Systemic Analysis of Software Intensive System Acquisition Issues

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John McGarry
U.S. Army TACOM-ARDEC

Overarching Questions …

- *Why do we always seem to be trying to solve the same problems in our software intensive programs?*
- *How do we really improve? Do we know where to start?*
- *Are we focusing on the symptoms or the causes of our program issues?*

Tri-Service Assessment Initiative History

- TAI Initiated by OSD in 1998 to address repeated performance shortfalls attributed to software
  - Mission - Implement independent program assessments into standard acquisition practice to help improve program performance
- In May 2000, the Defense Science Board recommended independent assessments for all ACAT I-III programs
- Independent Expert Program Review (IEPR) Policy
  - Initially included in DoD 5000.2-R
  - Now addressed in FY03 Defense Authorization Act, Section 804 - Improvement of Software Acquisition Processes - acquisition evaluation and improvement requirements

Program and Enterprise Focus

Provide objective performance information to DoD decision makers:

- Provide assistance directly to DoD Program Managers to help them identify and correct program issues that impact individual program performance
- Provide information directly to DoD Enterprise Managers about recurring systemic issues that impact performance across the DoD program base

Tri-Service Assessment Initiative Activities

- Independent Expert Program Reviews (IEPR)
- Single Program Focus
- Objective - Improve Program Performance

- Cross-Program Analysis
- Enterprise Focus
- Objective - Identify and Characterize Recurring Performance Factors

TAI Activities are Based on an Integrated Assessment Architecture

Systemic Analysis

- Identifies recurring program performance issues, risks, and problems
- Quantifies the extent to which these issues are observed
- Determines the cause and effect relationships between identified program performance issues
- Allocates issue responsibility within the DoD acquisition management structure

Systemic Analysis Phases

Phase 1 - Completed July 2001

- Top down analysis approach
- Initial models - proof of concepts
- Assessment architecture integration
- Initial data set - 10 assessments

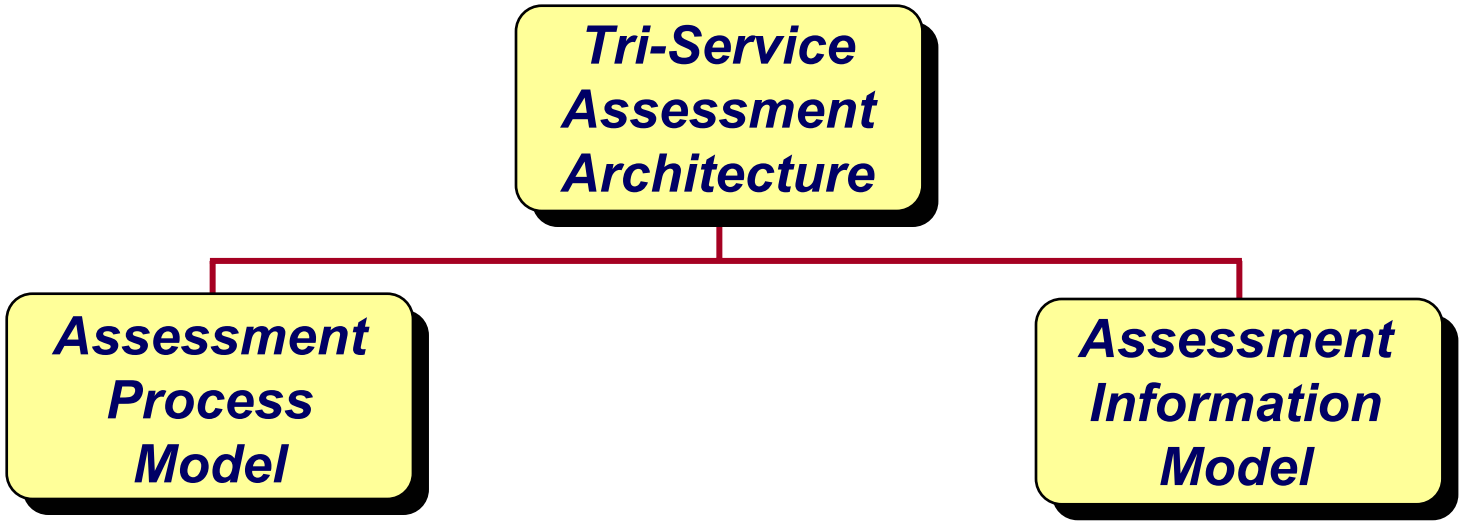
Phase 2 - Completed December 2002

- Bottom up analysis approach
- Based on quantification of recurring issues and sequences
- Information driven analysis objectives
- Systemic database
- Extended data set - 23 assessments

Phase 3 - Began January 2003

- Phase 2 transition - 32 assessments
- Predictive issue pattern analysis
- Quantification of program issue impacts
- Architecture and analysis process improvements

