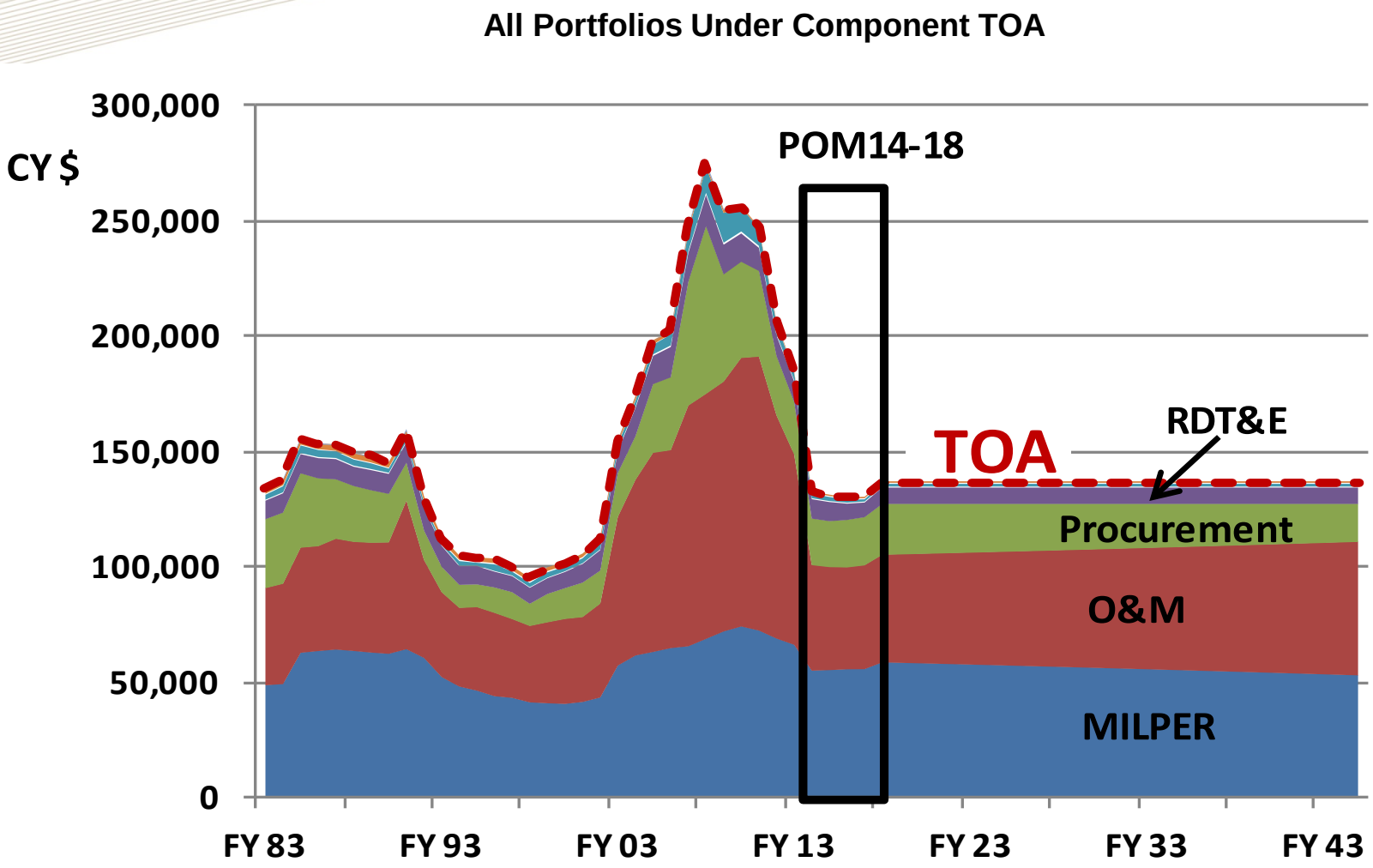
What is "Affordability"?

- Since the late 1990s, the military services have all spent large sums of money on programs that did not deliver their intended military capability
- Many of these programs spent billions and delivered nothing at all

"The purpose of Affordability Analysis is to avoid starting or continuing programs that cannot be produced and supported within reasonable expectations for future budgets."

