Causal Factors of Software Intensive System Issues

Tri-Service Assessment Initiative

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Objectives

- Convey what we have learned through a systemic "Cross – Program" analysis of multiple software intensive DOD programs
- Identify some of the recurring factors that materially impact software intensive acquisition and development efforts
- Provide some ideas on how we can improve based on the results from real program experiences

Presentation Outline

- IEPR and TAI Overview
- TAI Systemic Analysis Approach
- Enterprise and Program Level Findings
- Recurring Cause and Effect Issue Relationships
- The Way Forward - Recommendations

Independent Expert Program Reviews

- **IEPR Policy Update**
  - ACAT ID/IC programs shall conduct an IEPR after Milestone B and before CDR
  - IEPRs shall be considered for ACAT IA, II, and III programs
  - IEPR Implementation Plan provides guidance for implementing policy and will be staffed after DoD 5000 release

- **Tri-Service Assessment Initiative**
  - Primary implementation for conducting IEPRs
  - Sponsored by OSD - Software Intensive Systems Office
  - Three year history
  - Structured multiple-level assessment architecture

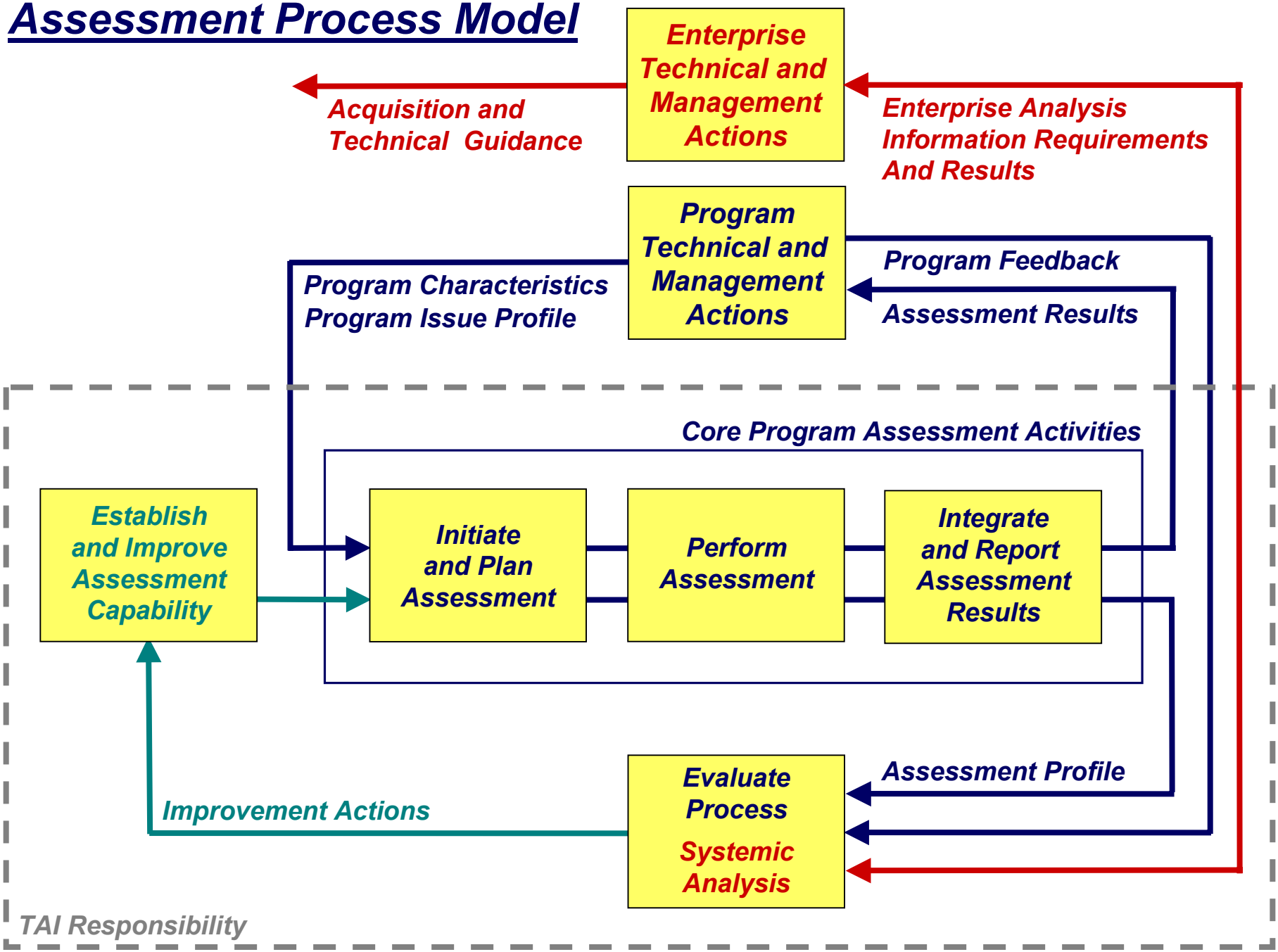
TAI Assessment Architecture

- Identify and prioritize program issues
- Develop value-added recommendations

- Generic Program issue structure
- Defines assessment "scope"

