Systems Engineering Program Metrics

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ODDR&E/Systems Engineering

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Mission Context

Director, Systems Engineering
Steve Welby

Systems Analysis

"Weapon Systems Acquisition Reform Act of 2009"

S.454-10; d.(1): The development and tracking of detailed measurable performance criteria as part of the systems engineering master plans…

S.454-10; d.(3): A system for storing and tracking information relating to the achievement of the performance criteria and objectives specified…

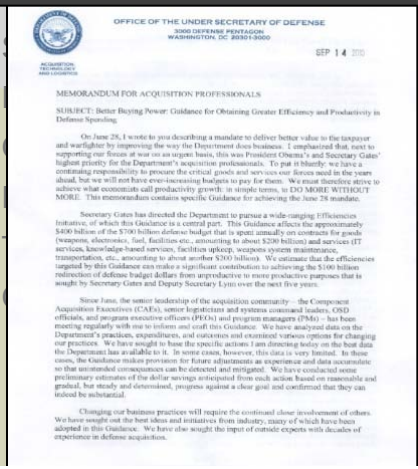
S.454-12; SEC. 103.b.(4): Evaluating the utility of performance metrics used to measure the cost, schedule, and performance of [MDAPS], and making such recommendations …to improve such metrics.

Major Program Support
James Thompson

- Program Support Reviews
- Systems Engineering Plans
- Program Technical Auditing
- OIPT/DAB Support
- DAES Database Analysis and Support
- Performance Measurement
- Systemic Root Cause Analysis

Mission Assurance

AT&L Memo, 14SEP2010
Subject: Better Buying Power: Guidance for Greater Efficiency and Productivity in Defense Spending



OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

SEP 14

MEMORANDUM FOR ACQUISITION PROFESSIONALS

SUBJECT: Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending

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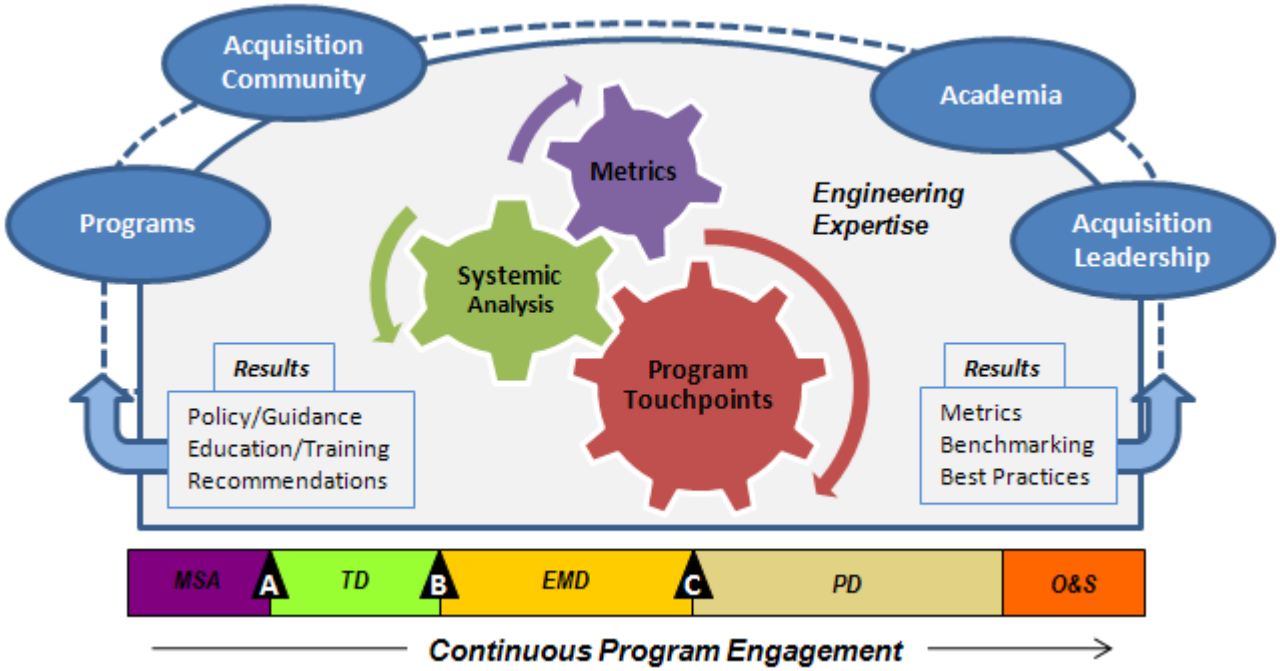
"…Set shorter program timelines and manage to them…"

