Capabilities-Based Cost Estimating:
Capabilities Knowledge Base (CKB) Analysis Tools and Applications

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2009 ISPA / SCEA Professional Development and Training Workshop

Agenda

What is Capabilities-Based Cost Estimating?

Pre-Milestone-A and Capability-Based Cost Estimating

Capability-Based Cost Estimating

❖ *We Can Use the Capabilities of Current Systems and Their Associated Costs to Provide Cost Estimates For Capability-Gap-Filling Solutions*

Pre-Milestone-A Cost Estimating

❖ *Analysis That Uses Information Known Prior to Milestone A to Create a Cost Estimate*

❖ *Theoretical Worst Case Scenario: Capabilities Only*

❖ *If We Know More, We Can Improve Fidelity*

❖ *A Risk-Informed Estimate That Provides a Likely Cost Range*

Pre-Milestone-A Cost Analysis is Needed to Better Inform Early Investment Decisions

Past Successes:

Joint Effects Targeting System (JETS) Milestone-A AoA Cost Analysis

JETS Milestone-A AoA

❖ **JETS Provides a Hand-held Ability to Identify, Locate, and Transmit Targeting Data using Two Subsystems:**

- Target Location/Designation System (TLDS)
- Target Effects Coordination System (TECS)

TLDS

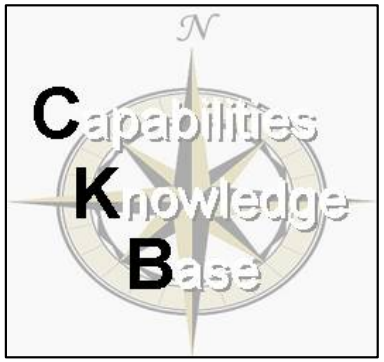
TECS

❖ **ODASA-CE Served as Cost Analysis Lead**

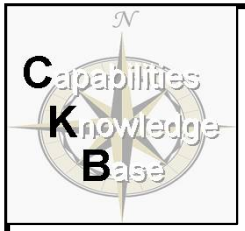
❖ **Cost Analysis Approach:**

- *TLDS:* Leveraged analytical relationships within the data set to link capability and cost; Developed Cost Estimating Relationships (CERs)
- *TECS:* Identified software developments with analogous capability and mission set to develop costs estimates for each alternative

Capabilities Knowledge Base (CKB) Overview



CKB Overview



Data Warehouse

Includes:

1. Relational Database of Systems and Capability Maps
2. Capabilities-Based Dictionary and Architecture
3. Performance Specification Archive

Data Archive

Adobe PDF Archive of:

1. Selected Acquisition Reports
2. Defense Acquisition Executive Summary Reports
3. DoD Budget Exhibits
4. Authoritative reference documents

Analysis Tools

Includes:

1. Analogous Systems Calculator
2. Capability Gap Calculator
3. Cost per Capability Calculator
4. Inflation Index Tables

CKB Data Warehouse Overview

Data Warehouse

❖ **The CKB Data Warehouse currently contains data for over 200 existing Department of Defense (DoD) military systems.**

Specification	CKB
ACAT Levels Included	I, II, III
Services Included	Army, Air Force, Navy, DoD
Systems Included	229
Data Fields per System	90
JIAT (Data Standards) Compatible	Yes
Automated Downloading	Yes

CKB Data Warehouse: Data Types

Data Warehouse

- **There are four types of data included:**

Capability	Cost / Budgetary	Programmatic	Technical Attributes
System Capability Architecture (SCA)	RDT&E	Acquisition Category (ACAT)	Crew Size
Functional Capability Areas (FCA)	Procurement	Lead Organization	Horsepower
Joint Capability Areas (JCA)	MILCON	Milestone Dates	Maximum Speed
	O&M	MILHDBK881A System Type	Range
	Unit Costs (APUC & PAUC)	Service	Rate of Climb
	.....	.....	.....