TAI Assessment Architecture

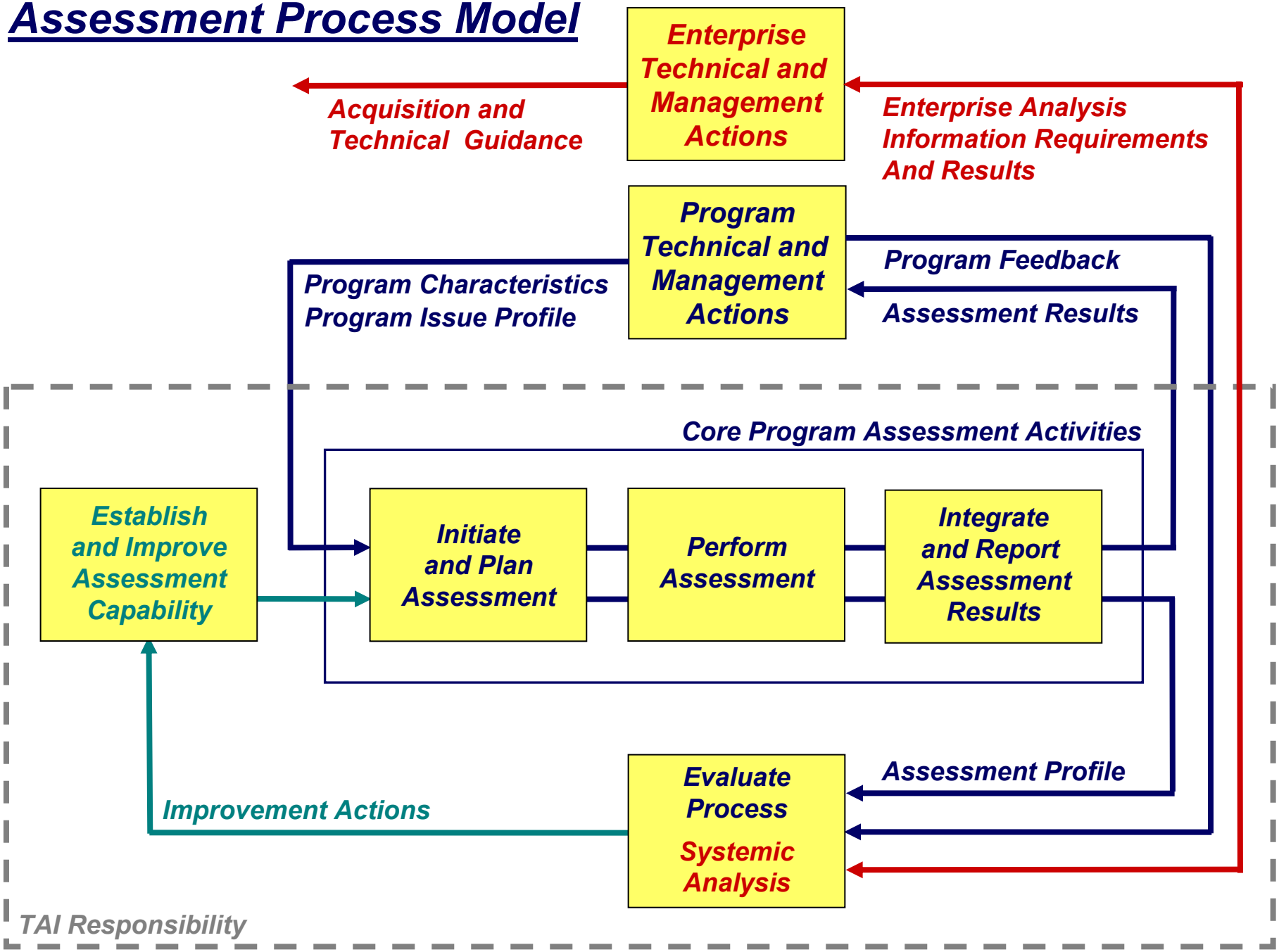


- Identify and prioritize Program issues
- Develop value-added recommendations
- Generates consistent information sets

- Generic Program issue structure
- Defines assessment "scope"
- Flexible typology

Both Components are Required for Individual Program Assessment and Systemic Cross-Program Analysis

Assessment Process Model



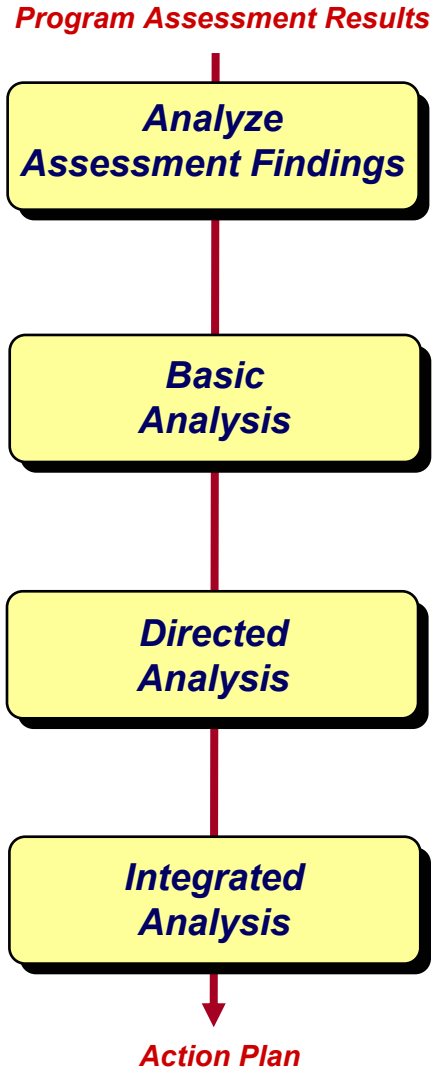
Assessment Information Model

- User / Customer
- Schedule
- Technical Product
- Technical Process
- Management
- Resources
- Financial
- Mission Requirements
- Environment
- Program Specific

Management Issue Typology Example

Issue Category	Issue	Sub-Issue
5. Management	5.1 Acquisition Strategy/Process	5.1.1 Acceptability 5.1.2 Feasibility 5.1.3 Suitability
	5.2 Program Planning	5.2.1 Acceptability 5.2.2 Feasibility 5.2.3 Suitability
	5.3 Program & Program Management	5.3.1 Organization 5.3.2 Suitability 5.3.3 Change Tolerance
	5.4 Contracting and Subcontracting	5.4.1 Conditions-Constraints 5.4.2 Cost Accounting 5.4.3 Progress Tracking 5.4.4 Arrangements 5.4.5 Timeliness 5.4.6 Change Management
	5.5 Communication	5.5.1 Interfaces 5.5.2 Openness 5.5.3 Teamwork