"…remain cognizant of our programs' progress…and identify problems quickly…"

OUSD(AT&L)/SE
Major Program Support Directorate

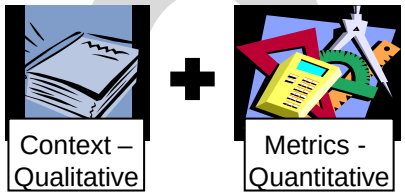
Mission Statement:

- Foster an acquisition environment of collaboration, teamwork, and joint ownership of program success through a proactive program oversight process ensuring appropriate levels of Systems Engineering discipline are applied through all phases of the acquisition life cycle



Themes

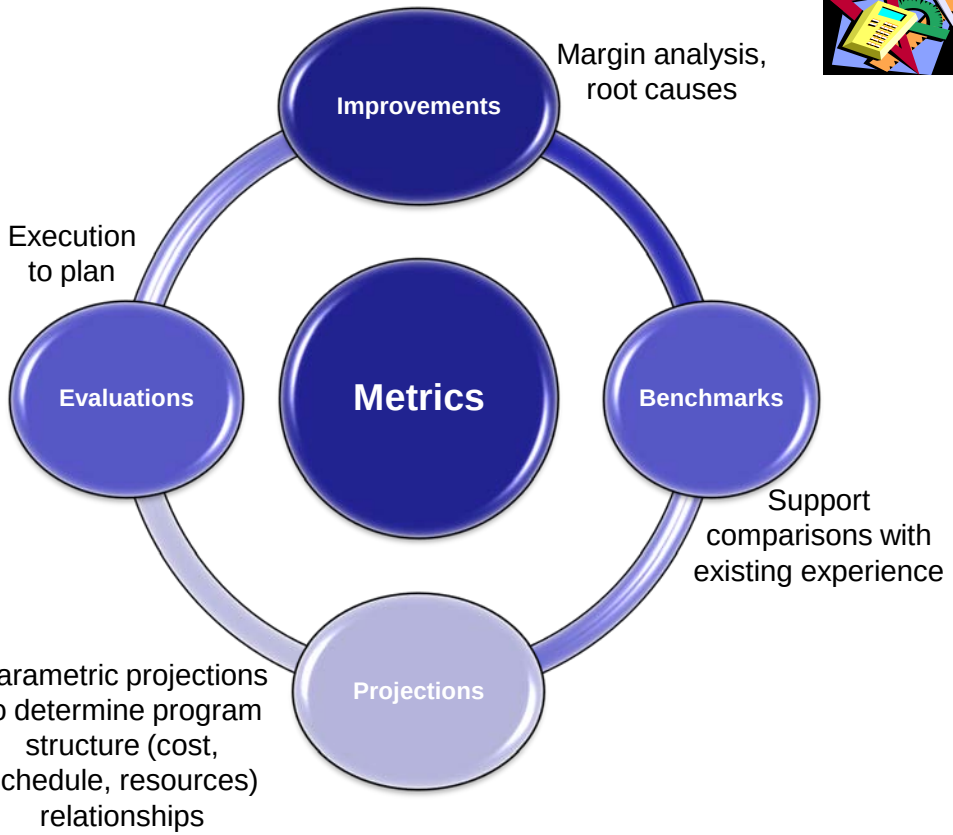
- **Building Bridges/Collaboration**
  - Services for Service-led PSR
  - Industry for metrics/measurement
- **Communication**
  - Results fed-back thru multiple channels (e.g. SEP Prep Guide update, Annual Report, program engagement, conference/symposia
- **Integration**
- **Metrics**
  - Help programs establish effective SEP that includes metrics
  - Track execution to plan
  - Augment qualitative information with engineering quantitative data
    - Software
    - Reliability
    - Manufacturing
    - Integration



