Linking COMPASS Sustainment Cost Estimates with ACEIT

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Purpose

To familiarize the Cost Analysis community on how lifecycle sustainment costs generated by the Computerized Optimization Model for Predicting and Analyzing Support Structures (COMPASS) can be integrated with the Automated Cost Estimator (ACE) to provide more refined cost estimates in the area of Operations and Support (O&S) costs.

Agenda

- COMPASS Overview
- COMPASS Capabilities
- Analyses Using COMPASS
- COMPASS Applications
- COMPASS Inputs, Outputs, and Methodology
- Bridging the Gap

Computerized Optimization Model for Predicting and Analyzing Support Structures

Software is free and can be obtained from Logistics Support Activity (LOGSA) at https://www.logsa.army.mil/lec/compass/

COMPASS Overview

- Army-approved model as recommended in Army Regulation (AR) 700-127 Integrated Logistics Support
- COMPASS integrates a multitude of user-defined inputs to determine an optimal, least-cost, sustainment policy while estimating costs in 16 cost categories
- COMPASS optimizes to reach a target operational availability (Ao), defined as the percent of time a system is operational (uptime ÷ total time)
- COMPASS can also evaluate costs for a given maintenance policy

COMPASS Capabilities

- Was initially developed in the 1980s to determine maintenance policy and estimate initial sparing
- Model support structures, optimize and evaluate costs associated with varying sustainment Courses of Action (COA)
- Adapted for use in Analyses of Alternatives (AoAs), Business Case Analyses (BCAs), and as a general sustainment cost estimating tool
- Evaluate should-cost considerations and sensitivities