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

Assessment Process Model



Information Model Issue Structure

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

Systemic Analysis Objectives

- Identify systemic issues that impact program success
- Understand their cause and effect relationships
- Develop recommendations to improve SIS acquisition:
  - policy and guidance
  - education and training
  - tactical and strategic decision making
- Provide DoD users with a source of objective lessons learned
  - Enterprise (OSD, Services, SISSG, PEOs)
  - Program (PMs, staffs)
  - Technical Interface (DAU, SEI, IEPR WG, etc)

Systemic Analysis (SA) Process

TAI Program & Other Data Sources

Analyze Assessment Findings

- Typology Allocations
- Frequency of Occurrence
- Enterprise - Program Allocations

Diagram Causes and Effects

- Recurring Issue Pattern Definitions
- Frequency of Occurrence
- Enterprise - Program Allocations
- Interactions

Integrate Results

- Executive Level Conclusions
- Systemic Analysis Model
- Initial Root Cause Identifications

Recommendations

TAI Data Profile

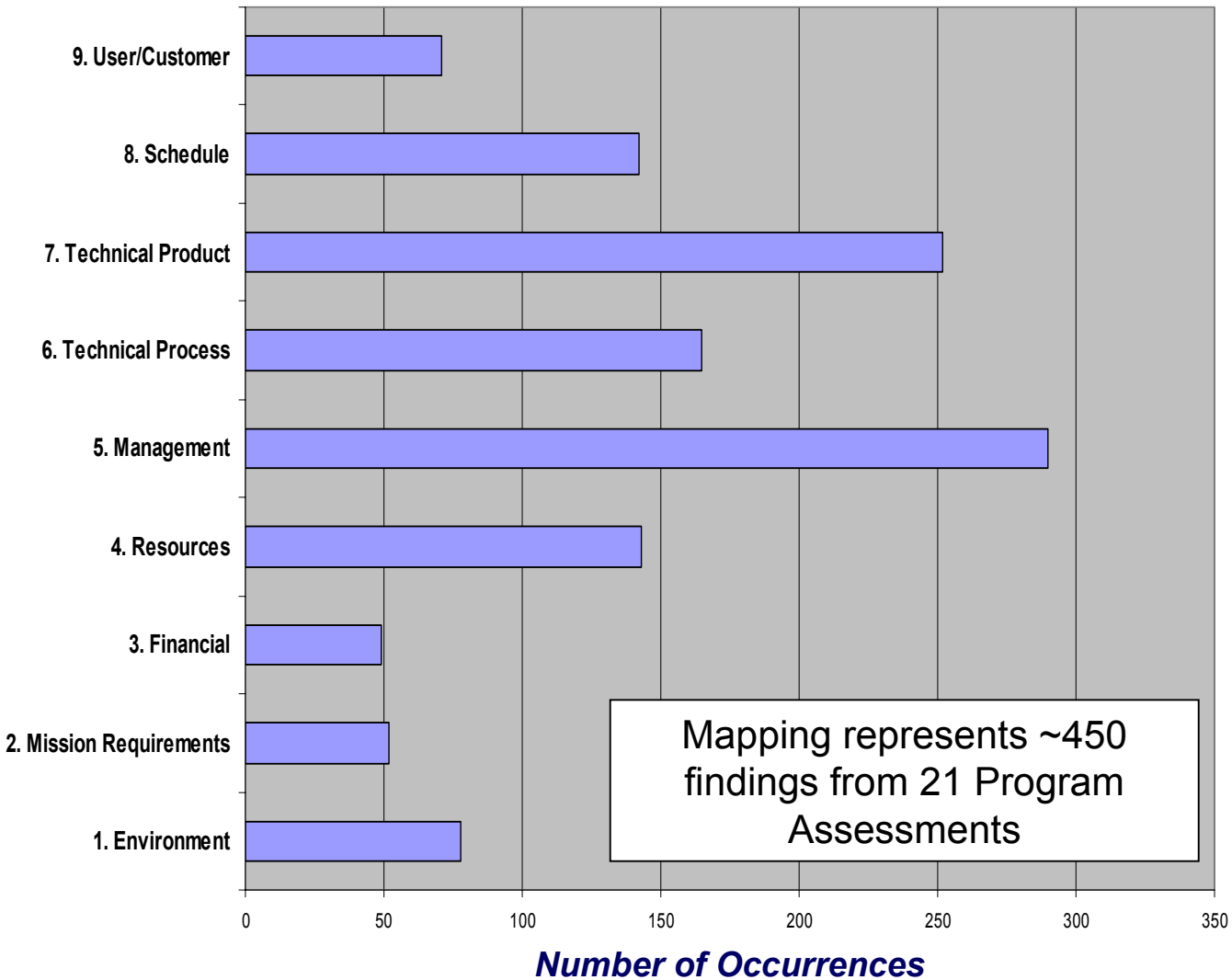
Phase 1 (Jan 01-Feb 02)
10 Programs

Phase 2a (Jan 02-Apr 02)
11 Programs

Combined
- 8 Army
- 9 Navy
- 2 Air Force
- 2 Other

~ 450 Findings

Findings Mapped To TAI Issue Typology



Program Profile:

