



A Game-Theoretic Approach to Optimizing Behaviors in Acquisition

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Project Overview

Problem

“Government As The Integrator” (GATI) is now preferred approach

Incentives among contractors may not align with program objectives

Poor contractor cooperation causes delays, overruns, poor performance

Government is still learning how to “play” the “game” of GATI acquisition

Research builds on prior work in:

- 1. Joint Program dynamic modelling*
- 2. Signalling game cybersecurity modelling*
- 3. Acquisition Archetypes*

Solution

Align contractor incentives using customized incentive mechanisms

Combine different incentive mechanisms to be more effective

Contractors acting in their interests also serves program interests

Approach

Describe & analyze GATI contractor incentives using game theory

Use agent-based modelling to quantify the game outcomes

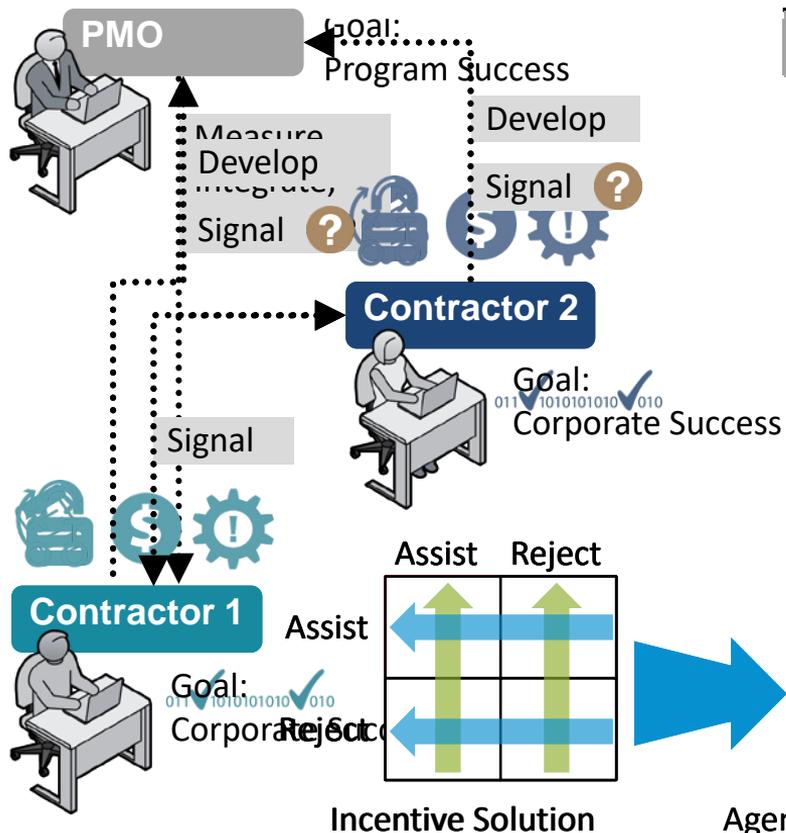
Simulate incentive mechanisms in context of a full acquisition program

Select the most promising combinations of mechanisms

2017 Work: Interview acquisition program staff to gather empirical data

Future Work: Pilot most promising mechanisms and measure results

Research Approach



12 The outcomes of the piloted efforts can be measured in terms of: 1) compliance with program's "Giver/Receiver" list schedule, 2) EVM performance and schedule variance, 3) defect counts from testing of that interface, and 4) the number of waivers/deviation requests submitted for interface issues.

Incentive Mechanisms in Combination

Distinct types of incentives affect contractors differently—and the combined impact can be more effective in influencing a range of contractors sufficiently to change their behavior.



Business: Future Business Incentives (*appeal to High-Level Management*)

- **Example: Reputation Tracking:** Reputational impacts affect future business opportunities in the absence of award or incentive fee.



Money: Direct Financial Incentives (*appeal to Project Management*)

- **Example: Truth-Revealing Incentive Mechanism (TRIM):** A sliding CPIF fee based on schedule (e.g., sooner completion, larger fee incentivizes early delivery).
- **Example: Shared Destiny:** All teams only receive as much award fee as the worst team gets, so all are incentivized to help the poorest performing team.



Social: Team Networking Incentives (*appeal to Project Teams*)

- **Example: Co-Location:** Teams with greatest potential for poor cooperation are co-located (and kept badge-less) to foster communication and trust.