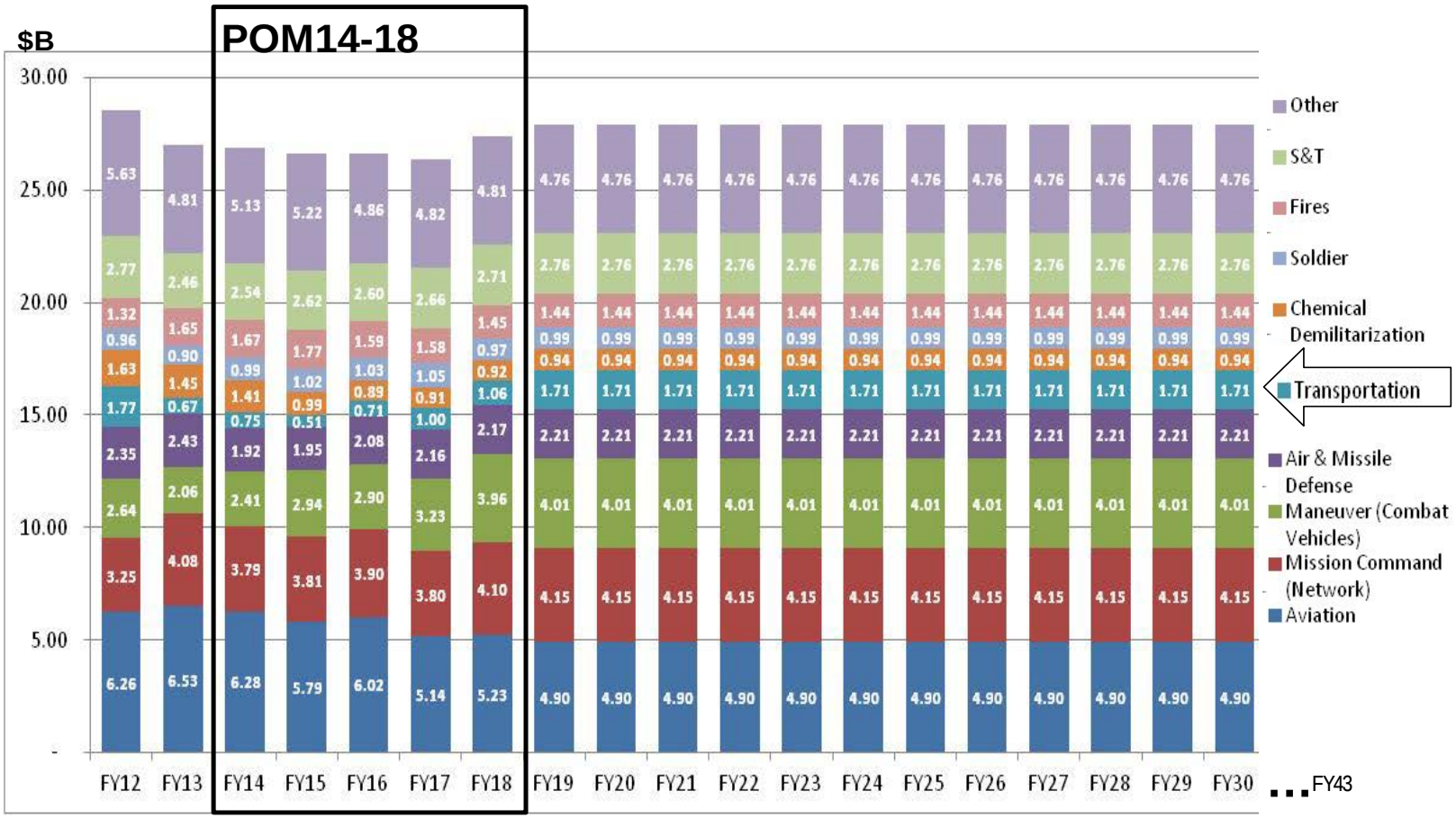
DoDI 5000.02, Enclosure 8,
"Affordability Analysis and Investment Constraints" (2015)

