



Acquisition Research Program: Creating Synergy for Informed Change

System-of-Systems Acquisition: Alignment and Collaboration

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Topics

- Summary of Preliminary Research
- Lack of Alignment and Collaboration Issues
- Web-Based Collaboration Mechanisms
- Modeling & Simulation of Collaborative Web-Based Systems
- Successful Web-Based Systems and the Challenge to SoS Acquisition
- Conclusion



Summary of Preliminary Research

- Previous System-of-systems (SoS) acquisition research identified two important issues leading to problems in SoS acquisition:
 - lack of alignment
 - lack of collaboration.
- A collaborative web-based system is proposed
 - Personnel of all SoS associated programs can input and retrieve information required to align individual programs.
- Development of the SoS and component systems is treated as a critical-path network
 - Need points for SoS-component collaboration component are identified
- Successful collaborative web-based systems have been analyzed and a success factor has been identified
- An attraction mechanism to effect SoS inter-program collaboration has been characterized



Lack of Alignment Issues

- Most common type of DoD SoS development is one in which a SoS is to be created by integrating separately developed systems – legacy systems, developmental systems, or some combination of both
- Lack of alignment means a system is not ready for its integration into a SoS, a result of
 - Lack of the front-end SoS systems engineering (SE)
 - And/or lack of collaboration
- SoS integration testing requires the availability of surrogates and later the “as built” component systems in a timely manner
 - Acquisition schedules for the component systems are typically developed independently of the SoS development schedule.
 - No assurance that the SoS integration testing can be completed as planned
 - Even when the schedules are aligned a component system may not meet the performance or interface requirements



Lack of Collaboration Issues

- The lack of alignment is related to the lack of collaboration.
- Collaboration in the development of a SoS is multi-dimensional
 - Between DoD system program offices
 - Between contractors
 - Between DoD program offices and contractors
- Inter-organizational collaboration requires collaborative capacity - the ability of individual system programs to enter into, develop, and sustain inter-system programs in the pursuit of SoS collective outcomes



Issues in Achieving Effective SoS Collaboration

- Individual system programs must have the ability to enter into, develop, and sustain inter-systems programs collaboration
 - There must be a mechanism of to develop and maintain such an ability.
- Mechanisms include structures for coordination
 - Meetings, deadlines, etc.; sufficient authority of participants; clarity of roles; and assets such as personnel that are dedicated for collaboration
 - Interpersonal networks, effective communication and information exchange, technical interoperability, and training (Hocevar et al. 2006)
- Mechanisms remove barriers against and implement factors favorable to the realization of collaborations
- However, there is cost associated with implementing and maintaining collaboration mechanisms

Hocevar, S.P., Thomas, G.F., & Jansen, E., "Building collaborative capacity: An innovative strategy for homeland security preparedness," in Beyerlein, Beyerlein & Kennedy (Eds.), *Advances in interdisciplinary studies of work teams: Innovations through collaboration*, pp. 263-283, Vol. 12, New York: Elsevier JAI Press, 2006.