Systemic Analysis Process



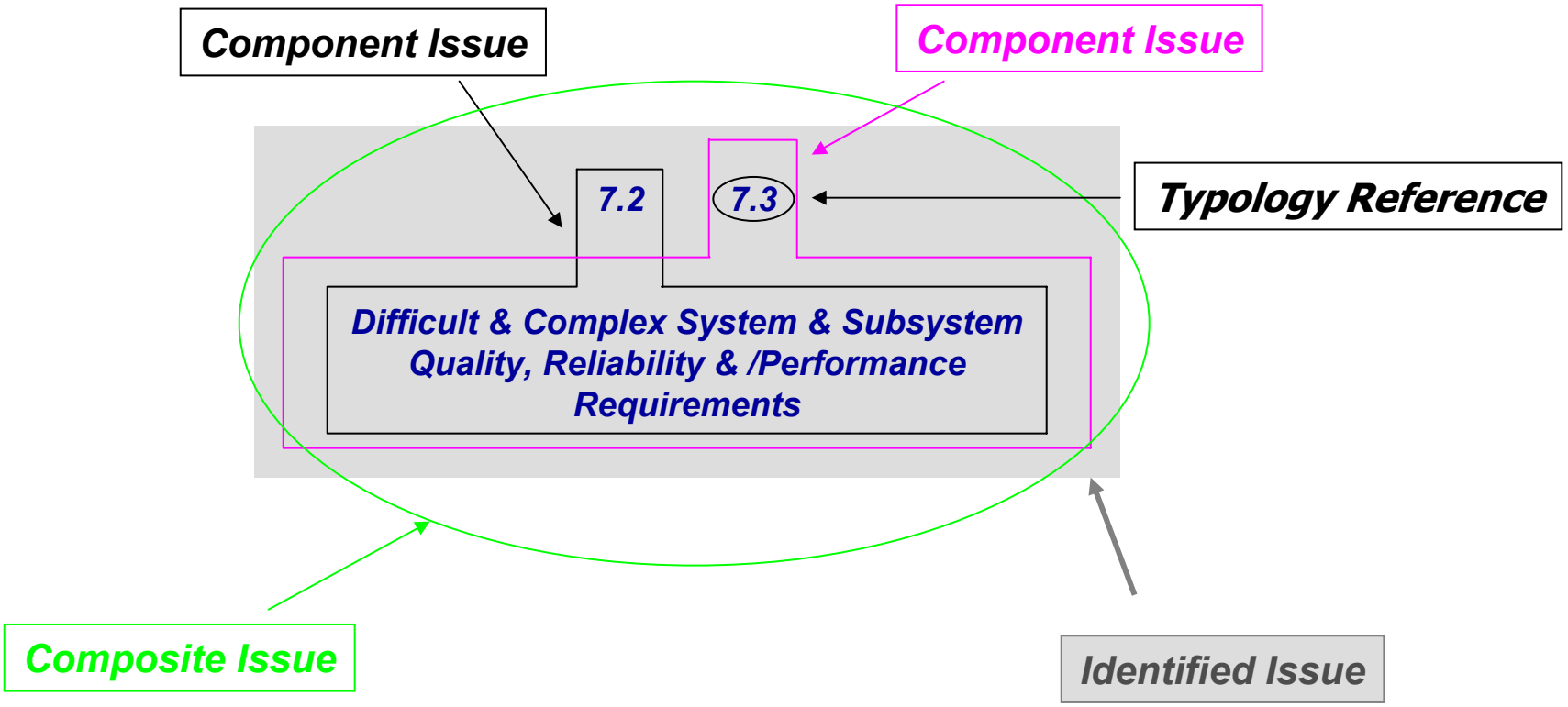
- Systemic Peer Review
- Assessment Characterization
- Issue Identification
- Risk Typology Allocations
- Initial Cause and Effect Model

- Issue Frequency of Occurrence Analysis - Data Normalization
- Enterprise - Program Issue Responsibility Allocations
- Definition of Information Needs
- Issue Concurrency Analysis
- Issue Sequence Identification and Analysis - Interaction
- Issue Characterization - Triggers / Symptoms

- Executive Data Call
- Basic Analysis Review
- Definition - Prioritization of Information Needs
- Individual Issue Category Case Analysis

- Issue Correlation
- Risk Analysis
- External Correlations
- Systemic Analysis Model
- Executive Level Conclusions / Summary

Systemic Terminology

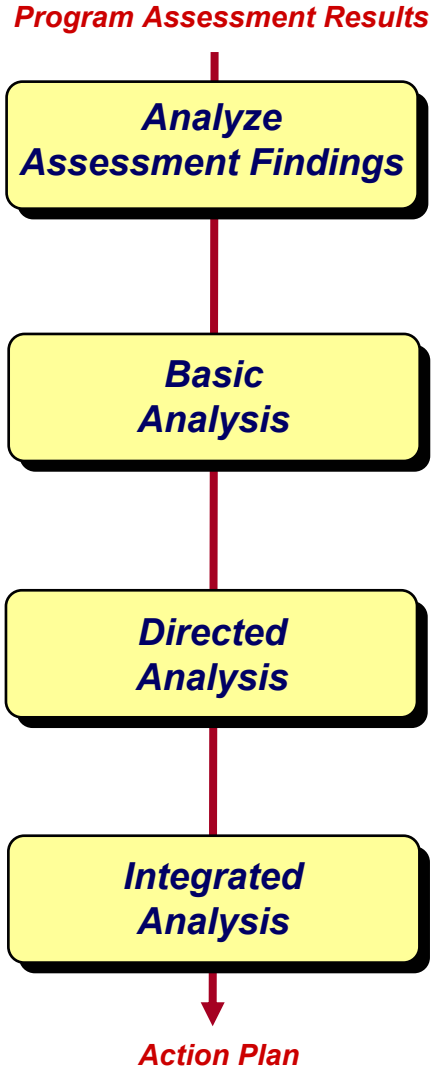


List of Banned Words

(B-Words)

- Infrastructure
- Paradigm
- Vision
- Stakeholder
- Overarching
- Taxonomy
- Meta - Anything
- Business Process Reengineering
- Disambiguate
- Seamless
- Ideate
- Mentor - Mentee
- Enplanement
- Disaggregate
- Processcentric
- Object Oriented
- Y2K (Retired)
- Better-Faster-Cheaper
- Cartonization
- Best Practice
- Acluistic

Data Management



- Individual Program Assessment Library
- Program Characterization Profile
- Cause and Effect Modeling Tool - Diagrams
- Systemic Database (PSM Insight)
- Data and Analysis Baseline Management - CM

- Standard Information Needs Baseline
- Basic Analysis Query Baseline Management
- Basic Analysis Data Summary Reports
- Standard Systemic Terminology
- Information Management
- Data Normalization

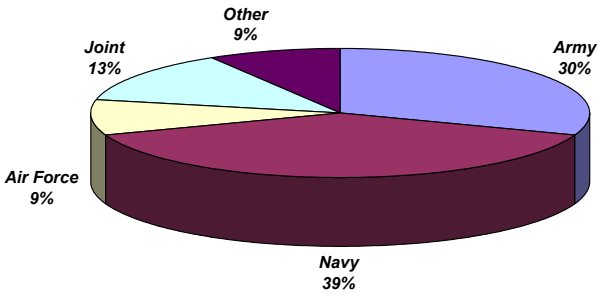
- Prioritized Information Needs Baseline
- Directed Analysis Query Baseline Management
- Directed Analysis Summary Reports
- Integrated quantitative - context analysis

- Systemic Analysis Model Baseline
- Report - Information Management
- List of References
- Product and Baseline Control