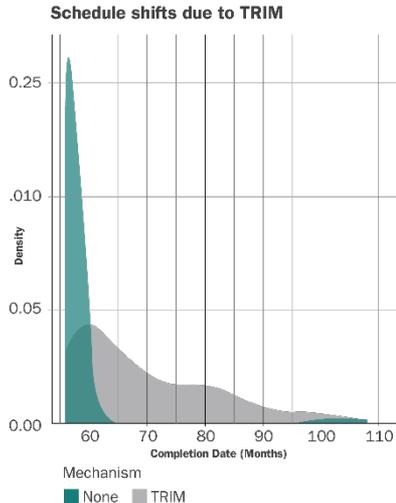
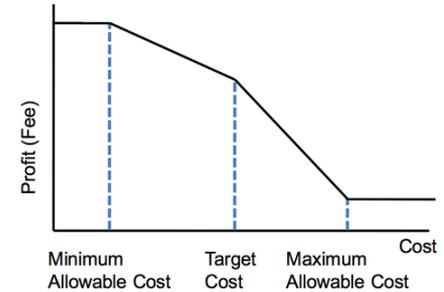
Takeaway

Combine multiple incentives to align the contractor organization with the PMO, maximizing improvement

Truth-Revealing Incentive Mechanism (TRIM)

Example: PMO wants to keep contractors working on the program, and not diverting resources toward other profitable activities

The TRIM¹ mechanism has a sliding incentive fee for CPIF² contracts based on completion date (e.g., sooner completion, larger fee, with rapidly diminishing (non-linear) returns)—incentivizing early delivery.



Using a hybrid agent-based/system dynamics model of TRIM, ran 200 simulations of contractor actions with randomized values from input distributions to determine the distribution of key performance measures.

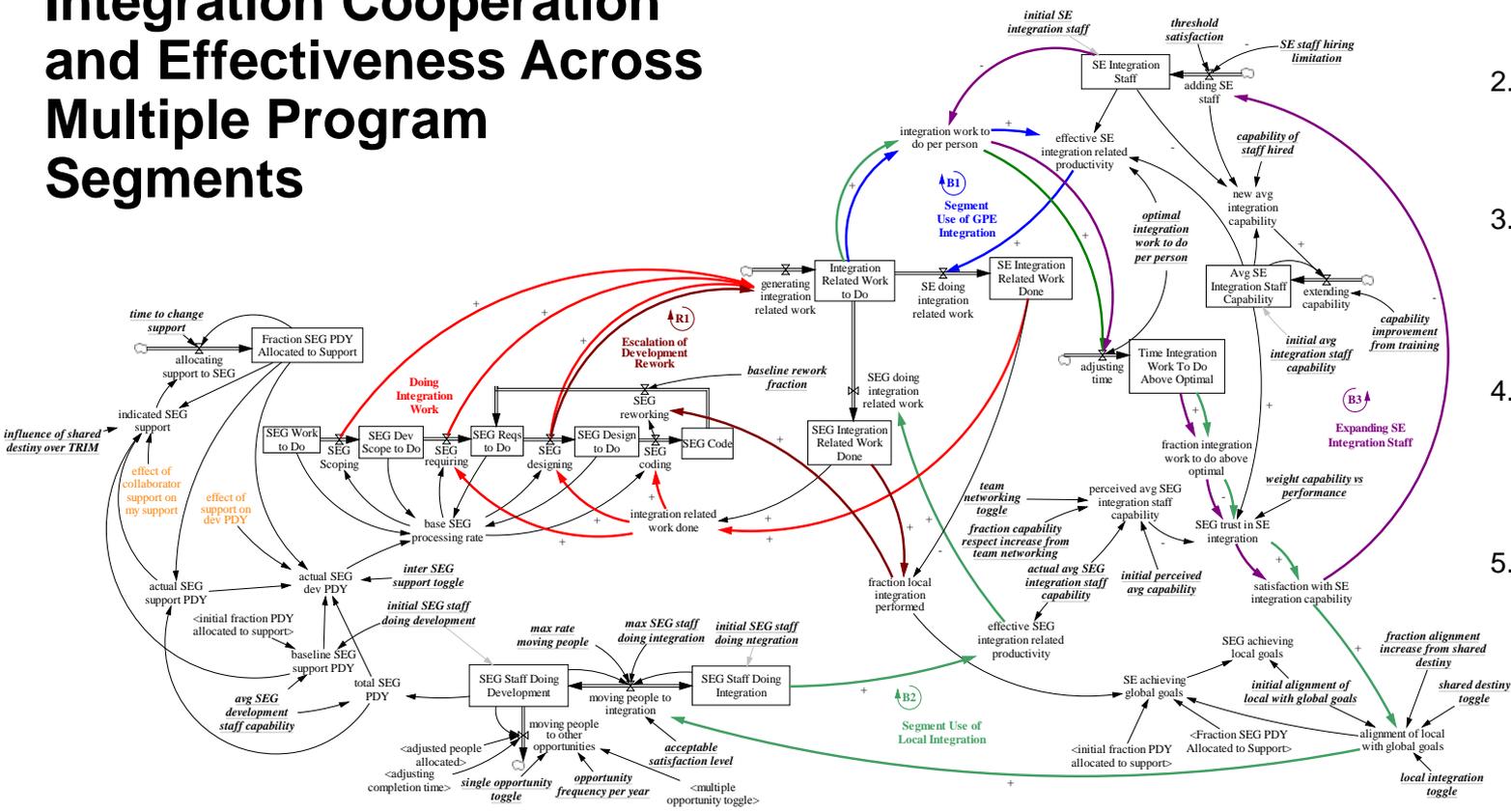
Result: For a simulated 56-month/4.5-year program:

- *With TRIM:* only 6 of 200 runs fall below on-schedule (97% on schedule)
- *Without TRIM:* no runs are on schedule, and half the runs go more than a year over

¹Truth-Revealing Incentive Mechanism [Coughlan 2010]

²Cost-Plus Incentive Fee

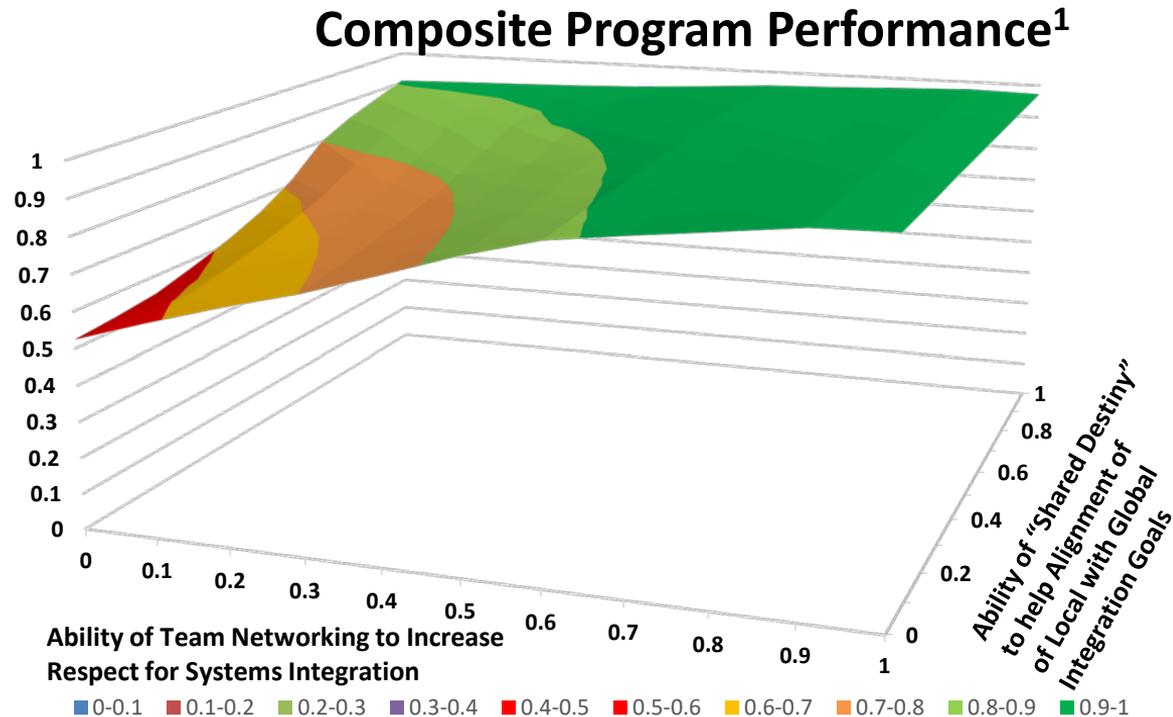
Model of Systems Engineering Integration Cooperation and Effectiveness Across Multiple Program Segments



Principles:

1. Systems Engineering is resource-restricted with respect to doing systems integration.
2. Segment integration goals are often inconsistent with program goals.
3. Segments view integration effectiveness locally, rather than at the global program level.
4. Segments see program-level Systems Engineering as wasteful and ineffective.
5. Program-level Systems Engineering is more effective than perceived.