CKB Data Warehouse: System Capability Architecture (SCA)

Data Warehouse

- A Robust, Balanced Capability Analysis Architecture Has Been Created
  - The System Capabilities Architecture (SCA) Must Be Specific, Distinguishable, Well-Defined, and Analysis-Ready to Enable Parametric and Boolean Logic Analysis
  - Qty 74 Capability Descriptors Available Per System
  - Capability Architecture Mapped to Recognized DoD Capability Structures

**** JCA = Joint Capability Areas** *** FCB = Functional Capabilities Boards***

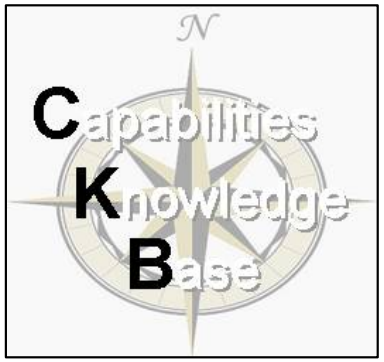
Capability	Definition	Example(s)
1. Maneuver – Environment	An entity that maneuvers via the ground, water, or air.	Vehicles; ships; and aircraft.
1.1 Ground	An entity that maneuvers on the ground.	Ground vehicles and tanks (ex: Joint Light Tactical Vehicle -- JLTV).
1.2 Maritime	An entity that maneuvers on the surface of the water.	Ships (ex: DDG 51).
1.3 Submerged	An entity that maneuvers below the surface of the water.	Submarines (ex: SSN-774 Virginia NSSN).
1.4 Air	An entity that maneuvers within the air of the Earth's atmosphere.	Aircraft; helicopters; and unmanned aerial vehicles (UAVs). Ex: C-130J Hercules.
1.5 Space	An entity that maneuvers beyond the air of the Earth's atmosphere (i.e. space).	Shuttles; rockets; and other spacecraft (ex: Titan IV, Expendable Launch Vehicle -- ELV).
2. Control	An entity of any type that is controlled.	Ground vehicles; ships; UAVs; and UGVs.
2.1 Manned	An entity of any type that is manned or controlled by a person within the entity.	Any manned water, ground, or air vehicle (ex: Stryker).
2.2 Unmanned	An entity of any type that is not controlled by a person within the entity.	Unmanned aerial vehicles (UAVs) or any unmanned ground or water entity (ex: VTUAV -- Fire Scout).

CKB Data Archive Overview

Data Archive

- **The CKB Data Archive currently contains data over 1300 authoritative cost / budgetary reports.**
- **Reports are stored in Adobe PDF Format.**
- **Archive Consists of:**
  - Selected Acquisition Reports (SAR)
  - Defense Acquisition Executive Summary Reports (DAES)
  - DoD Budget Exhibits
  - Authoritative reference documents
- **Benefits:**
  - Allows users to reference authoritative source documents and additional system-related information.

CKB Analysis Tools and Applications



CKB Analysis Tools Overview

Analysis Tools

- **The CKB Data Analysis Tools are divided into two major components:**
  - Data Navigation:
    - Allows the user to efficiently search for and locate information within the Data Warehouse and Data Archive.
    - There are currently two means of searching the data available:
      - Keyword Search
      - Data Filtering
  - Analytical Tools:
    - Perform a specific analysis algorithm based on the user's input.
    - There are currently three analytical tools available:
      - Analogous Systems Calculator
      - Capability Gap Calculator
      - Cost per Capability Calculator

CKB Analytical Tools

Analogous Systems

Utilizes Jaccard Indexing. Measure the distance from a new capability set to existing already acquired capability sets; use these distances to identify analogies and estimate costs.