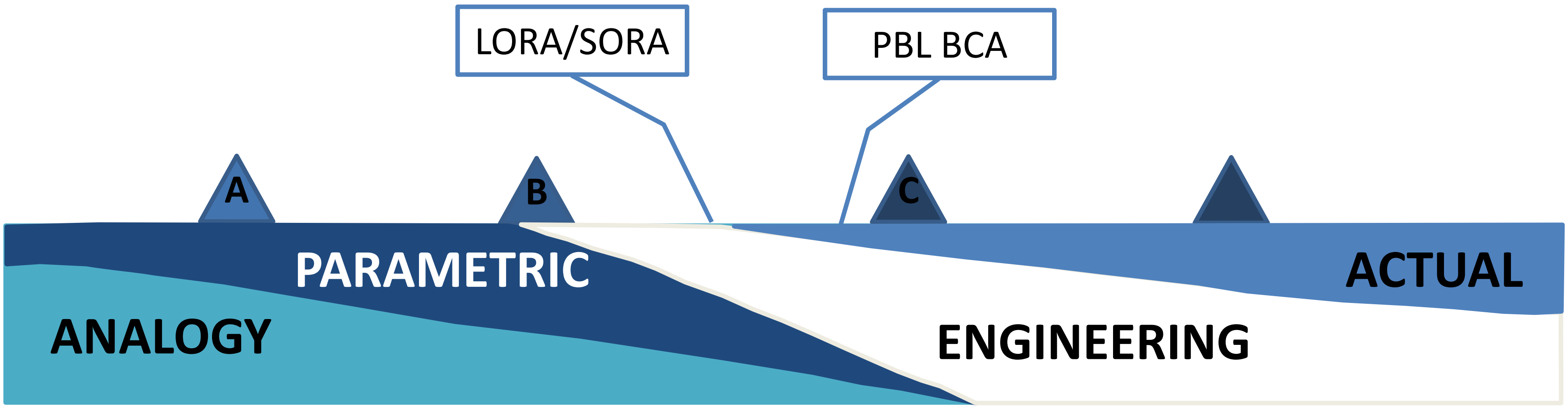
Analyses Using COMPASS

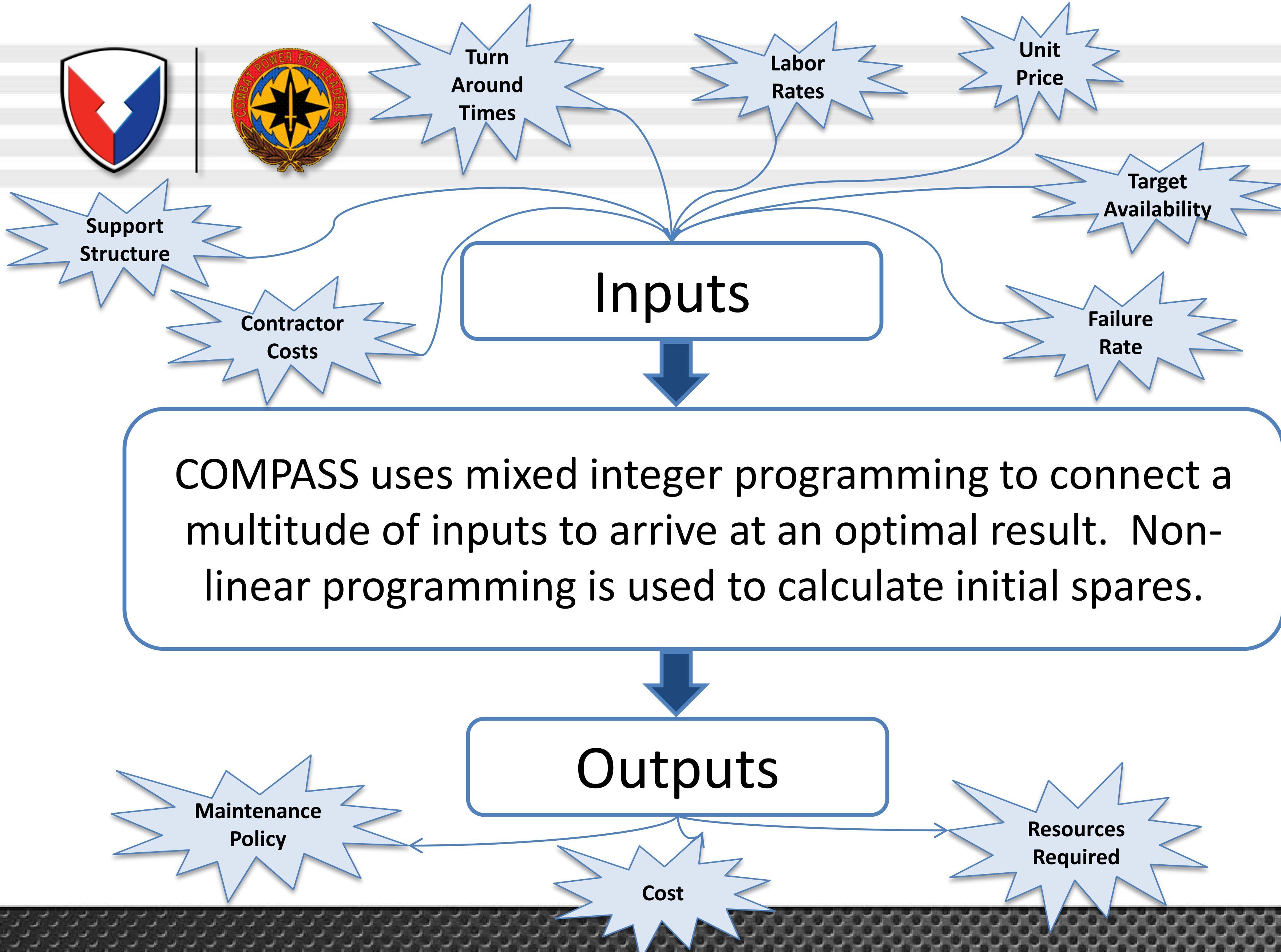
- Sparing and availability analyses
- Field repair feasibility assessments
- Level of Repair Analysis (LORA) – COMPASS is used to determine the optimal level of repair – field, intermediate, depot
- Source of Repair Analysis (SORA) – COMPASS is used to determine the optimal source of repair – organic, contractor, toss
- LORA and SORA are precursors to Core Depot Assessment (CDA) and Core Logistics Analysis (CLA)
- Performance Based Lifecycle Product Support (PBL) Business Case Analysis (BCA)