Visualizing the Effects of Cooperation Incentives on Performance ₋₁

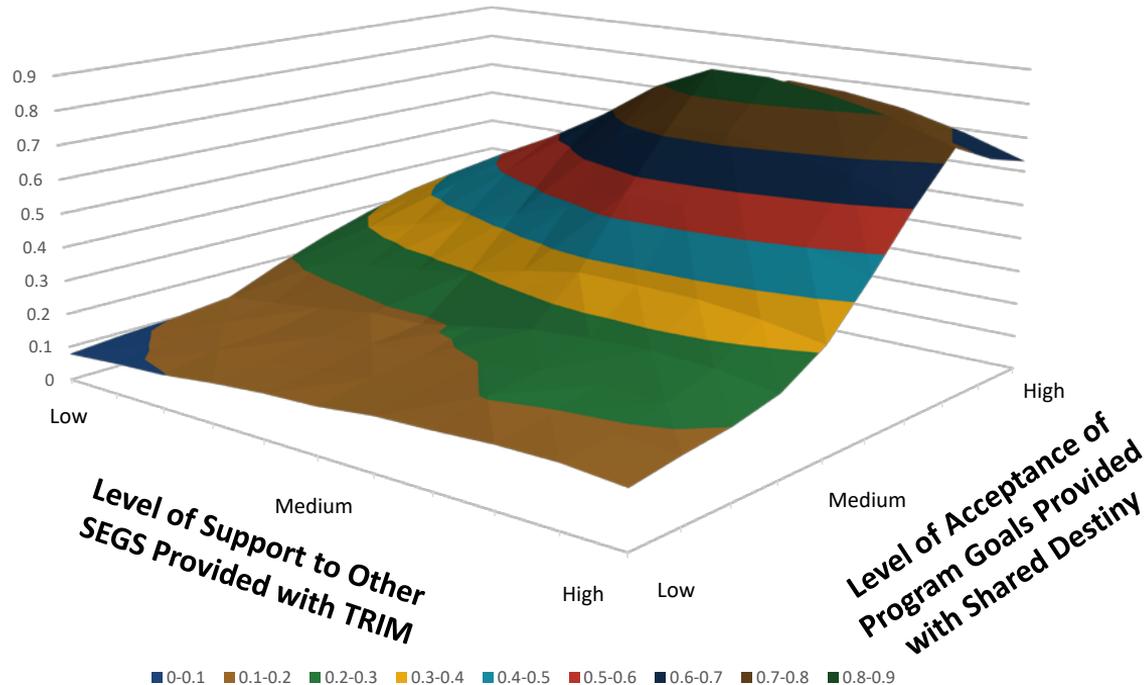


The effects of combinations of different incentive mechanisms on program performance can be analyzed and predicted

¹Composite Program Performance = Segment Schedule Performance Index * Segment Productivity Index * Extent Global Goals are Achieved