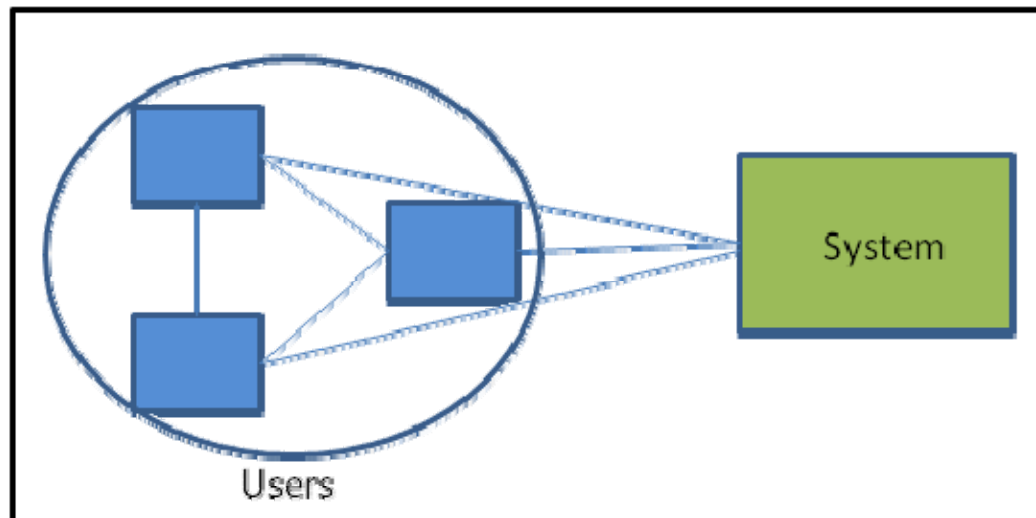
Web-Based Collaboration Mechanisms

- In this work, the key idea is to capitalize on collaborative behavior observed on some existing web-based systems
 - Web-based systems minimize the cost of face-to-face meetings yet meet collaboration requirements including support of interpersonal networks, effective communication, ease of training, ...
- The web-based system concept inspires the mechanism proposed in this research for inter-program collaboration
- A collaborative web-based system is proposed, on which personnel of all programs associated with a SoS can input and retrieve information required to align the individual programs
- To identify and assess the issues associated with achieving web-based inter-program collaboration, modeling and simulation (M&S) is employed



Modeling and Simulation of Successful Web-Based Collaborative Systems

- What are the factors that lead to successful collaboration in on-line systems?
- Successful on-line systems have been analyzed by modeling them as SoSs consisting of users, data bases, computers and networks



Three Successful Web-Based Systems Have Been Analyzed Using M&S

- eBay, Facebook & Xerox's Eureka
- Each was modeled using the discrete event simulation application Extend™
- Attractor mechanisms are key to achieving a sustainable, high participation rate
- Each model included a function of cost and/or value that influenced the attractor mechanism
- Cost and/or value functions all had the form of S curves