Capability Gap Calculator

Easily identify capability gaps across portfolios; evaluate how a new capability set will mitigate those gaps

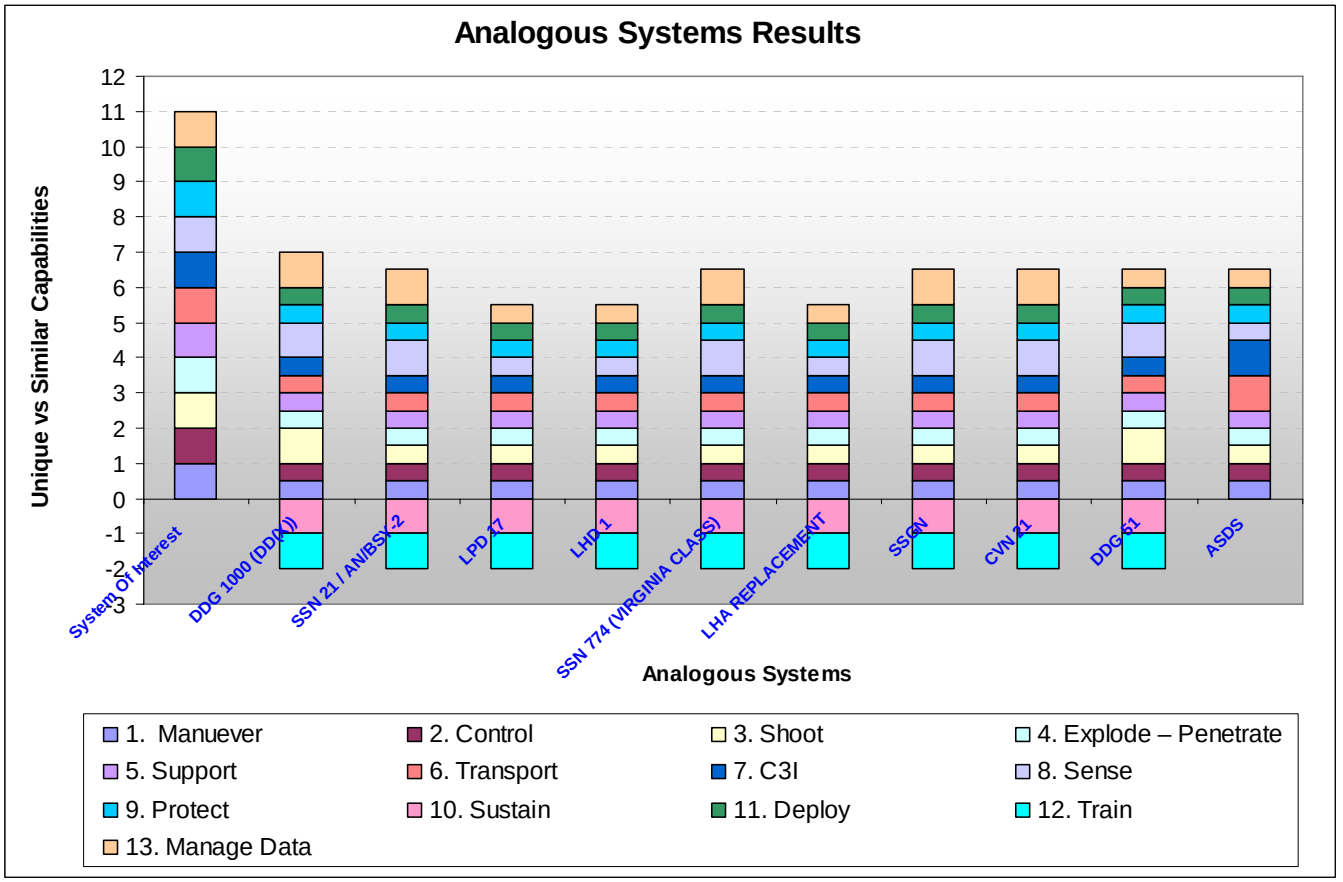
Cost Per Capability Calculator

Solves a multiplicative system of equations to calculate a cost per capability across entire defense portfolio or smaller sub-portfolios

Potential Future Tools

Automated Data Export to Parametric Tools for Cost Estimating Relationship (CER) Development
Cost Risk Analysis Aids
Others