Use existing information for better decisions

SE Metrics Goals
"What we are trying to achieve"

- Emphasize quantitative understanding consistent with Industry practice of system engineering
- Make visible relationships between system/equipment design objectives and performance
- Harness and use existing information for timely and better decisions at the appropriate levels



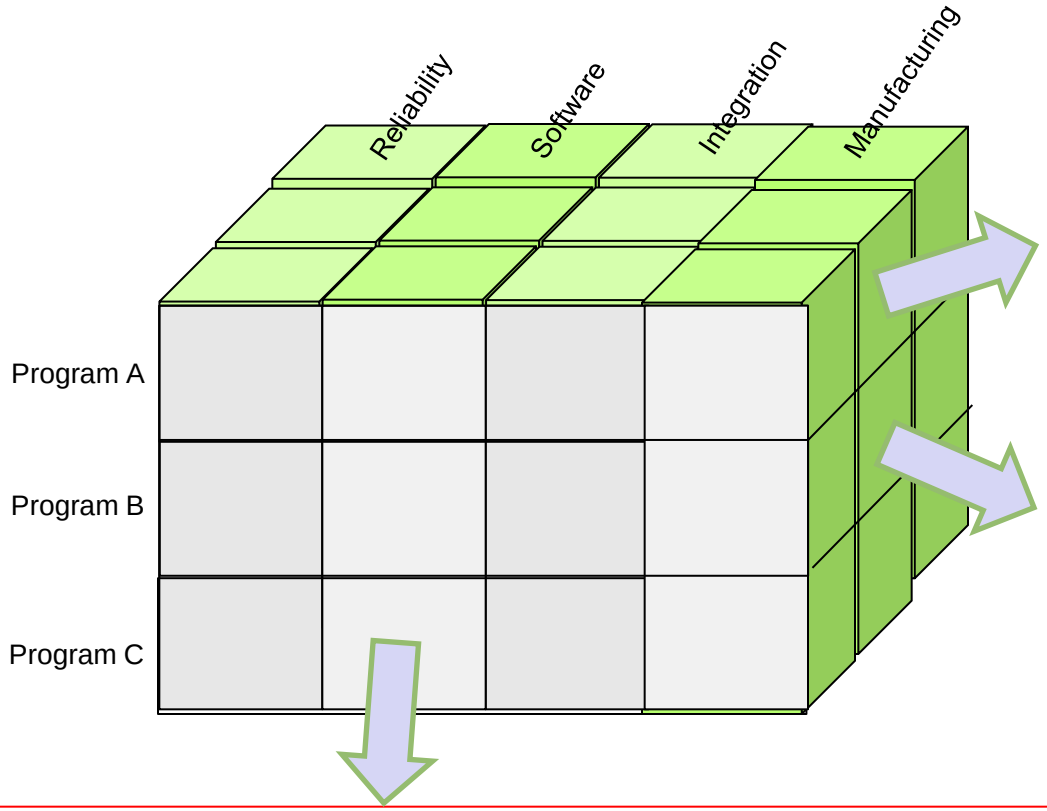
"To measure is to know."
"If you can not measure it, you can not improve it."
Lord William Kelvin (1824-1907)

The Few vs. The Many

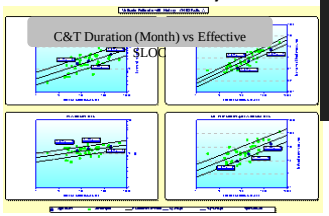
- **There are a lot of metrics out there already**
- **More is not better**
- **Selectively harness the appropriate measure based on information needs and decision points**

vs.