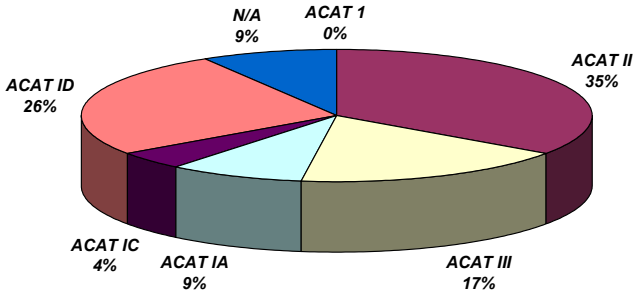
Data and Analysis Limitations

- Customer constraints on the scope of the individual assessments
- Degree of individual assessment adherence to the TAI assessment architecture
  - education and experience
  - inherent team biases
  - degree of assessment detail
  - architecture design
- Size of the assessment program base
  - limits comparative analysis by distribution factor
  - impacts degree of data self-normalization
- Variance inherent in quantifying subjectively derived information
- Lack of quantifiable issue impact data
- Lack of successful program data
- Time sensitive issue validity
- Complexity of program issue interactions
- Program level vs. enterprise level responsibility bias

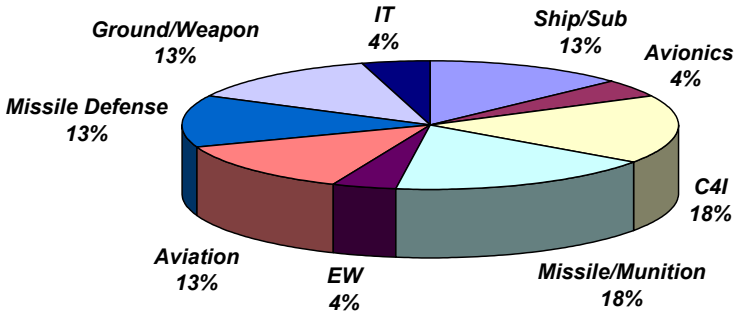
Assessment Distribution



Distribution of Assessments by Service



Distribution of Assessments by ACAT Level



Distribution of Assessments by Domain

Systemic Analysis Executive Summary

Recurring Issue Trends

- Exist across assessed programs
- Regardless of program characteristics
- They are more prevalent than expected
- Traditional acquisition and development problems have yet to be adequately addressed
- Policies and decisions related to identified issues have a long program impact life span
- New recurring issues are emerging as DoD acquisition strategies and technologies change

Systemic Analysis Executive Summary

Program Performance Issues

- Causative issues produce different performance symptoms in different programs
  - single issue can cause many symptoms
  - many unique issue combinations
  - relatively complex performance interactions
- The predominant number of identified issues are "triggering issues", not symptoms
- We continue to focus on the symptoms with little success
- Traditional solutions and approaches are predominantly "stovepiped"
- Even the "basics" in many instances are not implemented adequately

Systemic Analysis Executive Summary

Program Failure

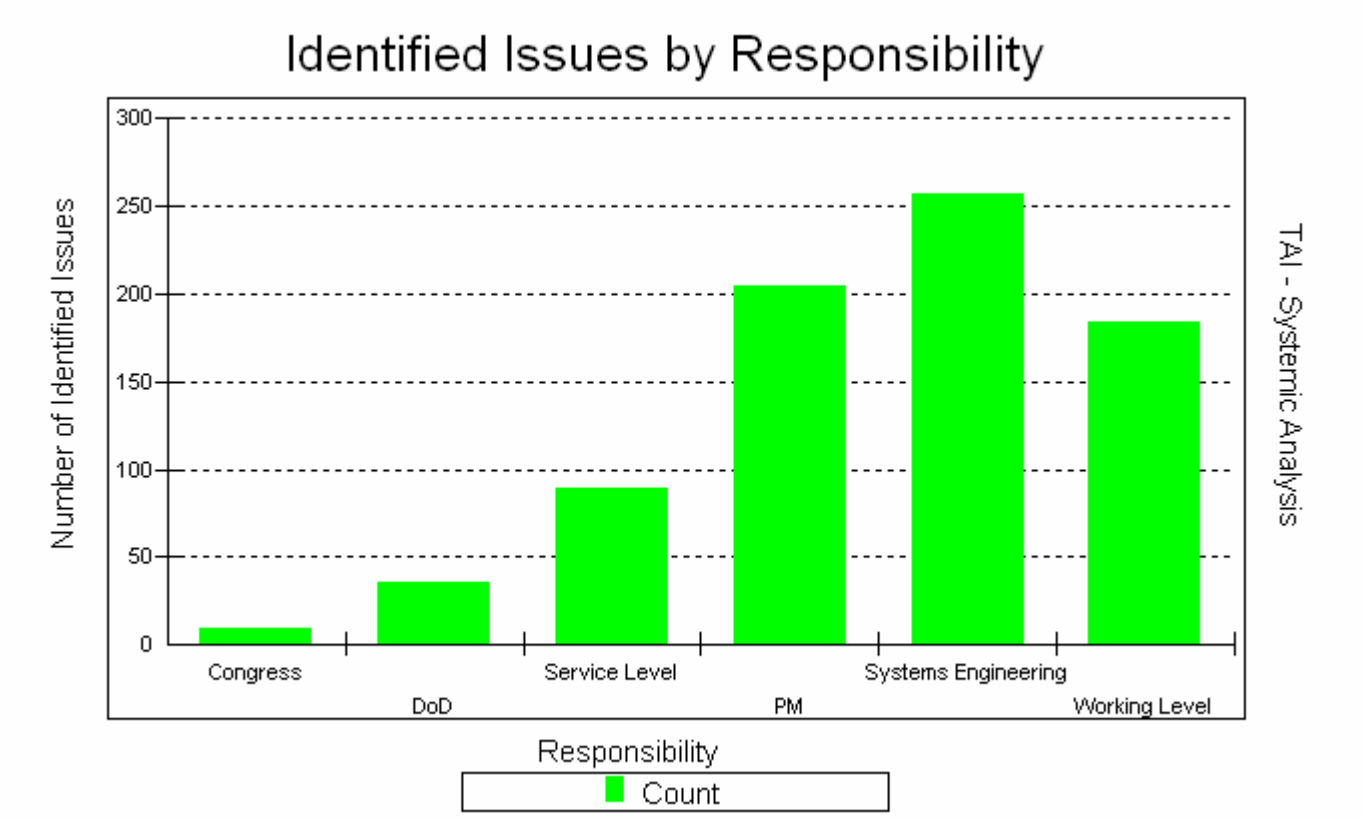
- Is related to a combination of unrealistic enterprise constraints / expectations and poor program execution
- Enterprise level issues materially impact program performance
- Program specific management and technical capability are primary and critical issues
- Cost is the primary "managed to" constraint (program survival)
- The gap between "program expectations" and "program performance" is significant across the board