- All ACAT Levels
- Diverse Domain Areas
  - ✓Missile/Munitions
  - ✓Ground Weapon
  - ✓Combat System
  - ✓IT
  - ✓Aviation
  - ✓C4I
- Varied Lifecycle Phases
  - ✓SDD
  - ✓CTD
  - ✓PD

Findings Allocated to Issue Structure

1.0 Environment

- Policies are generally unfunded at the program level - unfunded mandates create program constraints
- Most corrective actions focus on the program level
- Successful programs suffer less outside interference
- Successful programs address valid priority mission needs at the right time
- Congressional and service resource competition creates significant program constraints
- Policies and practices may be applicable individually but in combination may conflict
- Policies are often based on unfounded assumptions and untested causative models
- Policies are believed to apply equally to all programs
- Technical mandates are not always supported with concurrent infrastructure constructs

2.0 Mission Requirements

- There is generally no program structure or funding to address program level or family of systems requirements
- Prototype systems are advanced to production system status without adequate funding, resources, or process considerations
- There are extensive program interdependencies and concurrencies with limited coordination
- Volatile interoperability requirements
- Poor PEO/Service portfolio management - opportunity costs of selecting one program over another not fully understood
- Multiple mission requirements are defined by multiple program stakeholders

Findings Allocated to Issue Structure (cont.)

3.0 Financial

- Programs are constrained by unrealistic funding levels profiles
- Impacts of late funding cuts on ultimate program success is not fully understood
- No requirement - mechanism for program contingency funding (Enterprise)
- Successful programs fund coordinated development processes (Program)

4.0 Resources

- Critical long term dependence on existing skilled personnel
- Inelasticity between economy and resource availability impacts workforce (Program)
- Mismanagement of NDI of all types (COTS, Reuse, GFI, etc.)
- Component reuse from an uncontrolled source
- Proprietary tools and processes used on multi-developer programs
- Incompatible tools and processes allowed on multi-developer programs
- Successful programs have strong technical expertise in the program office
- Successful programs plan for and manage staff continuity
- Program infrastructure development and maintenance requirements are minimally funded (IPTs, common processes, common tools)

Findings Allocated to Issue Structure (cont.)

5.0 Management

- Poor IPT design and implementation impact decision making efficiency and effectiveness
- Contractual agreements - competitive environment negatively impact data sharing and communication
- Key program roles and responsibilities are undefined
- Inability to plan for or manage change
- Complex and inefficient program organizational structures
- Successful programs employ aggressive risk management
- Successful programs incentivize performance
- Backwards schedule planning from pre-defined milestones
- Lack of program management “big picture”
- Unfettered software optimism
- Lack of system level software visibility (Program)
- “Information control” management culture (Program)
- Extensive program interdependencies and concurrencies with limited coordination (Both)

Findings Allocated to Issue Structure (cont.)

6.0 Technical Process

- Failure to comply with defined processes
- Failure of compliant processes to achieve program success
- Use of software to fix everything
- Incremental capability deferral
- Multiple and incompatible processes across developers
- Inadequate system level pre-platform testing
- No definition of program failure

7.0 Technical Product

- Failure to manage requirements at the enterprise level and stabilize at the program level
- Inadequate program structure - funding for interoperability requirements
- Complex technical interdependencies and interfaces
- Conflicting requirements from multiple stakeholders
- Lack of requirements traceability to all design components
- No end to end software architecture
- Late identification and correction of defects

8.0 Schedule

- Programs are required to meet enterprise mandated delivery dates
- Cutbacks on process to make schedule
- No schedule allocated for planned or unplanned rework
- Multiple and complex interdependencies - broken critical paths

Recurring Program Symptoms

- Over budget
- Late
- Poor Product Quality
- Miscommunication
- Poor / Late Decisions
- Costly Technology Refresh
- Poor Morale
- No Product Line Architecture
- Poor Interoperability
- Rework