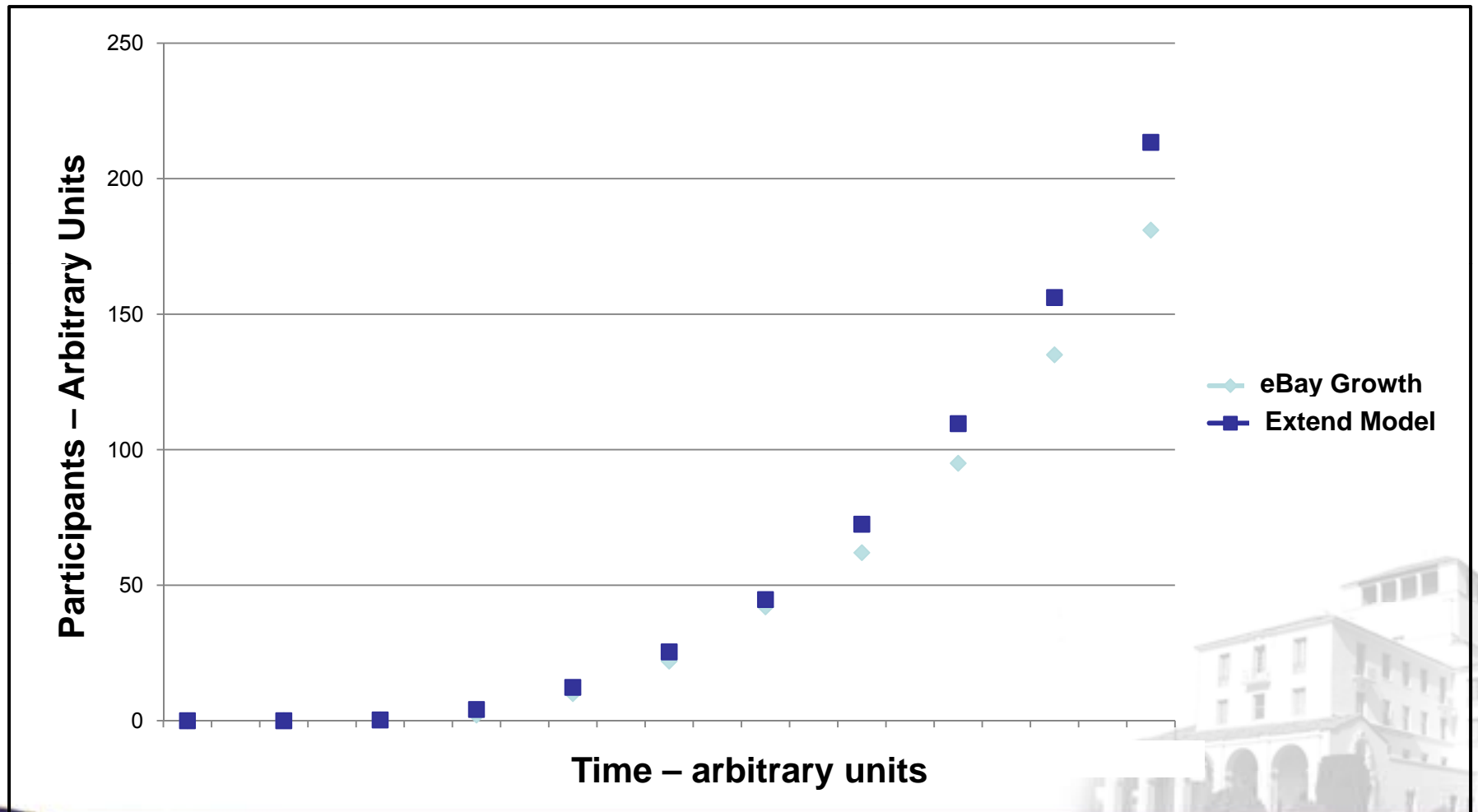


eBay

- eBay is an on-line auction and shopping website
- Value to the seller is low cost of sales and potentially a large number of buyers
- Value to the buyer is a wide selection of goods at low prices
- One of the important costs is risk, both to the buyer and seller
 - Buyer may not get goods or the goods may be misrepresented
 - Seller may not get paid
- Initially the risk was high but decreased with time as seller ratings and secure payment methods were introduced
- Risk = $1/(1 + e^{(t/2 - t)})$, an S-shaped function where t is the time after the start of eBay