SE Products (in Progress)

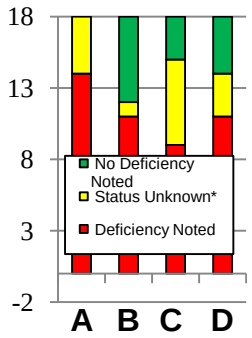


AT&L History



Individual program comparison versus benchmarks

Indicators



Performance Across Programs

Systemic Analysis

Systemic Findings 2010; Example - Software

- Software Development Plans do not exist, or lack needed information, outdated - 14% MDAP reviews conducted
- Significant variation in software development estimates – 13%
- Actual software reuse achieved significantly less than planned – 11%
- Lack of metrics prevent accurate awareness of software activities in each development phase – 10%
- Software requirements are ambiguous; not fully specified, developed and managed – 10%

Manufacturing Metrics
Selecting Metrics to Collect

- DoD weapon system manufacturing problems: systems cost far more and take much longer to build than estimated*
- Most programs use manufacturing metrics, but there has not been a disciplined effort to collect and establish benchmarks

EMD Metrics**: Develop affordable and executable manufacturing process

- Build to Packages
  - Scheduled and change history
- Qualification Tests of LRU /critical component
  - Number scheduled and completed
- Engineering Change Numbers
  - Class 1/2 to product definition made after CDR
- Touch labor hours by end item

LRIP Metrics**: Establish initial production base; orderly increase in the production

- Delivery Performance
  - Contractual delivery date and actual date
- Touch labor hours
  - Total planned and actual hours
- Scrap, rework and repair (SRR) Hours
  - Target and actual by end item
- Travel work
  - Total travel hours by end item
- Engineering Changes
  - Number predicted and actual

Context

- Type of equipment being manufactured
- New materials processes are being used
- New factory line or existing line modified
- Last time contractor manufactured a similar system; percent similarity
- CAD/CAM system used

Notes:

*GAO Report April2010 "BEST PRACTICES: DOD Can Achieve Better Outcomes by Standardizing the Way Manufacturing Risks Are Managed "

** Metrics will evolve over time

Software Metrics

Benchmarking & Parametric Analysis Available

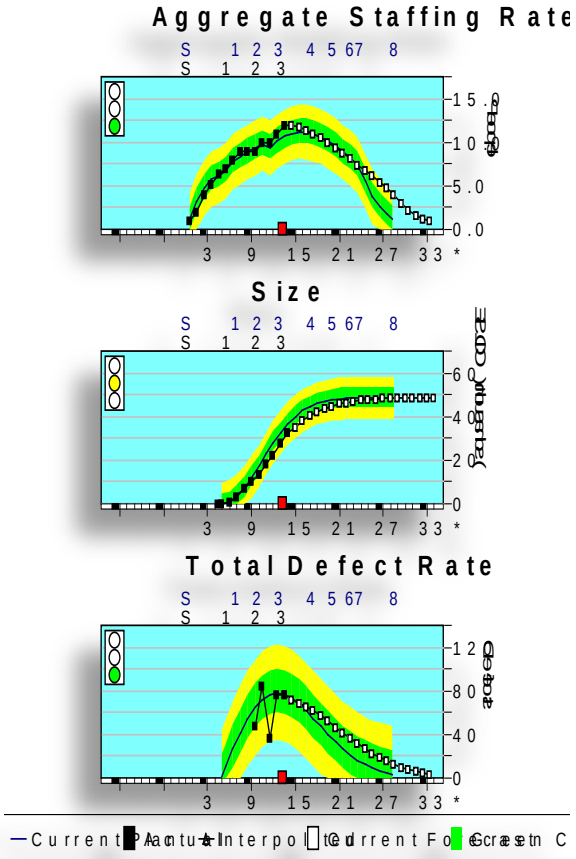
- DoD is collecting software metrics
  - Major Programs submit Software Requirements Data Report (SRDR) to Defense Cost and Resource Center