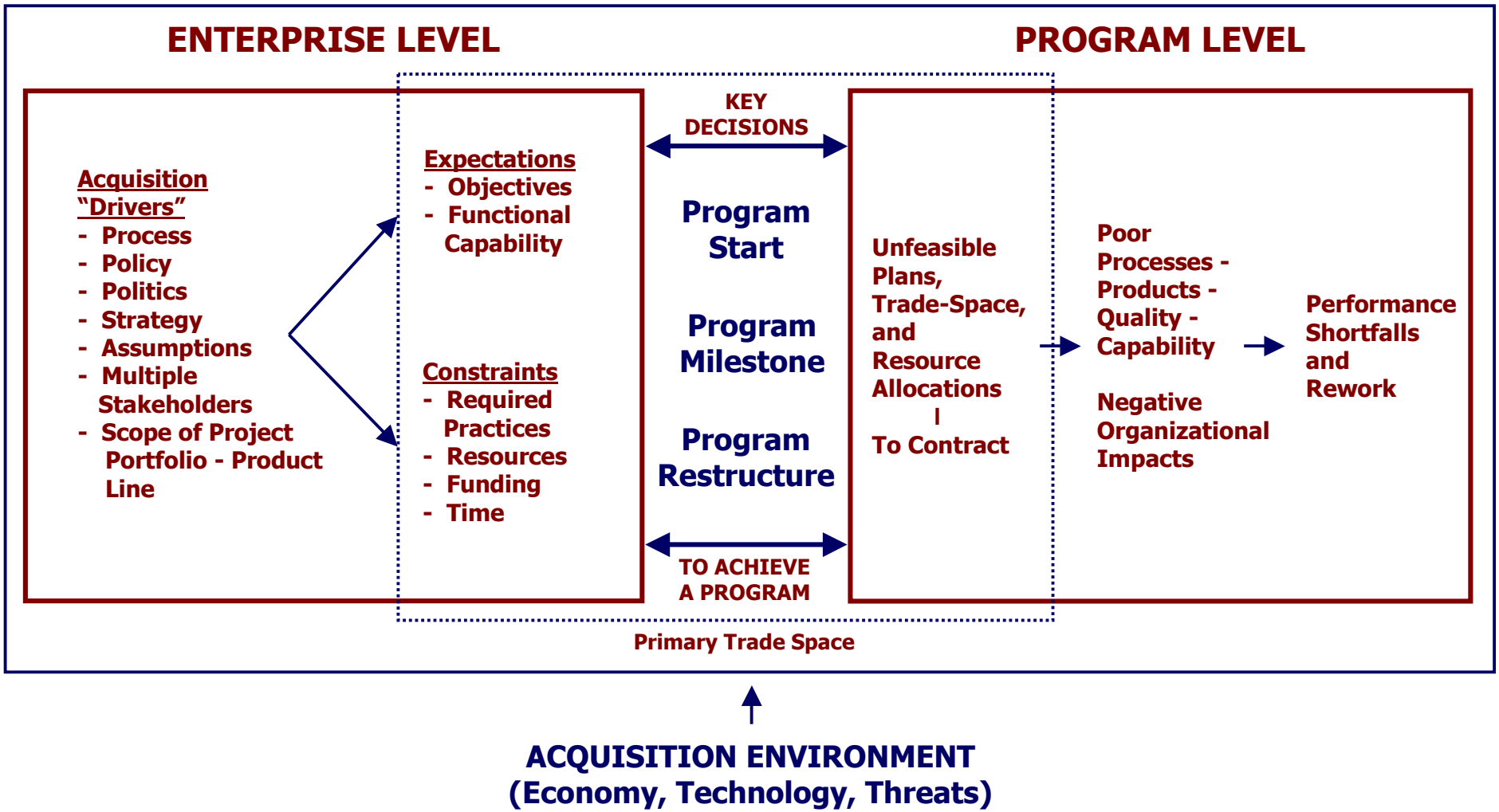
What Causes These Symptoms?

- Program performance shortfalls are related to a combination of enterprise and program level factors
  - can be poor program execution alone
  - can be a mismatch between expectations and program execution capability

- Causative issues produce different outcomes (symptoms)
  - single issue can cause many symptoms
  - many unique issue combinations
  - complex interactions