COMPASS outputs can feed into other analyses as necessary such as Break-even Analyses (BEAs) or Life Cycle Cost Estimates (LCCE)

COMPASS Applications

- COMPASS analyses are initially done with engineering estimates before Milestone C so proper planning can take place
- Analyses must be revisited periodically or with programmatic changes – this refines the estimate by incorporating actual system-specific performance data





Turn Around Times
Labor Rates
Unit Price
Target Availability
Support Structure
Contractor Costs
Failure Rate
Inputs
COMPASS uses mixed integer programming to connect a multitude of inputs to arrive at an optimal result. Non-linear programming is used to calculate initial spares.
Outputs
Maintenance Policy
Cost
Resources Required

COMPASS Inputs

- COMPASS inputs are used to develop a bottom-up cost estimate based on the target Ao
- COMPASS provides a system specific cost model based on engineering estimates rather than parametric/analogous estimates
- Data is typically available from system engineers, program office, original equipment manufacturer, or organic depot
- COMPASS uses defaults based on historical data for some inputs, however all inputs can be changed as needed

COMPASS Inputs

- COMPASS inputs can be divided into two broad categories

System-level inputs

- System inputs
  - System density
  - Annual operating hours (OpTempo)
  - System life
- Support structure inputs
  - Levels of maintenance (2-level, 4-level)
  - Source of maintenance (organic vs. contractor)
- Support equipment and specialized repairmen required

Component-level inputs

- General component-level inputs
  - Line replaceable units (LRUs)
  - Shop replaceable units (SRUs)
- Repairable inputs
  - Mean time between failure (MTBF)
  - Mean time to repair (MTTR)
- Contractor component-level inputs
  - Cost
  - Turnaround time

COMPASS Outputs

- COMPASS determines an optimal maintenance policy based on the inputs and target Ao. The maintenance policy specifies the most economical level of repair (field, intermediate, depot) and source of repair (organic, contractor, or toss), as well as sparing levels for each part.

- Maintenance policy costs – broken down into 16 categories

COMPASS Cost Output Summary

System Life :	20 Years
Density (# of systems) :	250
Total Maintenance Policy :	$30,360,136
Availability Achieved :	89.99%

Price of the optimal maintenance policy is over the 20-year life and are in **Net Present Value (NPV)**

Target Ao automatically met or exceeded

COMPASS Outputs

Peculiar Support Equipment	$0
Common Support Equipment	$107,211
Peculiar Repairmen	$0
Common Repairmen	$0
Initial Spares	$4,220,901
Consumption Spares	$12,918,040
Holding Cost	$4,144,444
Transportation Cost	$406,835
Requisition Cost	$76,263
Cataloging Cost	$54,816
Bin Cost	$26,413
Common Labor Cost	$5,416,365
Screening Cost	$0
Documentation Cost	$0
Test Program Set Cost	$0
Contact Team Cost	$0
Contract Repair Cost	$2,654,115
Contractor Fixed Cost	$334,734
Total Maintenance Policy Cost	**$30,360,136**

These outputs can serve as the basis for sustainment costs within a program Life Cycle Cost Estimates (LCCE) developed in ACEIT.