Metric

- Sizing (SLOC)
  - For each build (new/modified/reused)
  - Begins at Milestone A with progressive detail throughout acquisition cycle

Numerical Context

- Peak staffing for each build
- Effort hours for each build
- Duration (start and end dates, both planned and actual) for each
- Any reliability standard (Mean Time to Defect, MTTD) or actual defects discovered
- System type (business, scientific, real time(e.g., avionic))
- Any metrics from previously completed builds/releases is useful for direct comparison



Reliability Metrics

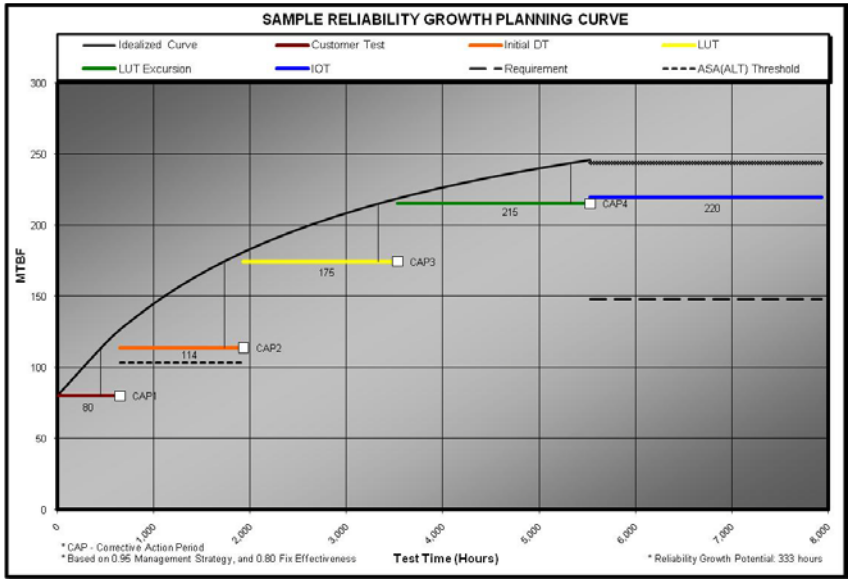
Reinvigorating DoD Metrics Field Collection Activities

- Achieving reliability objectives -- key enabler to meeting future stringent budget targets

Metrics

- General Reliability ("as planned" to "as achieved")
  - Operational Reliability
  - Logistics Reliability
- Reliability Growth Metrics
  - Mean Time Between Failures Initial ($MTBF_I$)
  - Failure Modes Identified/Addressed