Critical Program Performance Problems

Identified Issues	Relative Occurrence
Process Capability	91 %
Organizational Management	87 %
Requirements Management	87 %
Product Testing	83 %
Program Planning	74 %
Product Quality - Rework	70 %
System Engineering	61 %
Process Adherence	52 %
Program Schedule	48 %
Interoperability	43 %
Decision Making	43 %
...	
Configuration Management	26%

Issue Responsibility Allocations

Complex issues with multiple interactions across all levels of DoD management



Issue Responsibility

Congress - includes Congressional influence as well as program external environmental factors

DoD - includes DoD policy, directives and guidance

Service - includes Service level policy, directives and guidance

Program Manager - includes all program organic PM-level responsibilities, from both the acquirer and supplier (developer) perspectives

Systems Engineering - includes all system engineering-level responsibilities from both the acquirer and supplier perspectives

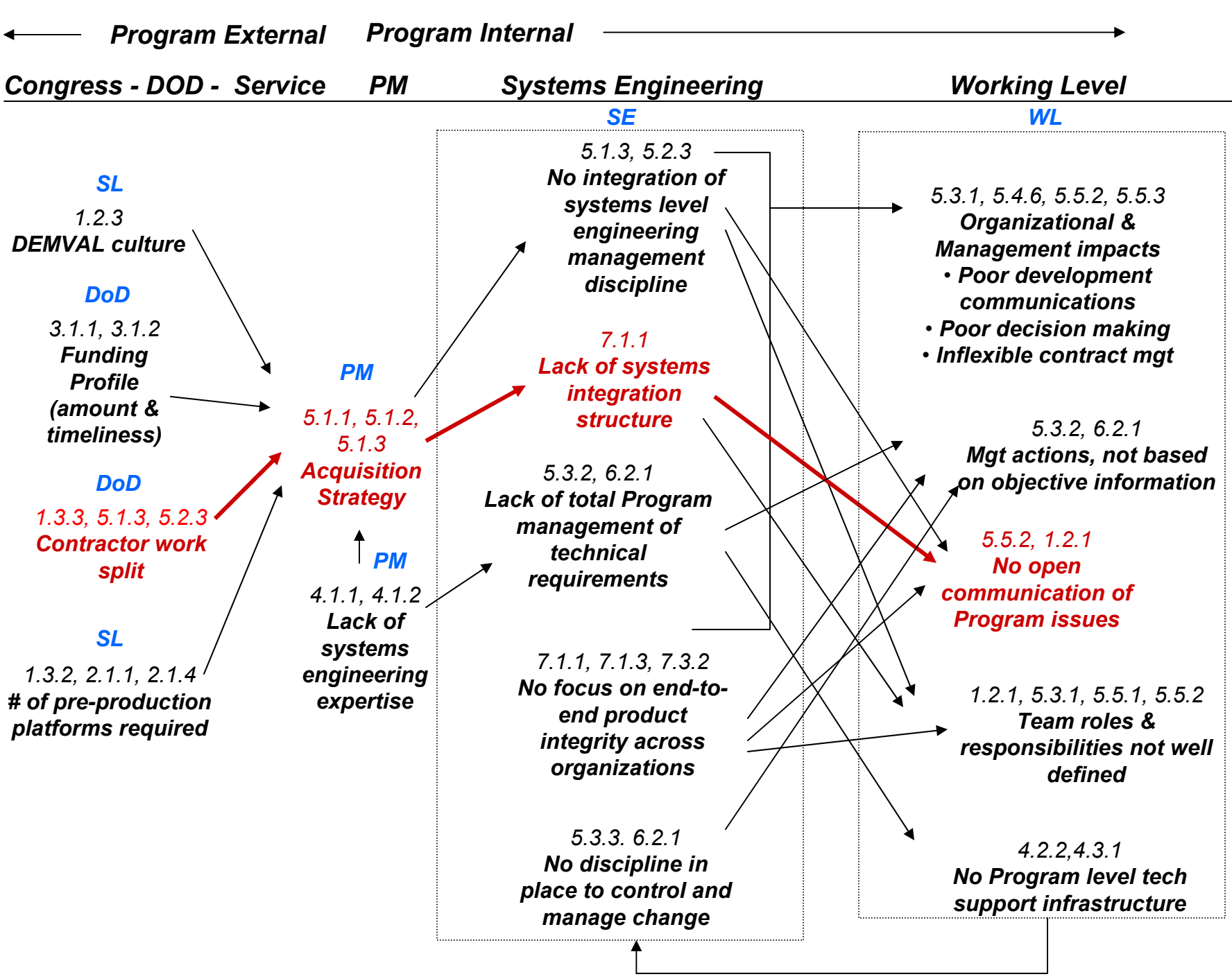
Working Level - includes all the responsibilities of the development staff executing the program-related tasks

Under pressure, Program Managers make trade-off decisions that impact, in order:

- Development progress
- Product technical performance
- Product quality and rework
- System usability
- Cost

