Integrated Maintenance Mission Operations Center Study

Sponsored by:

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GEORGE MASON UNIVERSITY

OR 680: Applications Seminar
Spring 2007

Joshua Icore
Mark Icore
Capt Scott Sweeney

Agenda

- 1430 Team Introductions and Agenda J. Icore
  - Slides 1-3
- 1430-1440 Problem Statement, Background, and Context S. Sweeney
  - Slides 4-8
- 1440-1450 Approach and Analysis M. Icore
  - Slides 9-15
- 1450- Conclusions and The Way Forward J. Icore
  - Slides 16-22

Team Introductions

- IMMOC Study Team
  - Joshua Icore, Team Lead
  - Mark Icore
  - Capt Scott Sweeney
- Sponsor:
  - Lockheed Martin Corporation
    Information Systems & Global Services
    Mission & Combat Support Systems
    - Mr. David Dumont
      - Sr. PM: Operations & Systems Evolution Support
    - Ms. Yolanda Lee
      - Project Engineer: Operations & Systems Evolution Support
- Academic Advisor
  - Dr. Kathryn Laskey

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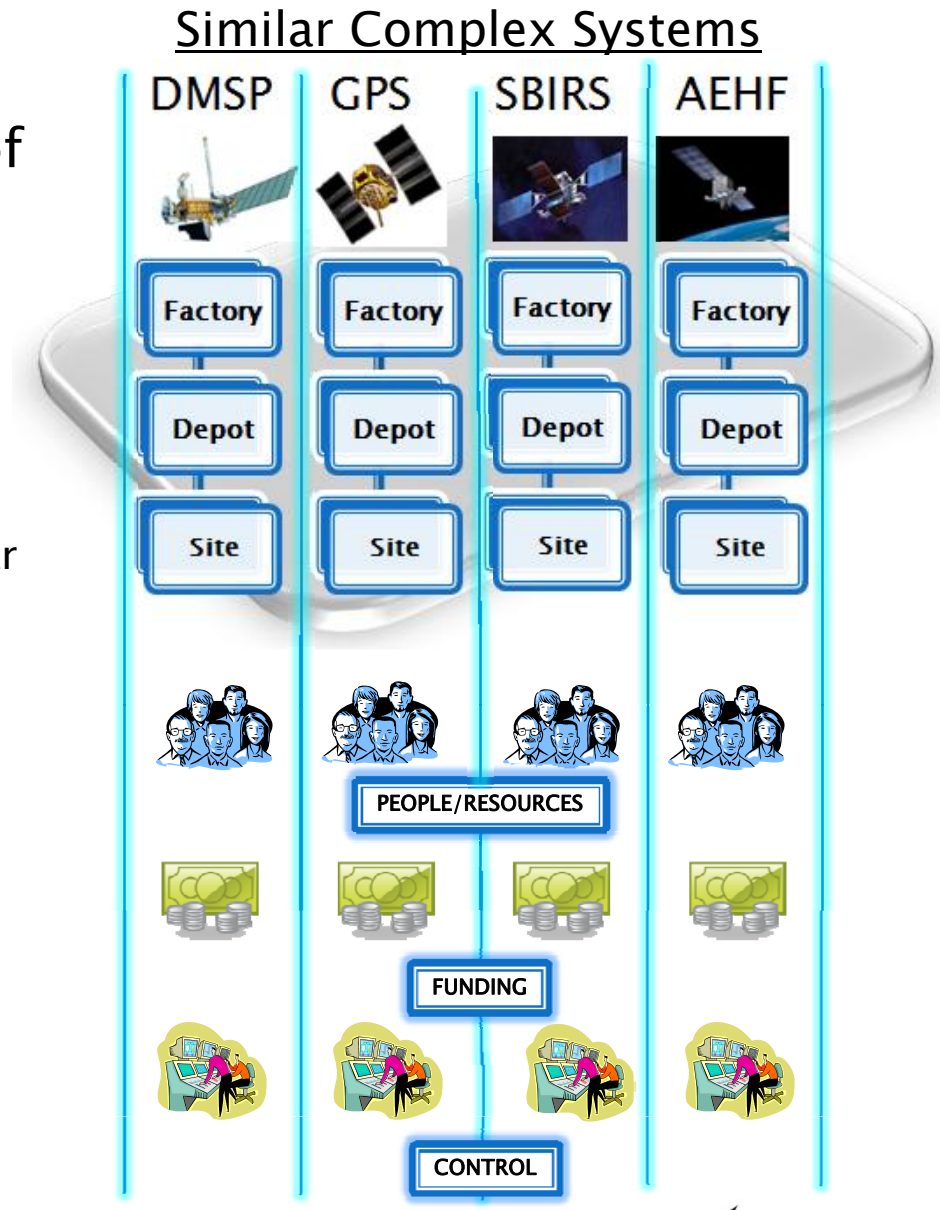
The Problem