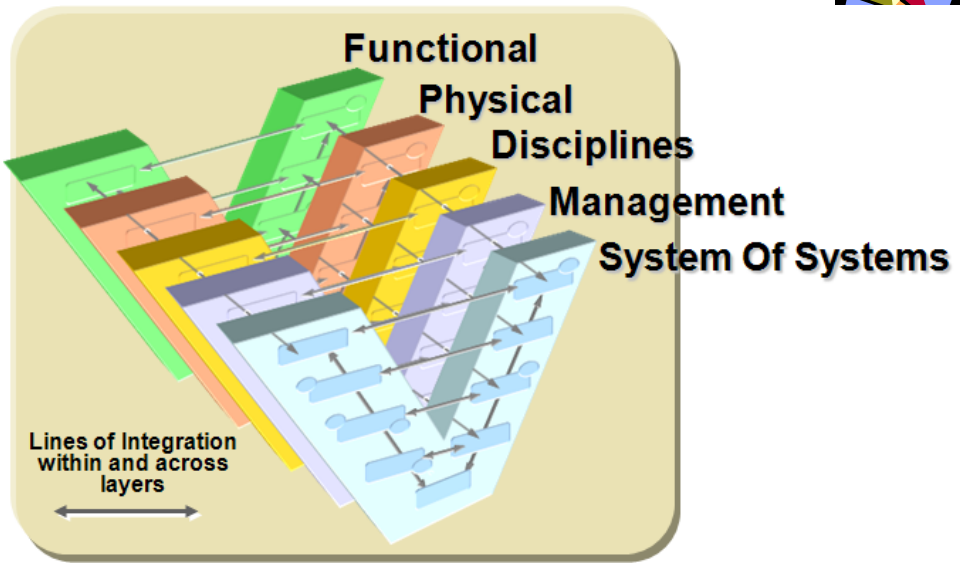
Start at program initiation vs. MS B



System	MTBSA (Point Estimates)		
	MS C (FY09)	Current (FY10)	Rqmt (CPD)
NIK	13	73	112
UAS	7.3	107	23
SUGV IQT	9.7	84	42
SUGV TT	9.7	339	42
T-UGS	38.9	595	127
U-UGS	24.3	503	105

Integration Metrics
Focus on Developing

- Difficult to define
- Integration challenges are generally recognized late in the acquisition process



Metrics

- Availability depends on when system configuration is defined and application
  - System Interfaces (internal)
  - System of System Interfaces (external)
  - Mission Threads
- Relevant to all applications
  - Number of Integration Laboratories
  - Integration Progress

Context

- Type of systems/equipment (e.g., aircraft, ship, dismounted soldier) and a description indicating the complexity of the system being integrated.
- Types of Configuration items being integrated (e.g., vehicle, communications, sensors, weapons, software processes, etc.)
- Schedule duration in months (Critical Design Review to IOT&E)
- Engineering resources (e.g. man hours)specifically devoted to integration as documented in the IMP

Negative Systemic Findings

Sep 2010

Top 10 Overall

1. Marginal program office staffing - 31% (seen on 31% of programs reviewed)
2. Progress is impeded by the lack of good communications between the Government and contractors. – 24%
3. Program has an inadequate system engineering process - 23%
4. Test schedule is aggressive/ success-oriented/ and highly concurrent - 23%
5. Current program budget is not sufficient to execute the proposed program – 20%
6. Requirements are not stable – 20%
7. Requirements are vague, poorly stated, or not defined – 20%
8. Requirements creep - 18%
9. Risk management tools and methodology are not sufficient - 18%
10. Incomplete or missing a systems engineering plan (SEP) – 17%

Focus area results

Category: Reliability

- Reliability is not progressing as planned or has failed to achieve requirements – 14%
- Reliability test program is needed – 14%; Reliability growth program not in place – 10%
- Reliability is currently based on analytical predictions and won't be demonstrated until late in program – 10%

Partnering with Industry

- **Systems Development Performance Measurement Working Group**
  - Sponsored by NDIA SE Division in conjunction with PSM
  - Timeframe: Jan 2011, 6 month duration (short-term)

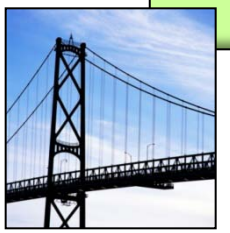
- **Objectives:**
  - Develop performance leading indicators that focus on readiness to proceed
  - Develop implementation solution space and mechanisms for measurement
  - Explore recommendations regarding developing industry benchmarks
- **Leverage data that is readily available**
- **Support DDR&E/SE Imperative:**
  - "Reduce cost, acquisition time and risk of our major defense acquisition programs"
- **Participation announcement forthcoming**

Get the right leading indicators in place to understand readiness – based on experience and risk

Conclusions

- **Metrics**
  - Elegant systems engineering designs require us to augment intuition and judgment with quantitative means and effective analytical methods
  - Harness the right measures to help inform decisions
  - Industry, Academia, Agencies, Services have role in shaping quantitative methods and driving efficiencies into acquisition
- **Integration**
  - Integrate the information for better domain management /problem solving
- **Communication**
  - Effectively shape, share and disseminate results:
    - Updates to policy and guidance (e.g. SEP Prep Guide)
    - Conference, symposia, white papers, etc
- **Building Bridges**
  - Services, Industry, Acquisition Leadership, Academia