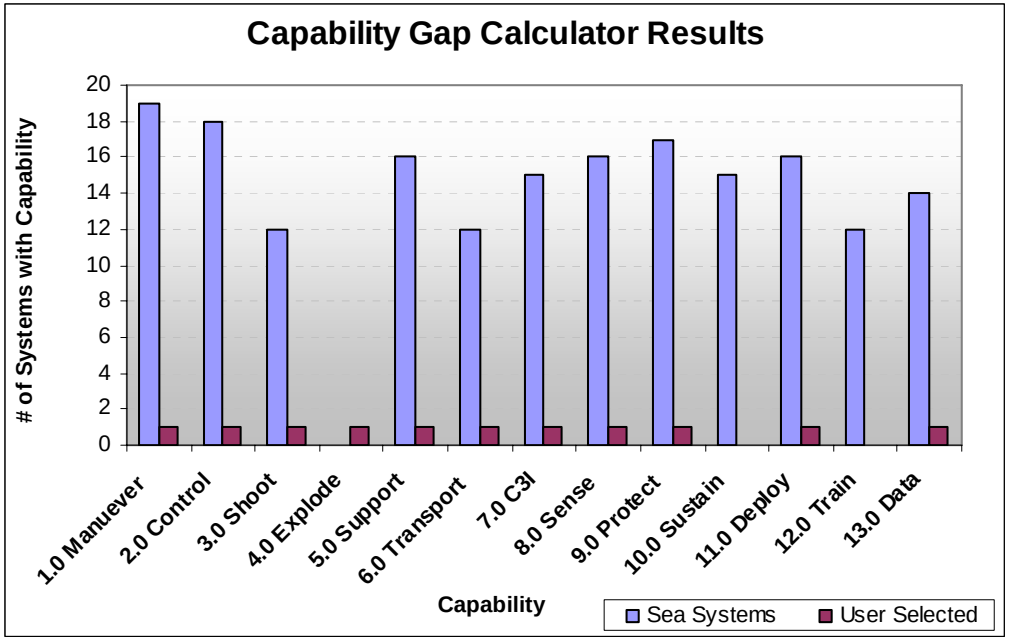
CKB Analytical Tools: Analogous Systems



Analogous Systems Tool Sample Results

- Analogous Systems:
  - *Methodology:*
    - Utilizes the Jaccard indexing and weighting method.
  - *User Inputs:*
    - Capability Set;
    - System Type; and
    - Degree of Similarity.
  - *Output:*
    - Stacked bar charts listing analogous systems.
    - Each bar represents a specific capability.
  - *Benefits:*
    - Identification of analogous systems for statistical analysis, etc.