Cause and Effect Impacts

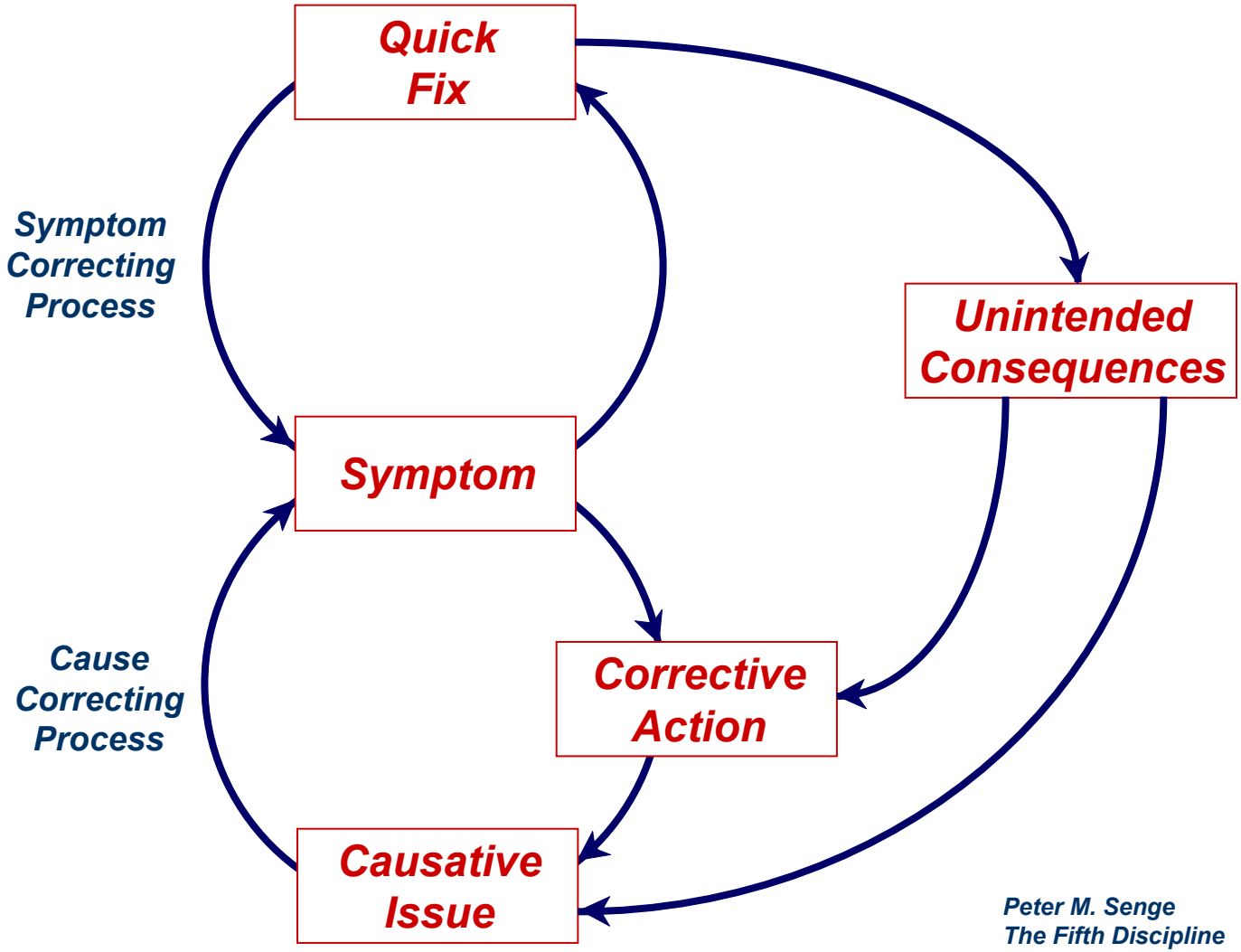
- Process Capability problems result in:
  - Inadequate Testing
  - Poor Change Management
  - Poor Product Quality
  - Progress Shortfalls
- Requirements Management problems result in:
  - Poor Product Quality
  - Product Rework
  - Progress Shortfalls
- Organizational and Program Management problems result in:
  - Inadequate Program Planning
  - Responsibility Conflicts
  - Poor Communications
  - Product Rework
  - Progress Shortfalls


Program External
Program Internal
Congress - DOD - Service
PM
Systems Engineering
Working Level
SE
WL
SL
1.2.3
DEMVAL culture
DoD
3.1.1, 3.1.2
Funding Profile (amount & timeliness)
DoD
1.3.3, 5.1.3, 5.2.3
Contractor work split
SL
1.3.2, 2.1.1, 2.1.4
# of pre-production platforms required
PM
5.1.1, 5.1.2, 5.1.3
Acquisition Strategy
PM
4.1.1, 4.1.2
Lack of systems engineering expertise
5.1.3, 5.2.3
No integration of systems level engineering management discipline
7.1.1
Lack of systems integration structure
5.3.2, 6.2.1
Lack of total Program management of technical requirements
7.1.1, 7.1.3, 7.3.2
No focus on end-to-end product integrity across organizations
5.3.3. 6.2.1
No discipline in place to control and manage change
5.3.1, 5.4.6, 5.5.2, 5.5.3
Organizational & Management impacts
• Poor development communications
• Poor decision making
• Inflexible contract mgt
5.3.2, 6.2.1
Mgt actions, not based on objective information
5.5.2, 1.2.1
No open communication of Program issues
1.2.1, 5.3.1, 5.5.1, 5.5.2
Team roles & responsibilities not well defined
4.2.2,4.3.1
No Program level tech support infrastructure

Recurring Issue Patterns

- *The diversity of the recurring issue sequences reinforces the complex nature of the interactions and relationships between identified issues*
- *The large number of unique issue sequences reinforces the need to focus attention on the causative, or triggering, issues*
- *The expected cause and effect issue relationships are clearly evident in the data*
- *Solutions will be equally complex*

Symptom or Cause?



Peter M. Senge
The Fifth Discipline

Technical and Management Processes

Analysis Results

- 91% of the assessments had process capability issues (75% triggers)
- 52% of the assessments had process adherence issues (63% triggers)
- 35% of the assessments had no adherence issues but still had capability issues
- Technical vs. Management Process Issues - 5:1 Ratio
- Capability vs. Adherence Issues - 5:1 Ratio
- Predominant deficiencies: requirements, risk / measurement, testing, systems engineering, change management