Detailed descriptions of each cost category can be found in the back-up slides

Deriving Annual Costs

	Year						
	Initial Costs	1	2	3	4	5	...
Initial/Additional Support Equipment	$79,995	$0	$0	$0	$0	$0	...
Annual Support Equipment Maintenance	$0	$2,030	$2,030	$2,030	$2,030	$2,030	...
Annual Repairmen	$0	$0	$0	$0	$0	$0	...
Initial/Additional Spares	$4,220,901	$0	$0	$0	$0	$0	...
Annual Consumption Spares	$0	$963,533	$963,533	$963,533	$963,533	$963,533	...
Annual Holding	$0	$309,126	$309,126	$309,126	$309,126	$309,126	...
Annual Transportation	$0	$30,345	$30,345	$30,345	$30,345	$30,345	...
Annual Requisition	$0	$5,688	$5,688	$5,688	$5,688	$5,688	...
Initial Cataloging	$8,213	$0	$0	$0	$0	$0	...
Annual Catalog Maintenance	$0	$3,476	$3,476	$3,476	$3,476	$3,476	...
Initial/Additional Bin Set-up	$8,383	$0	$0	$0	$0	$0	...
Annual Bin Maintenance	$0	$1,345	$1,345	$1,345	$1,345	$1,345	...
Annual Common Labor	$0	$403,997	$403,997	$403,997	$403,997	$403,997	...
Annual Screening	$0	$0	$0	$0	$0	$0	...
Initial Documentation	$0	$0	$0	$0	$0	$0	...
Initial Test Program Set	$0	$0	$0	$0	$0	$0	...
Annual Test Program Set Maintenance	$0	$0	$0	$0	$0	$0	...
Annual Contact Team	$0	$0	$0	$0	$0	$0	...
Annual Contractor Repair	$0	$197,966	$197,966	$197,966	$197,966	$197,966	...
Initial Contractor Set-up	$334,734	$0	$0	$0	$0	$0	...

- COMPASS Inputs and Outputs can be exported to spreadsheets.
- From these spreadsheets, it is possible to derive the annual costs in each category. This example is in base year dollars.
- During this process, it is possible to phase together multiple COMPASS runs to reflect changes over time.

Analysis Extensions

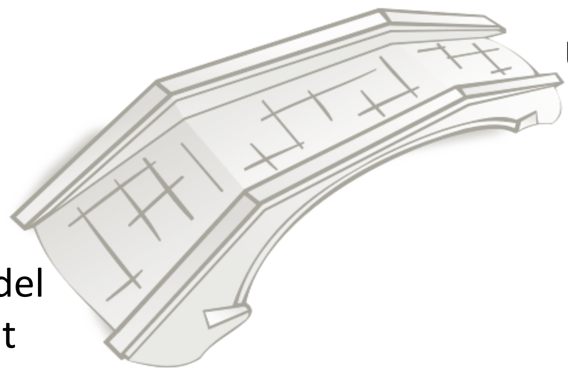
- Sustainment Cost Estimates using COMPASS
  - Each course of action is modeled to determine the optimal maintenance policy as well as the total cost of each
  - Attributes which frequently vary between alternatives include turnaround time and component reliability
- Phasing Analysis
  - Several COMPASS runs can be phased together using spreadsheet analysis to account for the fielding schedule, reliability improvements, and changes to other inputs over time
  - This methodology integrates the COMPASS outputs for each time period and can apply real discounting rates to place all costs in present value or can be left as annual amounts for incorporation and inflation within ACE
- Sensitivity Analysis
  - Sensitivities assess the impact of fluctuating inputs such as labor rates, turnaround times, and reliability

Summary

- COMPASS uses many system/component-level inputs to arrive at a best value maintenance policy with associated costs
- COMPASS outputs are broken into 16 cost categories which can feed into other programs such as ACEIT

Systems Analysis

Uses system-specific inputs to model and evaluate various sustainment courses of action in COMPASS



Cost Analysis

Uses COMPASS cost estimates to help evaluate and validate sustainment courses of action and strengthen estimates of sustainment costs

COMPASS is a valuable tool that allows Systems and Cost Analysis to jointly execute more refined sustainment cost estimates

QUESTIONS?

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COMPASS is free and can be obtained from LOGSA at
https://www.logsa.army.mil/lec/compass/

Back-up Slides

COMPASS Cost Categories

- **Support Equipment** is the equipment necessary to test and repair the components of the system. Since some support equipment is common equipment, the costs reflect only the time the equipment is used for the specific system. Since all contractor costs are rolled up into one contractor repair cost, there is no separate cost for support equipment in all-contractor alternatives.