CKB Analytical Tools: Capability Gap Calculator



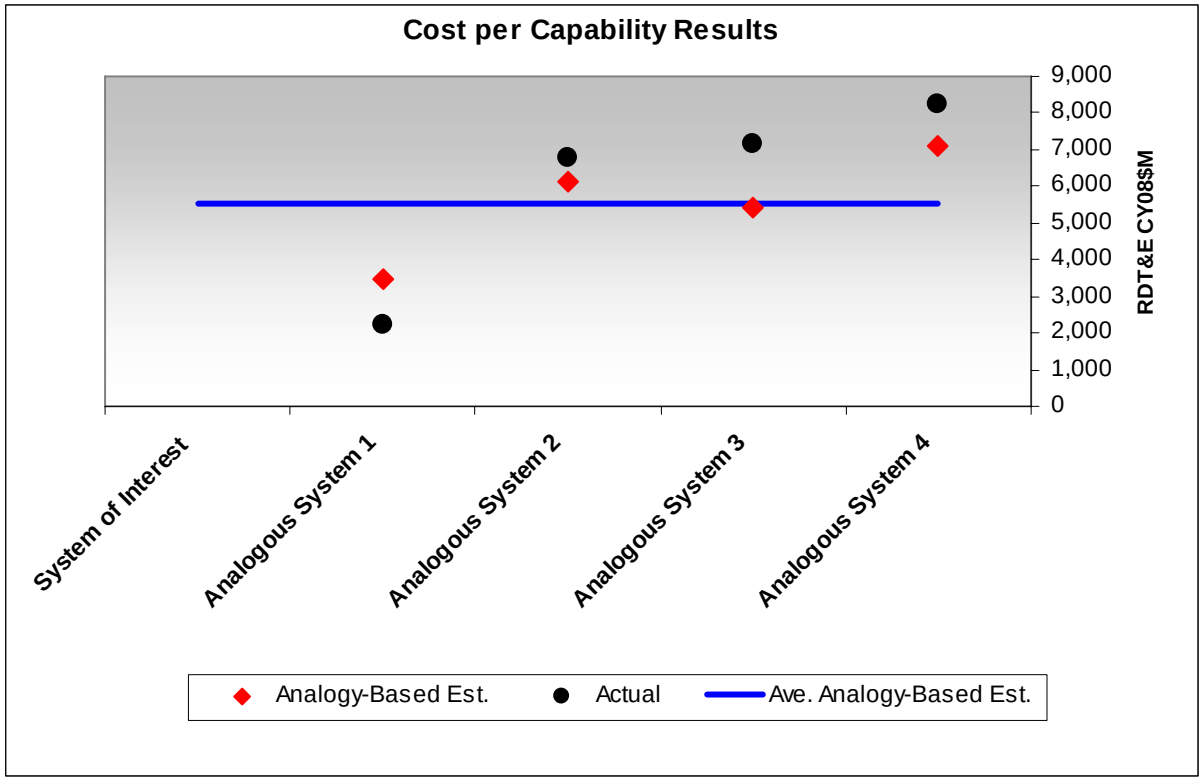
System Type:	Sea
SCA Level(s):	1

Capability	Sea Systems	User Selected	% of Systems
1.0 Manuever	19	1	95%
2.0 Control	18	1	90%
3.0 Shoot	12	1	60%
4.0 Explode	0	1	0%
5.0 Support	16	1	80%
6.0 Transport	12	1	60%
7.0 C3I	15	1	75%
8.0 Sense	16	1	80%
9.0 Protect	17	1	85%
10.0 Sustain	15	0	75%
11.0 Deploy	16	1	80%
12.0 Train	12	0	60%
13.0 Data	14	1	70%
Total Systems	20		

Capability Gap Calculator Tool Sample Results

- Capability Gap Calculator:
  - *Methodology:*
    - Comparison of the capabilities of the current system inventory to those specified.
  - *User Inputs:*
    - Capability Set; and
    - System Type.
  - *Output:*
    - Series of clustered columns.
    - Columns indicate if capabilities are currently possessed and / or if they would be mitigated.
  - *Benefits:*
    - Easily identifies capability gaps across portfolios.
    - Evaluates how a new capability set will mitigate those gaps.

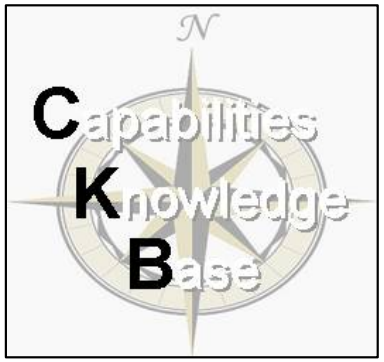
CKB Analytical Tools: Cost per Capability Calculator