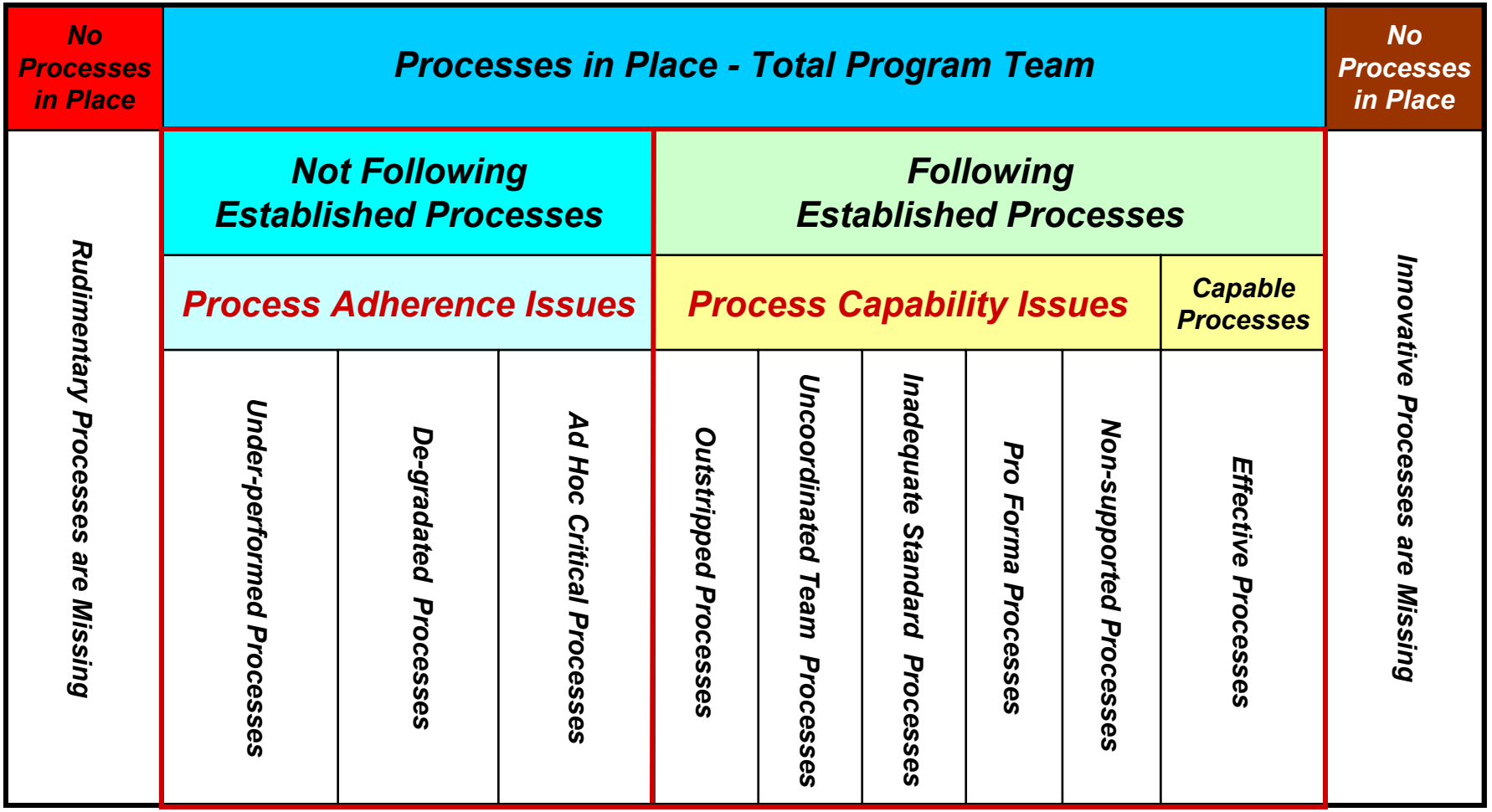
Implications

- False assumption that organizational process adherence equates to effective program process capability
- Adherent organizations still have significant performance shortfalls
- Key process concerns:
    a. organizational standard vs. program process requirement
    b. impacts of program constraints
    c. large program team process incompatibilities

Process Examples

- Software versions are not under CM control - poor change management - "fixed" defects delivered to the field - "lost" software baselines
- Incompatibility of software processes across subcontractors resulted in the incompatability of products delivered for integration
- Software requirements specifications written by systems engineers without input from software engineers - specifications reflected more design than requirements
- 20,000 requirements managed manually
- Risk identification without communication or risk management
- Concurrent SAIV and CAIV management emphasis

Process Issues Model



Systems Engineering

Analysis Results

- 61% of the assessments had systems engineering issues (23% triggers)
- 11 of the 16 programs that have requirements issues have SE issues
- 43% of the assessments have interoperability issues (50% triggers)
- Predominant deficiencies: non-existent SE, lack of SE expertise, poor SE implementation, dispersion of SE responsibility and authority, existing SE inadequate for program requirements

Implications

- Cost overruns, schedule slips and rework will continue to plague programs
- The most technically complex systems have the most systems engineering issues
- Interoperability of systems is in doubt
- Rapid exploitation of new/innovative technology is difficult

Systems Engineering Examples

- No end-to-end facilities for system level integration and test - full functionality first integrated and tested on the aircraft
- Multiple processes and methodologies for loading different software applications on the platform
- No final technical trade-off decision authority - Systems Engineering by committee
- Technical task allocations driven by profit objectives, not by domain experience and capability
- Integration used as a substitute for up-front systems engineering
- Family of systems - interoperability mandate without establishing technical or management authority across programs - politically allocated responsibilities

A Primary Systems Engineering Issue

System Interoperability

- Is not adequately planned, funded, or managed
- It is a program rather than an enterprise allocated responsibility
- "Family of Systems" management is largely ad hoc - no enterprise portfolio view - unfunded mandates
- A number of new interoperability issues are emerging
  - complex program organizational management
  - complex system testing
  - systems engineering and architecture shortfalls
- Current acquisition strategy trends will most likely make these issues more pervasive
  - direct source Congressional funding
  - acquisition responsibility reallocations