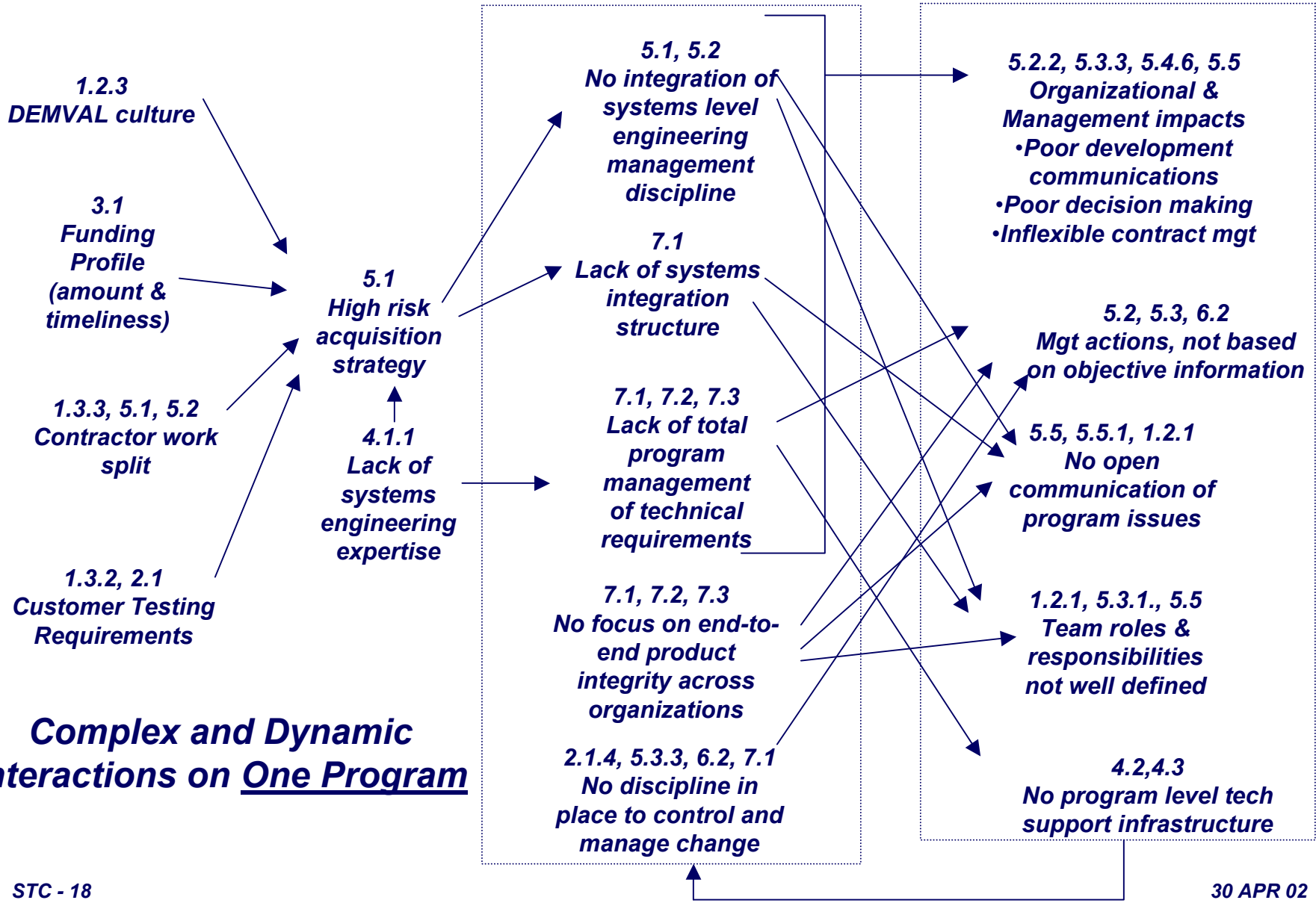
- Multiple sources - multiple causes - but definable relationships and patterns

Systemic Analysis Model



Enterprise Factors

Program Factors



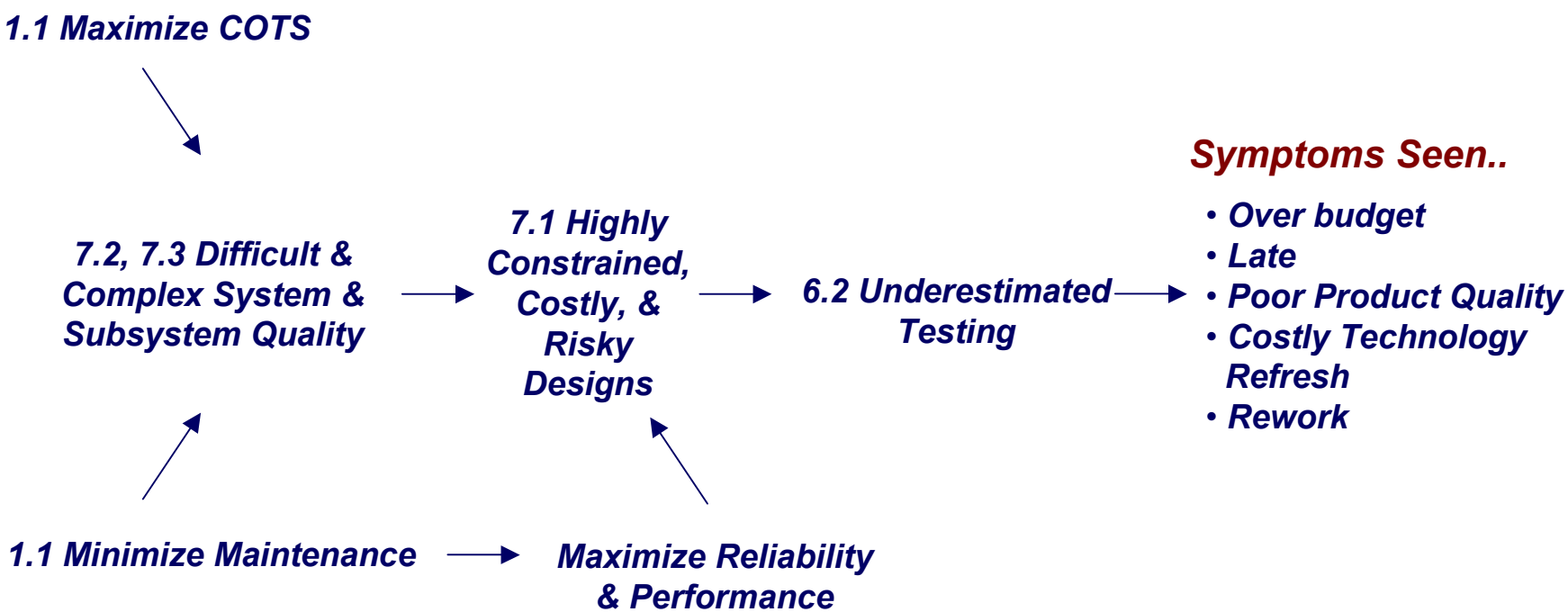
Complex and Dynamic Interactions on One Program