IDA | DAG Format 1 – TOA Top Line & Color of Money

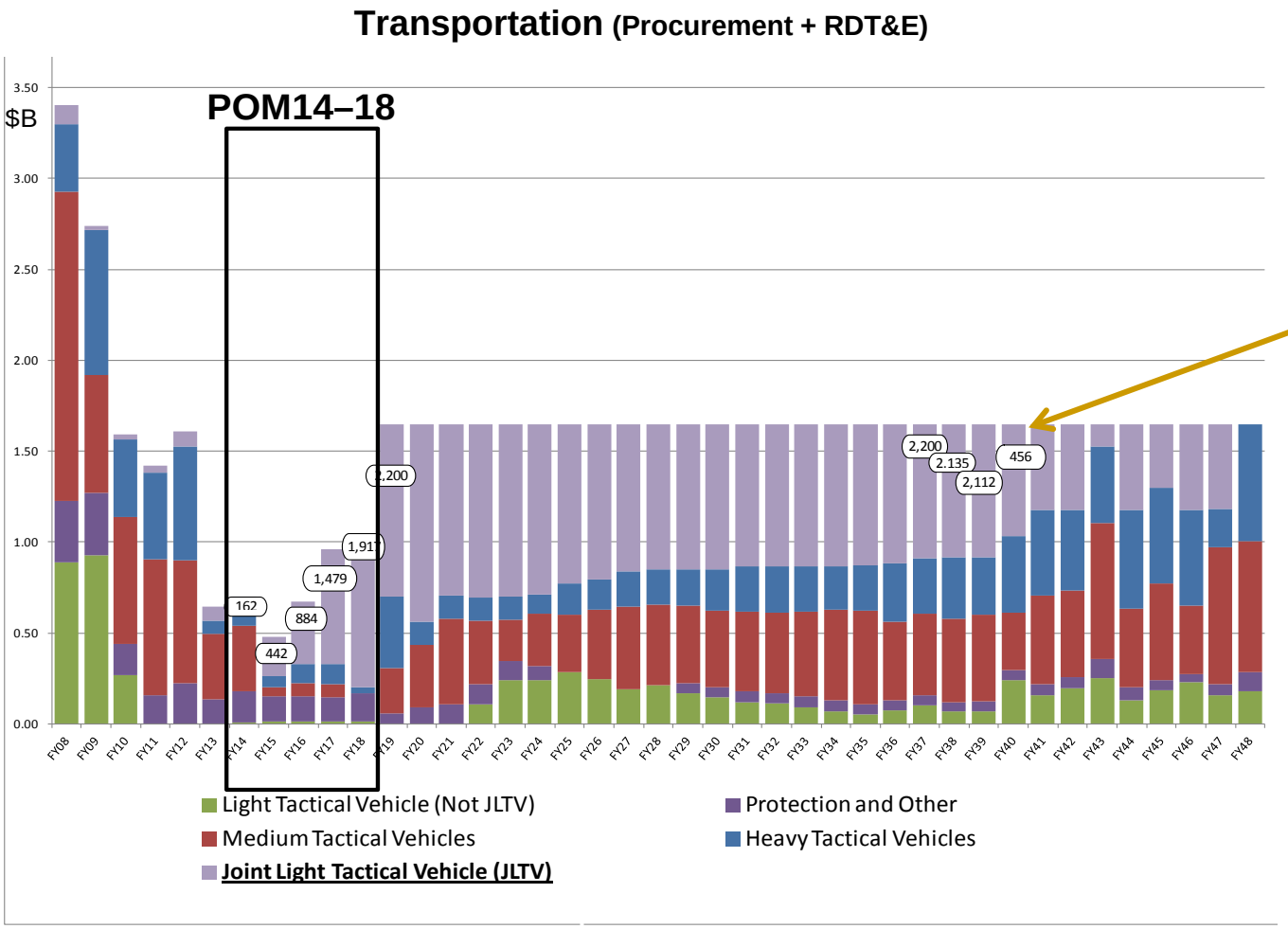


IDA | DAG Format 2 – Service Portfolios

Procurement + RDT&E Portfolios



IDA | DAG Format 4 – Portfolio Detail



New System Total Lifecycle Costs (total reserved profile)

$C_n \equiv$ average unit cost in year n

$L_n \equiv$ production quantity in year n

$T_1 \equiv$ theoretical first unit cost

$\beta \equiv$ learning rate parameter

$\delta \equiv$ annual forgetting rate

$\gamma \equiv$ production rate parameter

$$C_n = T_1 L_n^{\gamma} \left(\sum_{k=1}^{n} L_k \delta^{n-k} \right)^{\beta}$$