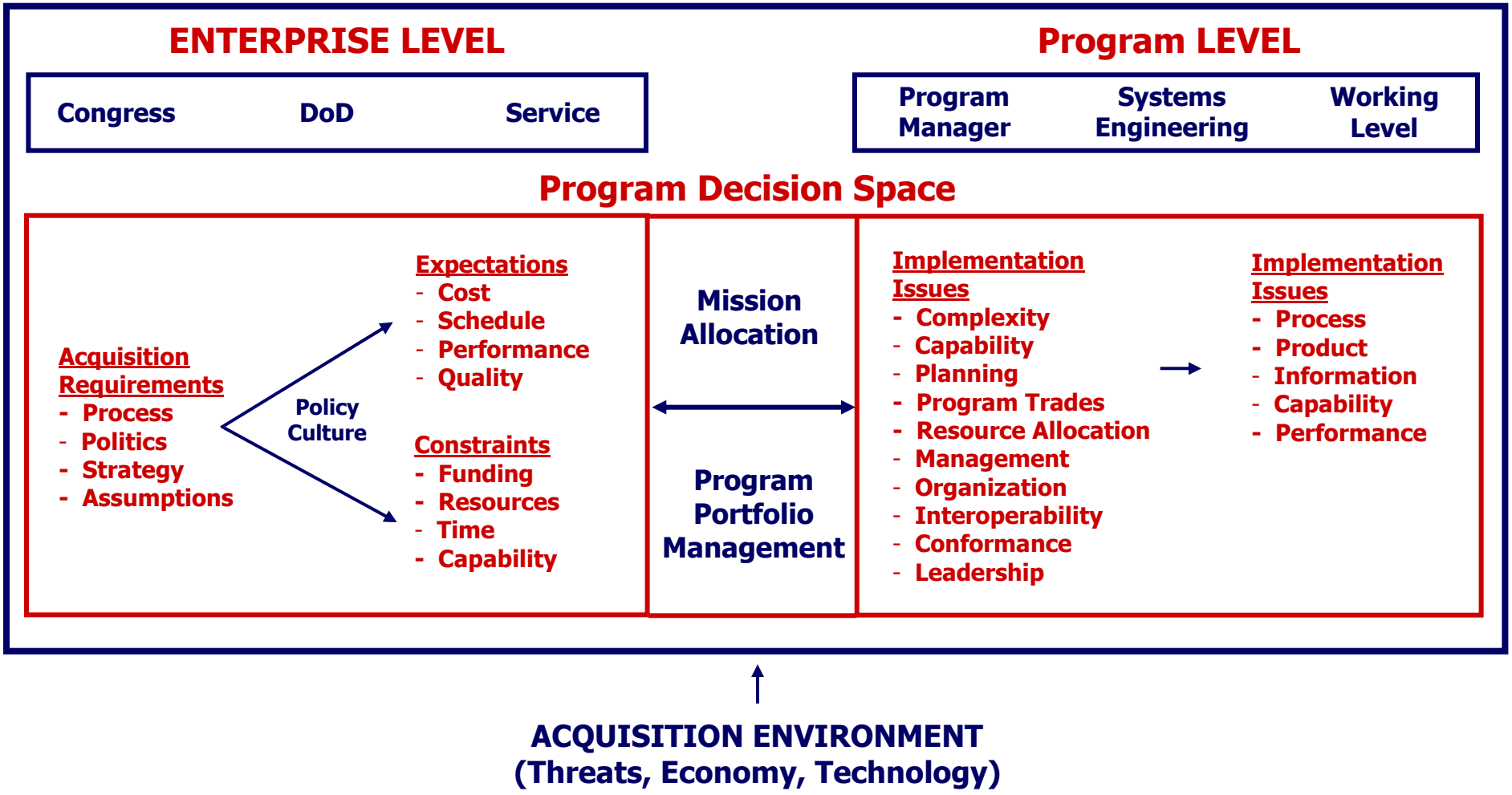
Analysis Summary

- The current DoD program issue profile shows little positive impact from past corrective actions, initiatives, and policy
- The Program Manager and the Development Team must address the majority of the program issues, even if they are caused by enterprise level decisions or behaviors
- Causative issues multiply downstream
- The Program Team creates many of their own performance problems
- There are no “single issue” program performance drivers

Acquisition Trends - Emerging Issues

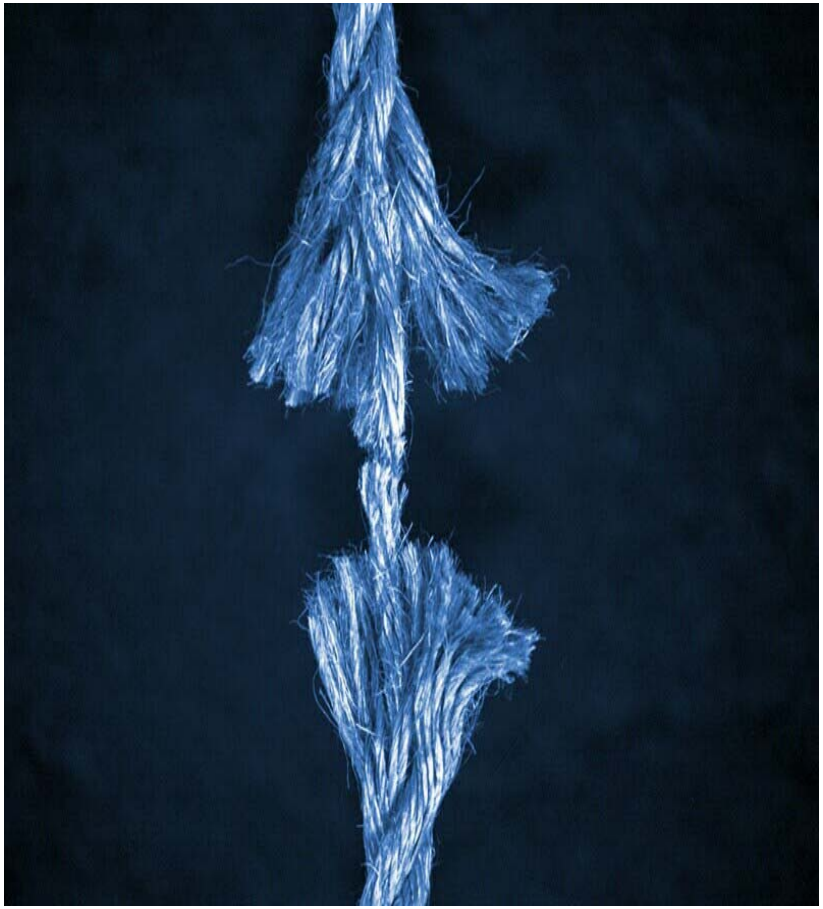
- Supplier program management and control
- Direct congressional to supplier "plus up" funding
- Massive mission based acquisition and supplier organizations
- Increasing system interoperability and codependency
- Extensive design for mission resiliency
- Fewer and less experienced resources
- Increasing cost consciousness
- Technology integration and update
- CMMI, Evolutionary Spiral, Capability Based Acquisition, Best Practices, others …

Systemic Analysis Model



TAI Phase 2 Systemic Analysis

The analysis predicts an increasing gap between what is expected and what is capable of being achieved



Key Considerations

- Need to establish performance parameters that can be implemented with success across the life of the program
  - Feasible plan
  - Understood constraints
  - Change tolerance
- Need to improve the capabilities of the development teams
  - Real systems engineering
  - Funded management and technical approaches critical to interoperability
  - Foundational processes reinforced
  - Process capability in addition to process adherence

Key Considerations

- Need to ensure that all program stakeholders agree on an integrated strategy for attacking the high priority overarching program issues:
  - Congress and enterprise
  - Program team
  - Education and technology infrastructures
- Need to augment acquisition policy with:
  - A clear understanding of the complex interactions and constraints that programs are faced with
  - Adequate implementation guidance
  - Directed education

Next in Systemic

- *"User Designed" systemic information products*
- *Systemic Analysis technology improvements*
  - *Data quality*
  - *Time phased analysis*
  - *Predictive analysis*
  - *Relative impact analysis*
- *More assessments added to the program base*
- *Initial Systemic Analysis technology partnerships*
  - *CeBase*
  - *NAVAIR*
  - *Lockheed Martin*

Summary

- Systemic analysis based on objective program assessment results provides a unique opportunity to use actual data to make a difference
- The causes of program performance shortfalls are extremely complex - improvement strategies and associated action plans must address this complexity
- As an Enterprise we need to start by re-addressing the performance issues we thought we were already fixing

John McGarry
Executive for Performance Management

U.S. Army TACOM - ARDEC
AMSTA-AR-QAT
Picatinny Arsenal, NJ 07806-5000

(973) 724-7007
jmcgarry@pica.army.mil

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