Recurring Issue Patterns

- *Identified Recurring Causal Issue Patterns:*
  - *Unintended Policy Impacts (50%)*
  - *Interoperability Clashes (60%)*
  - *Ineffective Systems Engineering (50%)*
  - *Premature System Deployment (30%)*
  - *Inadequate Resource Infrastructure (60%)*
  - *Disconnected Education & Training (100%)*

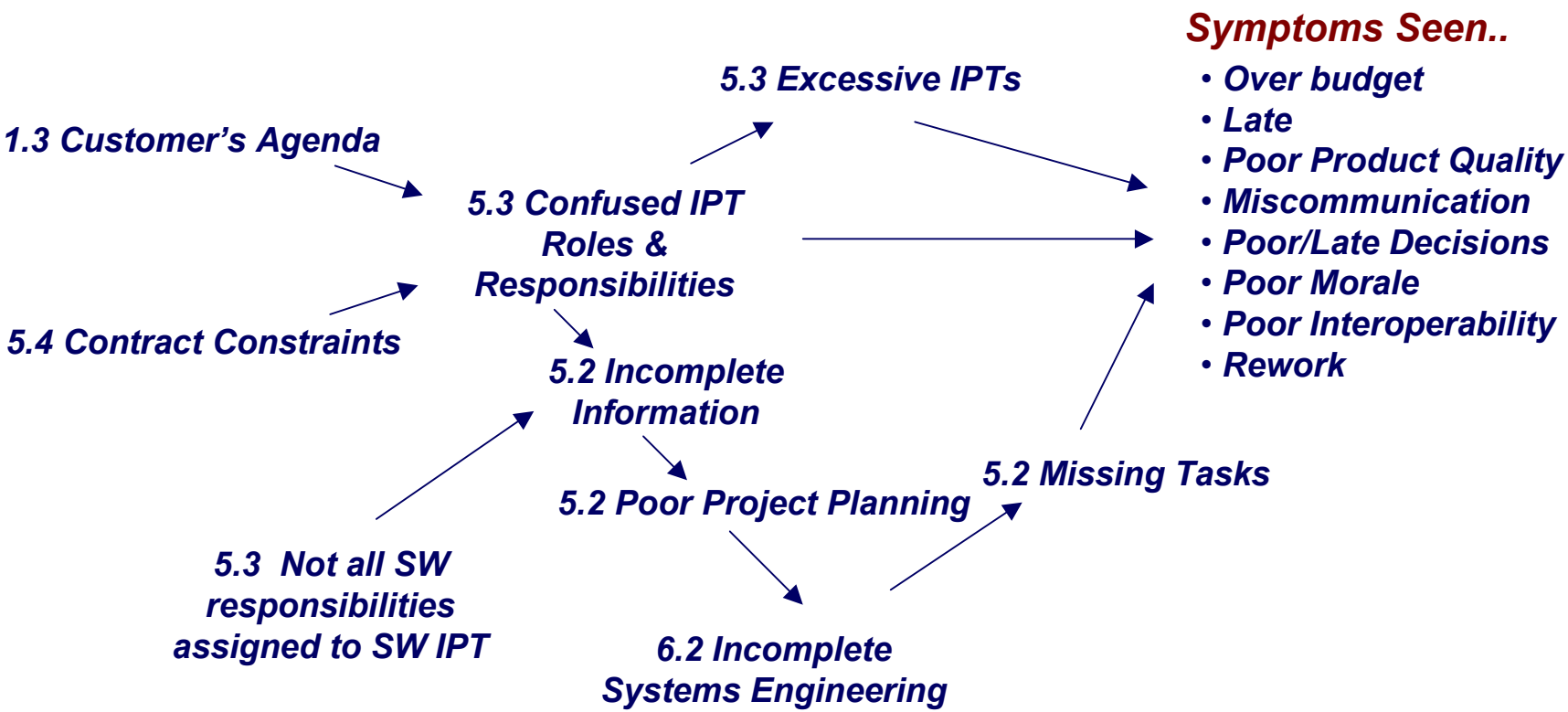
Unintended Policy Impacts (1/2)