- **Specialized Repairmen** are repairmen with a specific skill set required for repair.

- **Initial Spares** costs are the costs for any spares required to initially fill the sustainment pipeline. These spares include line replaceable units (LRUs), shop replaceable units (SRUs), and piece parts required to repair the SRUs. Depot turnaround time (TAT) and mean time between failure (MTBF) are major factors when determining the quantity of initial spares required. Therefore, alternatives with lower TATs and higher MTBFs require less initial spares.

COMPASS Cost Categories (cont'd)

- **Consumption Spares** are those components that are used to replace failed components that are not repaired. This includes the piece parts to repair higher level assemblies, assemblies determined to be beyond economic repair (washouts), and assemblies designated as throw-away items. Systems with higher MTBFs have fewer failures and therefore lower requirements for consumption spares than those with lower MTBFs. Since the cost for consumption spares is included in the contractor cost to repair, there is no separate cost for consumption spares in all-contractor alternatives.

- **Holding Costs** are those costs associated with holding inventory. These costs include items such as physical storage space, loss of parts due to damage during storage, or loss of parts due to obsolescence and are estimated within COMPASS at 6% of the inventory value per year. Therefore, differences in holding costs will be proportional to the difference in initial spares costs.

COMPASS Cost Categories (cont'd)

- **Common Labor Costs** represent all repair labor costs. Highly reliable systems have fewer failures and therefore lower labor requirements than systems with low MTBFs. Since common labor is the only repair labor utilized at the organic depot, this number is much higher for organic alternatives than for contractor alternatives. Common labor also applies to labor conducted at the field level which includes on-system remove and replacement of parts.

- **Screening Costs** are the costs associated with screening and diagnosing an item for failure before it is evacuated further in the supply chain. These costs include the required support equipment and labor associated with screening.

- **Test Program Set Costs** represent the cost for the government to purchase the software or data necessary to diagnose the cause of a failure to the next lower level assembly. If the contractor already owns this data, the all-contractor alternative has no test program set costs.

COMPASS Cost Categories (cont'd)

- **Contact Team Costs** are costs to have a team come to the location of the end item from a more rearward location.

- **Contractor Costs** include the *fixed contractor costs* and *contractor repair costs*. *Fixed contractor costs* represent any initial costs the contractor may incur and pass on to the government. *Contractor repair cost* is an all-inclusive cost that represents the average cost per part for the contractor to perform a repair. It includes the loaded labor costs (to include labor, administrative costs, overhead, and profit), consumption parts costs, and transportation costs. All-organic alternatives will have no contractor costs.

- **Other Costs** include **transportation costs, requisition costs, cataloging costs, bin costs, and documentation costs**. These are administrative costs which consider the coordination of transportation and receiving parts from the depot, the cost to set up national stock numbers, the cost of maintaining inventory, and the cost to purchase technical manuals.

Glossary

- **Ao** – Operational Availability. The percentage of time a system is operational. Uptime/Total Time.
- **AWCF** – Army Working Capital Fund.
- **BCA** – Business Case Analysis.
- **BEA** – Break-even Analysis.
- **CDA** – Core Depot Assessment.
- **CLA** – Core Logistics Analysis.
- **COMPASS** – Computerized Optimization Model for Predicting and Analyzing Support Structures
- **LCCE** – Life Cycle Cost Estimate
- **LOGSA** – Logistics Support Activity.
- **LORA** – Level of Repair Analysis.
- **LRU** – Line Replaceable Unit. A part which is one indenture below an end item.
- **MTBF** – Mean Time Between Failures. The average number of hours a system/part is operational until it fails.
- **MTTR** – Mean Time to Repair. The average number of hours it takes to fix a system/part.
- **OpTempo** – Annual operating hours.
- **PBL** – Performance Based Lifecycle Product Support.
- **SORA** – Source of Repair Analysis.
- **SRU** – Shop Replaceable Unit. A part which is one indenture below a LRU, two below an end item.