eBay Model Results

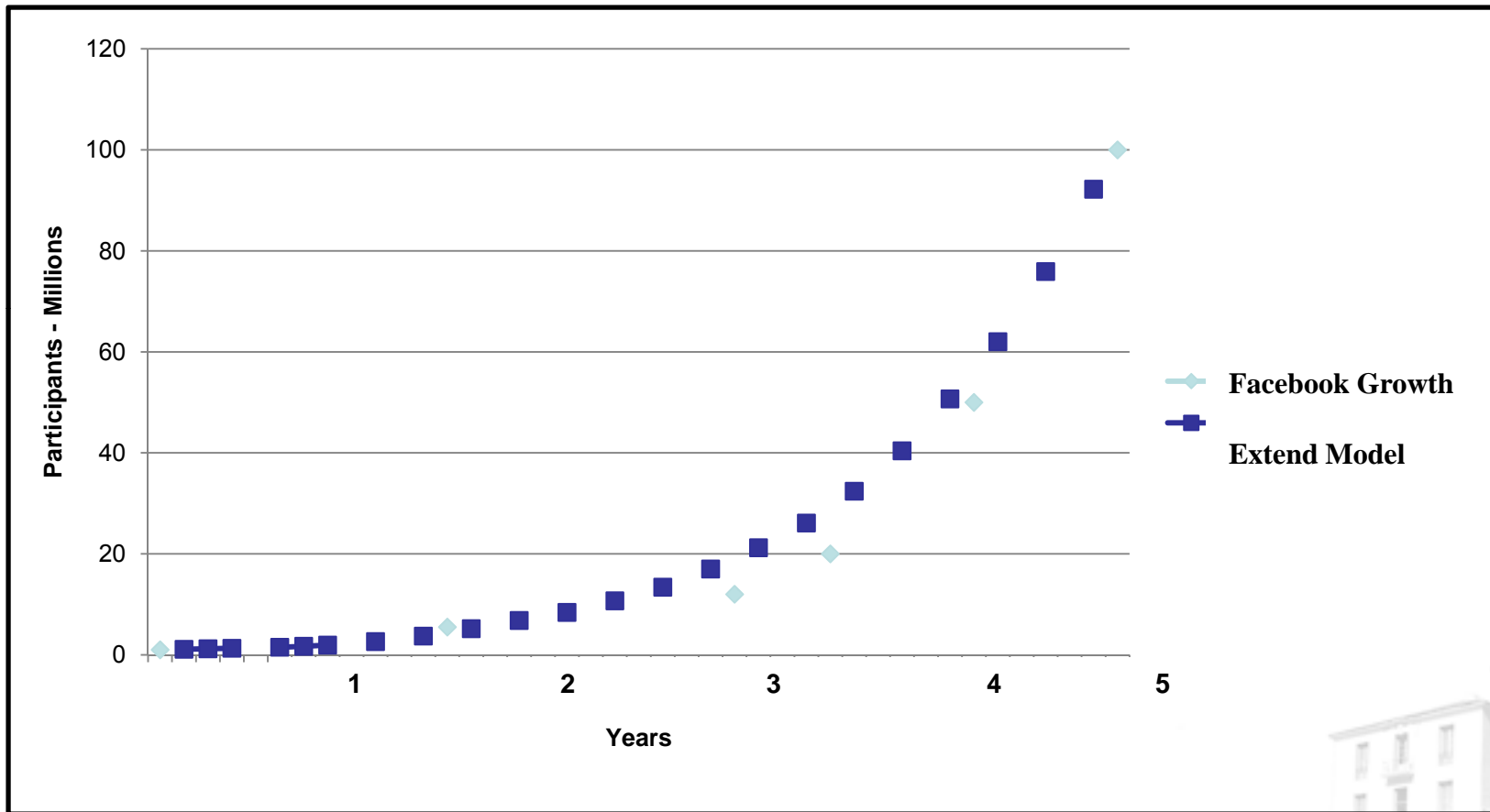


Facebook

- Facebook facilitates people forming social networks with their friends
- Value to participants is ability to communicate on a regular basis with a large number of friends by posting text and pictures
- Cost is the time and effort to maintain one's network of friends.
- Cost = $1/(1 + e^{(N/2 - N)})$, an S-shaped function where N is the number of friends in a network and $N = 130$ for the average Facebook participant



Facebook Model Results



Xerox's Eureka System

- Eureka allows service engineers to search on-line for solutions to copier miss-usage and repair problems
- A few expert service engineers initially populated the system with ~200 validated problem solving tips
- Other technicians began to utilize the database of validated tips and then occasionally would enter new tips
- Interestingly – even though the system allowed service engineers to save time - the main value to service engineers seems to be peer recognition received when credited with a useful tip
- Recognition = $1/(1 + e^{(T/2 - T)})$, an S-shaped function where T is the number of tips credited to an individual and T = 5 for the average Eureka service engineer. It seems that at T = 5 the additional recognition was not worth the additional effort to enter a new tip.



Calibration of the Eureka Model to Best Fit Xerox Data

Parameter	Eureka	Extend Model	Model Result	Expected Result Based on Scaling
Initial tips	200	10		
Technicians	19,000	1000		
Problems	50,000 (estimated)	2500		
Tips	36,000 @ 5 years		1820 @ 5 years	1800 @ 5 years
Participation rate	79%		65% @ 5 years	79% @ 5 years
Reduction in time to solve problems	~10%		~10%	~10%



Successful Web-Based Systems and the Challenge to SoS Acquisition

- Successful on-line collaborative systems have attractor mechanisms that are governed by a positive value/cost attractor mechanism
- The challenge in SoS acquisition is to develop an attractor mechanism that provides positive value to individual SoS programs
- There is value to the overall SoS program office at minimal cost
 - Better control of cost and schedule
 - Higher assurance of meeting performance goals
- There is higher cost to the component system program offices
 - Investment in implementing the system and training
 - More time spent in the collaborative process
- What is the value to the individual program offices?
 - Typically PMs are judged and rewarded on the basis of meeting their own program's cost, schedule and performance goals, not the SoS'
- The challenge is to provide sufficient value to individual programs in an on-line collaborative system



Conclusion

- System-of-systems (SoS) acquisition research has identified lack of alignment and lack of collaboration as two important issues leading to problems in SoS acquisition
- A collaborative web-based system is proposed, on which personnel of all programs associated with a SoS can input and retrieve information required to align the individual programs
- An attraction mechanism to effect SoS inter-program collaboration must be identified
- This work will form a basis for building a web-based SoS collaborative system to support DoD SoS acquisition programs