COTS vs. Supportability

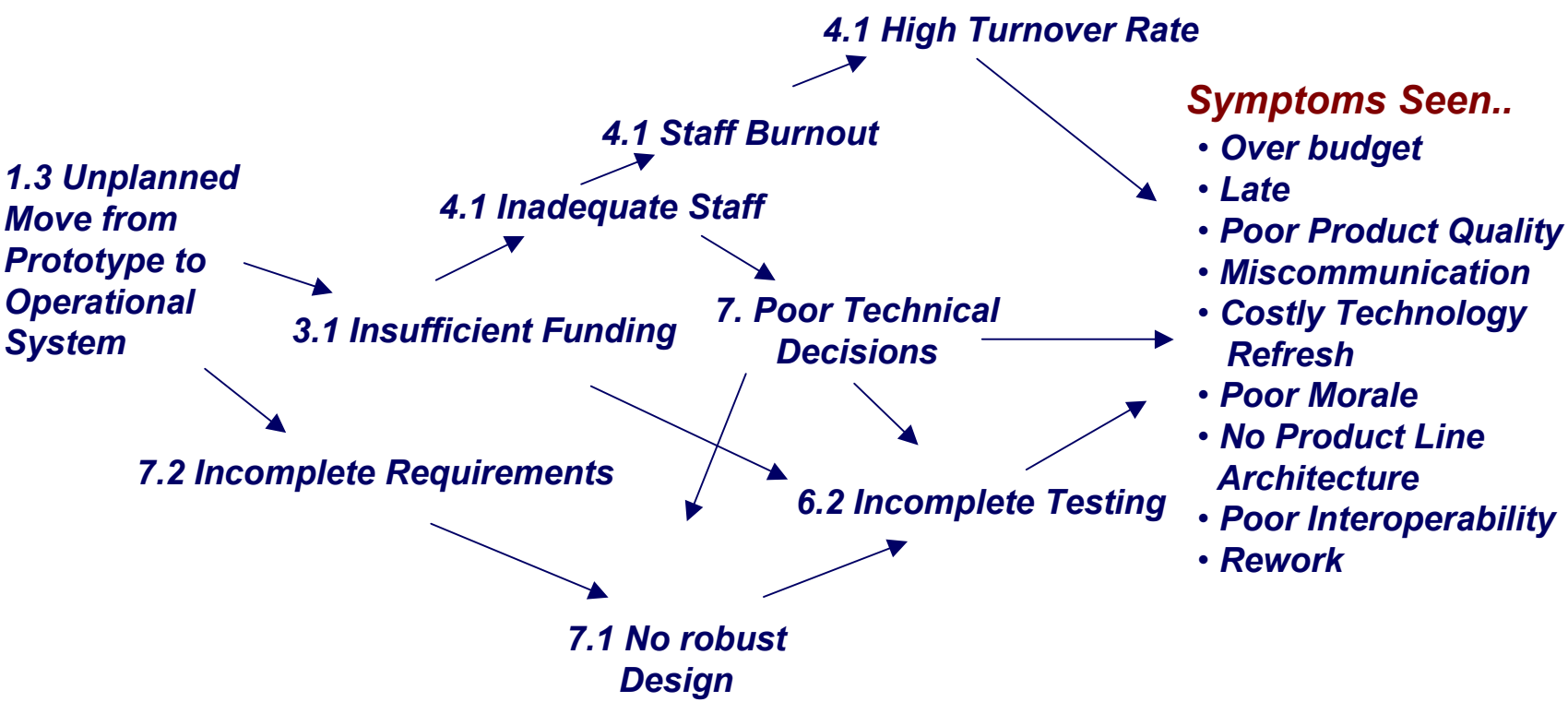


Unintended Policy Impacts (2/2)

