Influence Strategies for “Constituent-Competitive” Systems of Systems

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Motivation

- Many new systems use networks (information, transportation, etc.) and combine pre-existing components
- Components need not be co-located or form systems
- Decision making in most issues requires development and use of systems
- Traditional SE does not adequately address such systems
- Other existing applied decision making methods and theory that may not be present in these systems

Need new approaches for such networks in the context of larger networks that evolve through interactions between involved stakeholders

Research Questions

- What types of relationships and interactions occur among SoS constituents and how do they determine SoS behaviors?
- How can SoS influencers affect the structure of the SoS and behavior of the constituents?

AIR Framework for SoS

Anticipation-Intervention-Response Approach as Applied in Case Study

Effect of Strategies on Stakeholders

<table>
<thead>
<tr>
<th></th>
<th>Truck Revenue</th>
<th>Rail Revenue</th>
<th>Truck Cost</th>
<th>Railroad Cost</th>
<th>Truck Profit</th>
<th>Railroad Profit</th>
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<tr>
<td>Base</td>
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<td>Co-op</td>
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<td>$1.84</td>
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<td></td>
<td>$0.44</td>
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<tr>
<td>Total</td>
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<td>$0.58</td>
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<tr>
<td>Total</td>
<td>$3.52</td>
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</table>

Three Influence Strategies

- Total revenue, cost, and profit are shown in $B
- Consider three stakeholder groups:
  - Shippers: Lowest transport costs under co-op strategy
  - Truckers: Make more in tax case. While their costs surely did increase, traffic moved to short haul routes where short-haul operators had greater price leverage. Really dislike co-op option as it is in effect a wealth transfer to the railroads.
  - Railroads: More in co-op case. They have control over the common portion of co-op routes and can get a better share than they would be having to sell via a tax service.

Model of a Transport Market

- Research existing intermodal transport system and identify relevant stakeholders in this system
- Make a simplified transport network incorporating key characteristics of each shippers and carrier decision making
- Shippers choose routes based upon an estimate of total logistics cost conditional for accuracy in price and quantifying expected profit
- Trucks and Railroads have transportation costs and decision-making processes to maximize revenue
- There are transportation costs and information delays when moving goods
- Co-op is to include economic, strategic, and qualitative decisions
- Use the model to examine the effects of different influence strategies

Conclusions

- Decision making in systems of systems can be characterized as the interplay between reduced incentives between stakeholders (and influencers) and a network of technical interfaces between systems that they operate and manage
- Influencers can use a variety of strategies to change the behavior of constituents including incentives, information, integration, institutions, and infrastructure
- Modeling can aid in understanding the interactions between decision strategies that are being employed by and the responses to influence, however, it is unlikely to be fully predictive
- Successful implementation of influence strategies depends upon understanding the effect of strategies on all involved stakeholders

Research Opportunities

- What about constituent participation choice? Case study assumed fixed constituent population. “What if participants can enter/leave”
- Frameworks that look the view that decision making is a value maximizing activity and not necessarily a maximizing activity
- Potential true for institutional elements in SoS
- What about multiple influencers who are acting at the same time (or different time)? If either competitively or cooperatively?
- Does this approach scale, or will constituents need to be grouped into populations or larger SoS are considered
- How does the principal-agent problem change as the number of agents and/or principal becomes large?