"Performance Management via Metrics". Program Mgt Track 2. Thur 10:50am



For Additional Information

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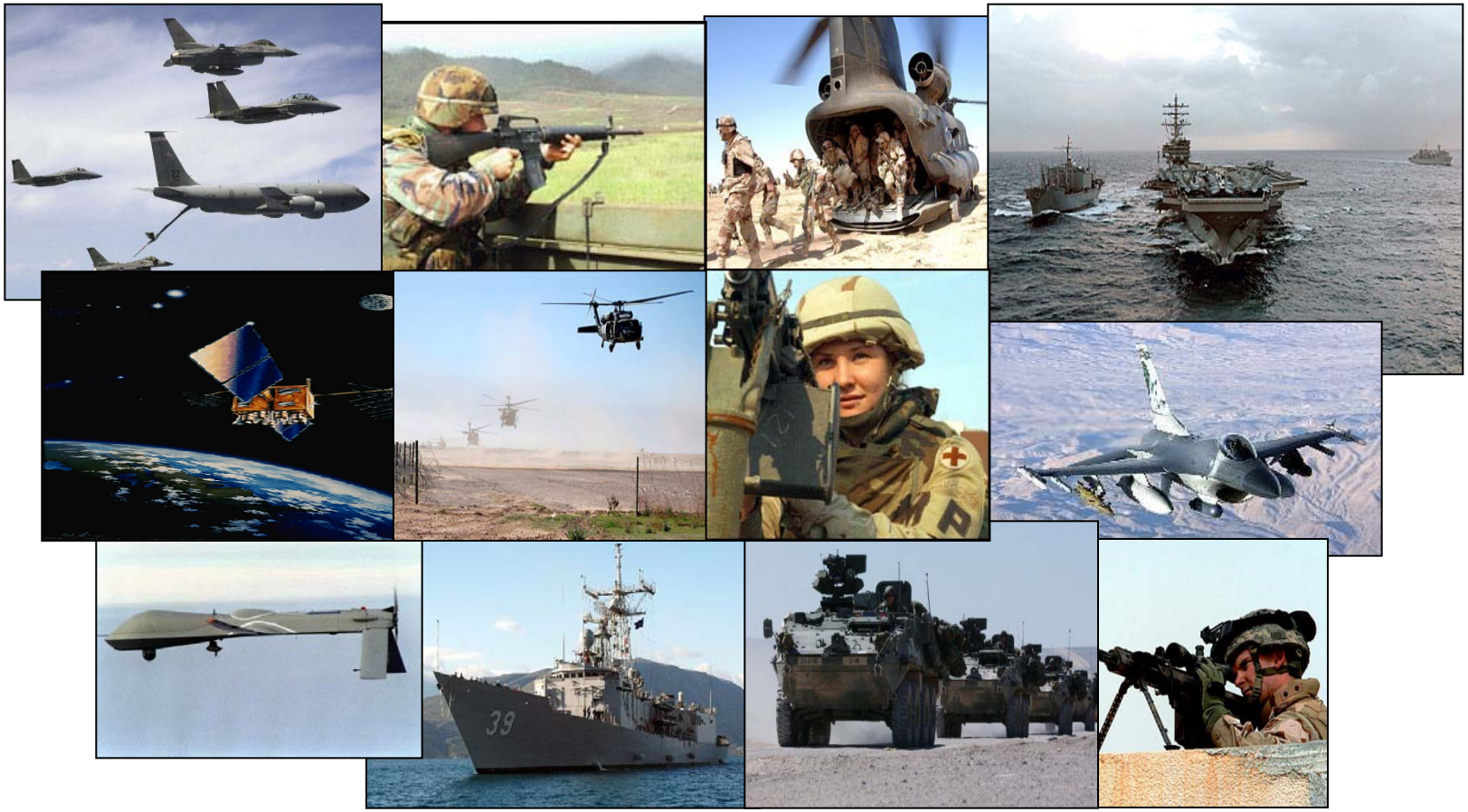
Systems Engineering: Critical to Program Success



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