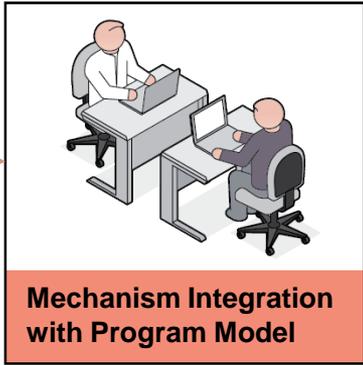
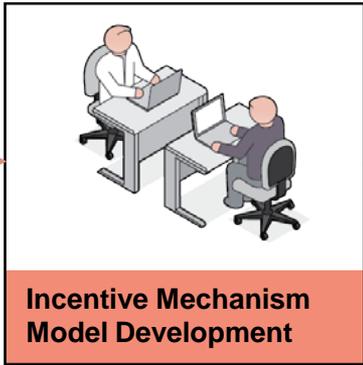
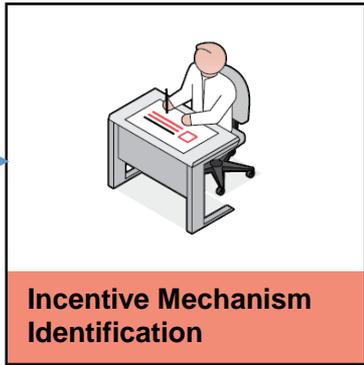
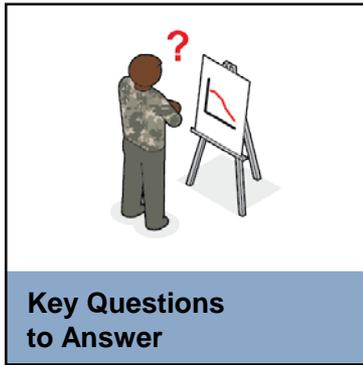
Visualizing the Effects of Cooperation Incentives on Performance -2

Composite Program Performance

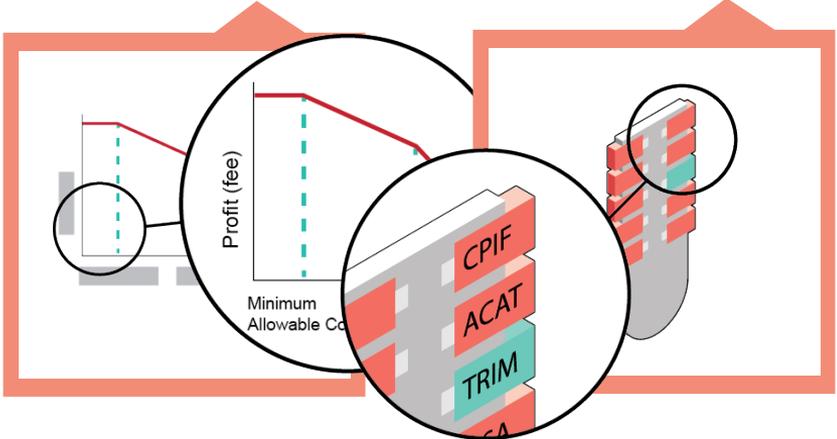


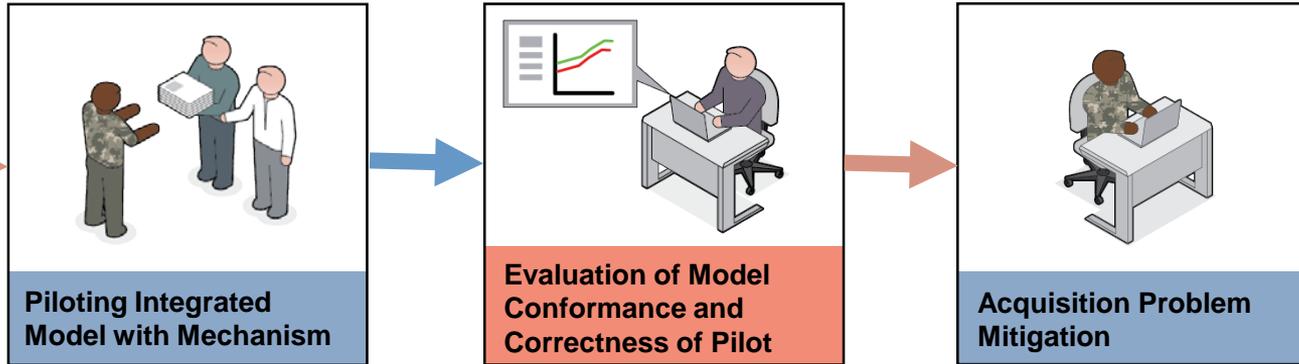
Result of combining the “Shared Destiny” and TRIM incentive mechanisms

Acquisition Program Support Engagement Model



Is poor GATI contractor cooperation hindering the program? And if so, how can I improve it?





Continuing Work

- Conduct interviews of acquisition program stakeholders, and collect feedback on game theory-based model and candidate incentive mechanisms

Future Research

- Pilot incentive mechanisms on program to validate effect on contractor cooperation

Vision

- Develop a virtual acquisition modelling laboratory serving DoD acquisition programs to help program managers make evidence-based decisions based on projected performance

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