Cost per Capability Calculator Tool Sample Results

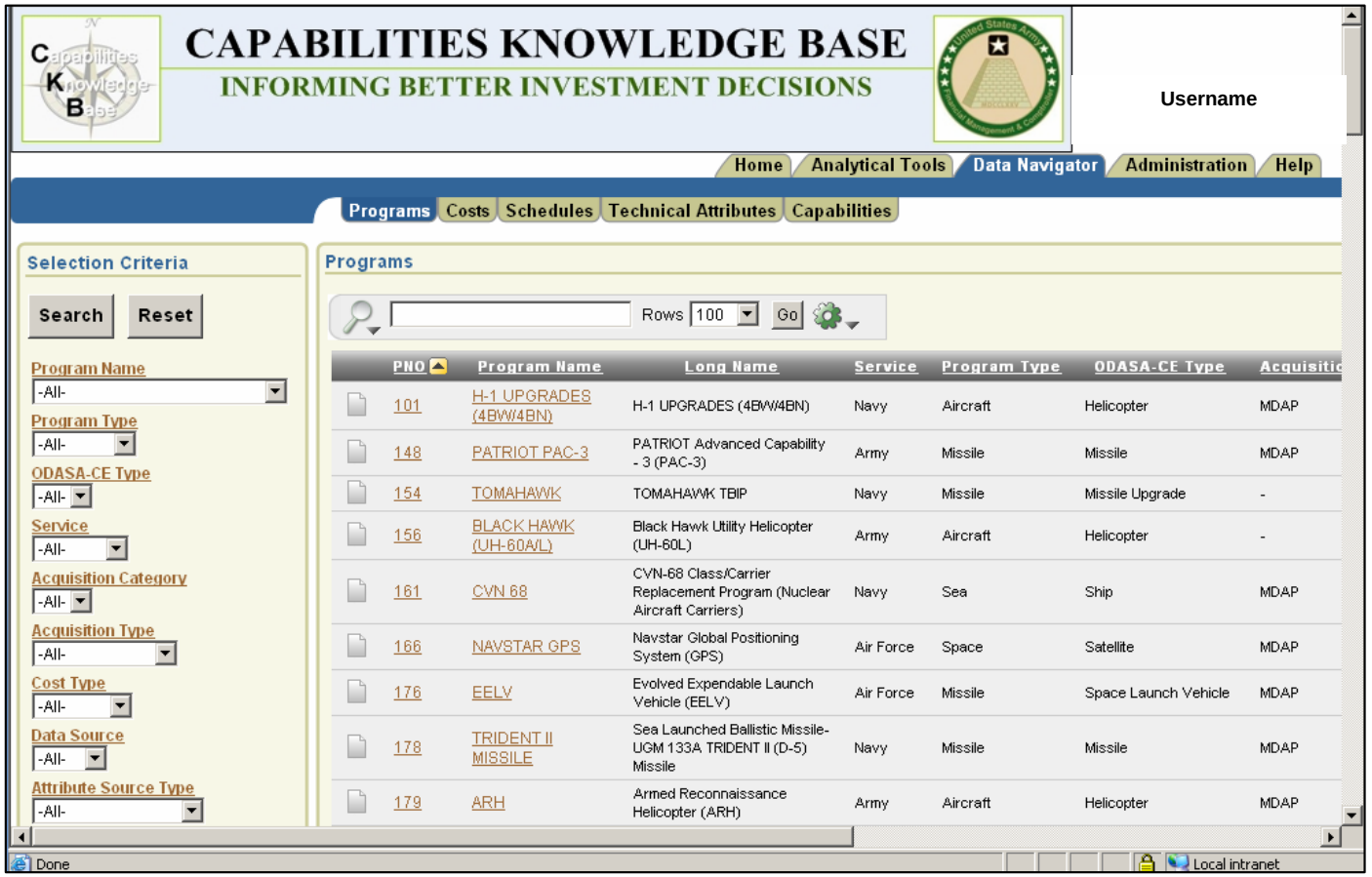
- Cost per Capability Calculator:
  - *Methodology:*
    - A multiplicative system of equations is solved to calculate a cost per capability.
  - *User Input:*
    - Capability Set.
  - *Output:*
    - Series of data points and a single solid line.
    - Data points represent actual and analogy-based estimates for analogous systems.
    - Solid line represents the average of the analogy-based estimates. This average is the estimated cost of the system of interest.
  - *Benefits:*
    - Provides a cost estimate at a system level and / or a capability level.