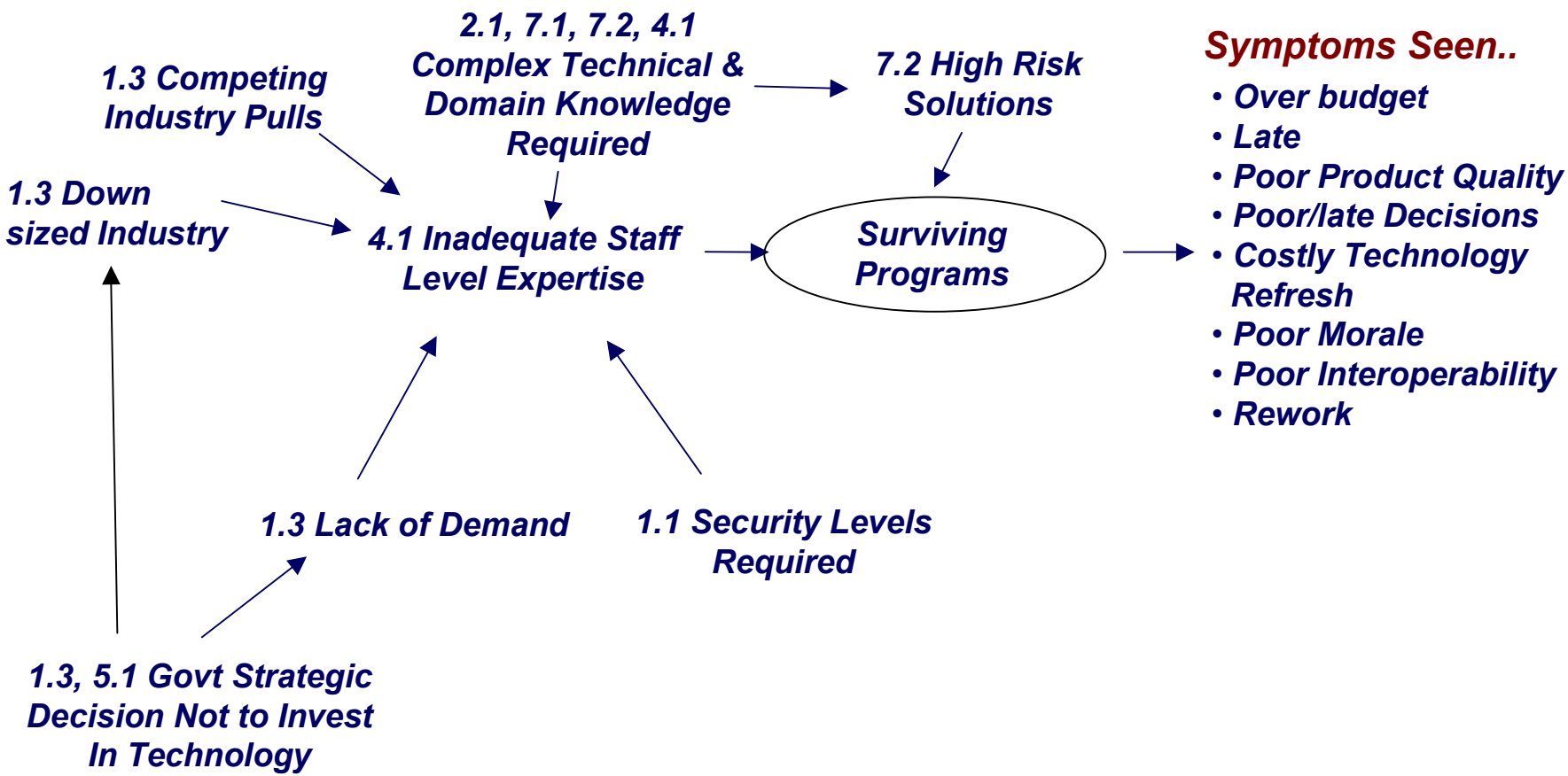
IPT Structure and Use



Premature Systems Deployment



Inadequate Resource Infrastructure



Disconnected Education & Training

Taught to Don't... →	What They Do... →	Symptoms Seen...
Set Unrealistic Cost/Schedule Targets Change Requirements Forget Risk Management Underfund Systems Engineering Forget to Communicate Cut Integration & Testing ▪ ▪ ▪	Aggressive Cost/Schedule Targets Change Requirements No Risk Reviews Shortchange Systems Engineering Unsound IPT Structure Reduce Testing ▪ ▪ ▪	• Over budget • Late • Poor Product Quality • Miscommunication • Poor/late Decisions • Costly Technology Refresh • Poor Morale • No Product Line Architecture • Poor Interoperability • Rework

Prospective Recurring Issue Patterns

- Inadequate Change Management
- Poor Technology Refresh Management
- Compliant But Inadequate Process Capability
- Incomplete Risk Management / Measurement
- Incomplete Portfolio Management
- Overly Aggressive Program Concurrency
- Unintended Impacts of Acquisition Reform

Latest TAI Findings (Phase 2)

- ***Production capability inadequately addressed***
- ***Inadequate or inappropriate development approach chosen or mandated***
- ***Intellectual property rights and proprietary issues***
- ***Unintended impacts of Congressional mandates***
- ***Management-related issues still dominate***

The Way Forward - Recommendations

- Improve and integrate IEPR results – Refine Systemic Analysis techniques
- Identify and Clarify both Issue and Success related causal patterns
- View Enterprise and Program Level corrective actions as part of an integrated solution
- Recognize and address issue and performance interdependencies
- Use a "Corrective Action Team" approach to address prioritized causative issues

Summary

- ***Systemic analysis based on real program assessment results provides a unique opportunity to use actual data to make a difference in SIS acquisition***

- ***The causes of SIS performance shortfalls are extremely complex – improvement strategies and associated action plans must address this complexity***