Next Steps



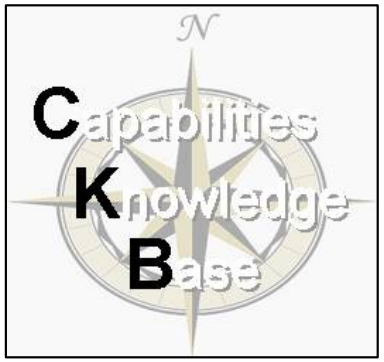
Next Steps: The CKB Web Portal

- CKB Web Portal under Development
- Initial Launch Planned for Summer 2009



The CKB Web Portal

Summary



Summary

- Pre-Milestone-A Cost Estimating and Capability-Based Cost Estimating, Although Related, are Distinct Concepts
- JETS Milestone-A AoA Capability and Performance-Based Cost Analysis Successfully Completed
- The Capabilities Knowledge Base Provides Data Visualization, and Tools to Aid Pre-Milestone-A and Capability-Based Cost Analysis
- The CKB Web Portal is scheduled to be released in Summer 2009

Questions or Comments?

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Back-up

JETS Milestone-A AoA: Cost Analysis Overview

ODASA Cost & Economics

- **Limited System Definition and Lack of Design Maturity Typical of Pre-Milestone-A Systems Necessitated Capability-Based Cost Estimating**

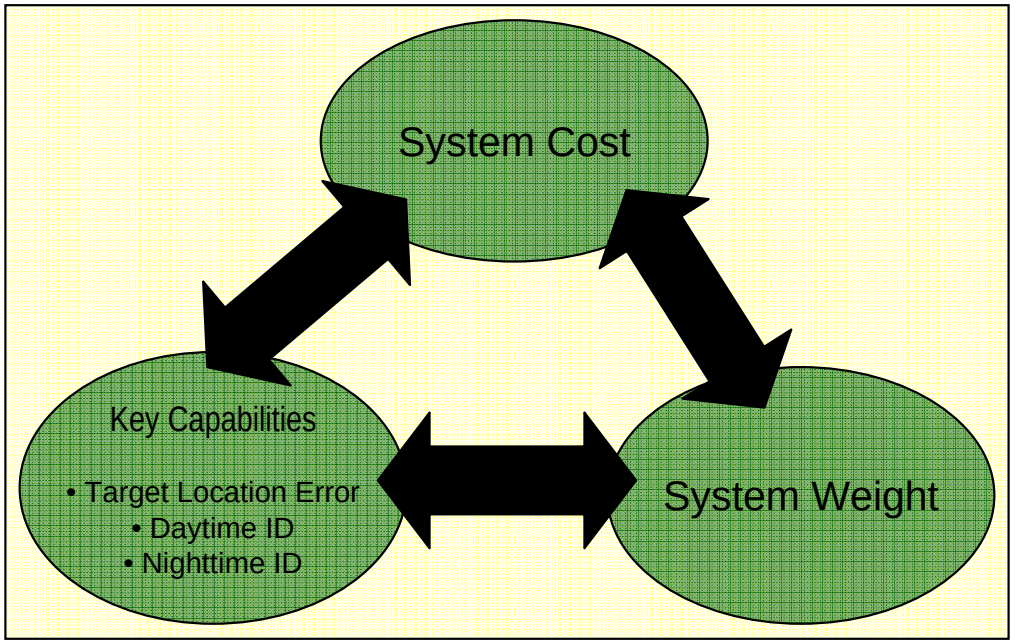
JETS Lacked Key Elements Typically Required for Conventional Costing:

- A dedicated program office
- System quantities
- An SDD or large-scale development contract
- A formal engineering design proposal

In other words….we only had Capability and Performance data available for analysis.

JETS Milestone-A AoA: Cost Analysis Methodology

- **Identification Key Capabilities (from the ICD and FNA Reports, respectively)**
- **Identification of Analogous Systems (from the ICD and FNA Reports, respectively)**
- **Data Collection**
- **Data Analysis:**
  - *TLDS:* Leveraged analytical relationships within the data set to link capability and cost; Developed Cost Estimating Relationships (CERs)
  - *TECS:* Identified software developments with analogous capability and mission set to develop costs estimates for each alternative



CKB Overview (Detail)