- Complex systems require significant maintenance set of activities
  - Software, hardware training, logistics, etc
- Most systems typically have their own maintenance **stovepipe**
  - Resources are only for that particular system
    - No sharing between similar systems
  - 3-level hierarchy: Operational Site, Depot, Factory
  - Maintenance is often sized to accommodate worst case situations (i.e.. Murphy's Law)
  - Very costly and inefficient as resources are often underutilized
  - Operations control maintenance activities
  - **Expensive!**



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Objectives and Scope

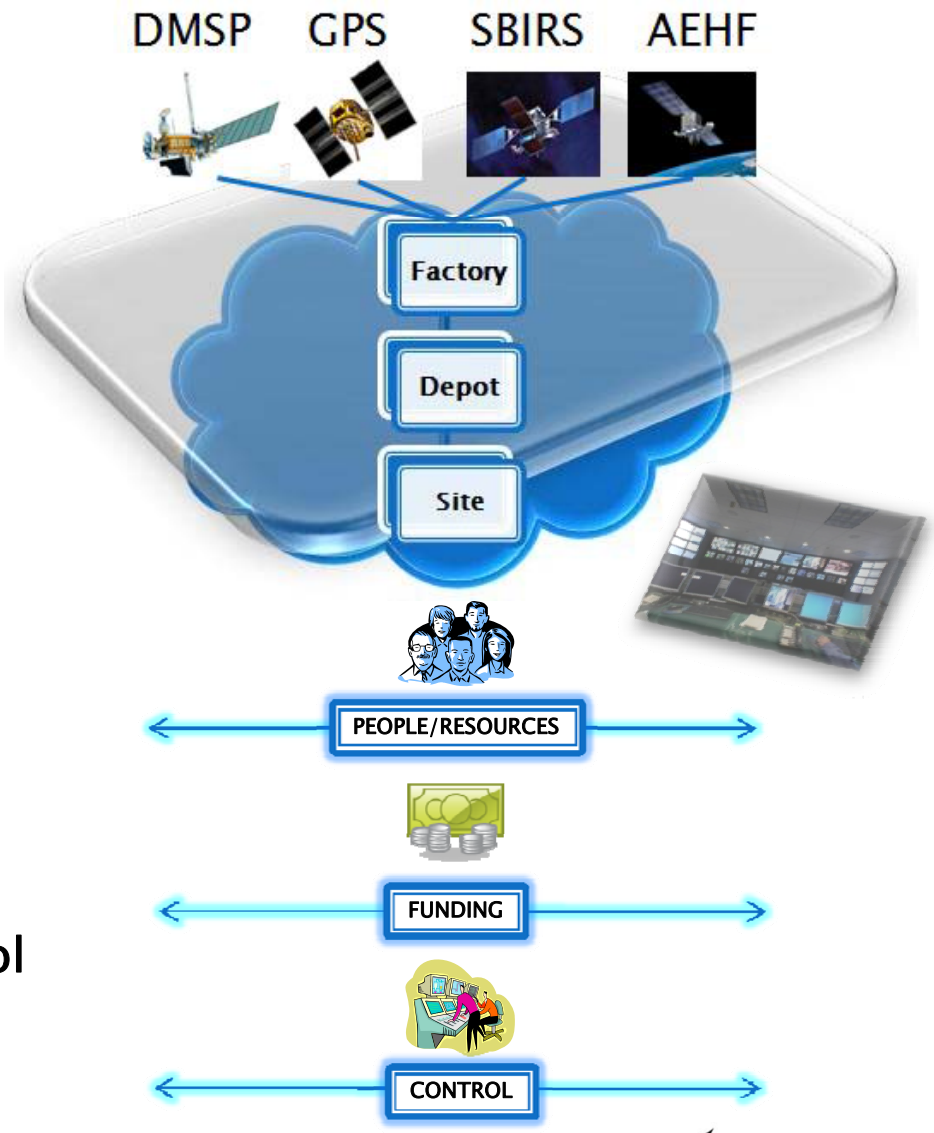
- Objective:
  - Reduce space-based system maintenance costs across common segments and improve maintenance execution
- Goal:
  - Create a framework for defining maintenance as service
  - Create a system for providing maintenance to multiple space-based systems
  - Analyze the mission requirements for the integrated maintenance mission system
- Scope:
  - Systems engineering effort focused on mission analysis
    - Top tier requirements
    - Objectives
    - Mission definitions

Proposed Solution

- Consolidate maintenance elements to realize:
  - increased efficiencies
  - reduced system downtime
  - reduced costs
  - *without degrading system performance*.

- The Integrated Maintenance Mission Operations Center
  - Performs system **Overwatch** tracking the operational status of the maintenance mission
  - Executes **Command and Control** of maintenance components

Similar Complex Systems



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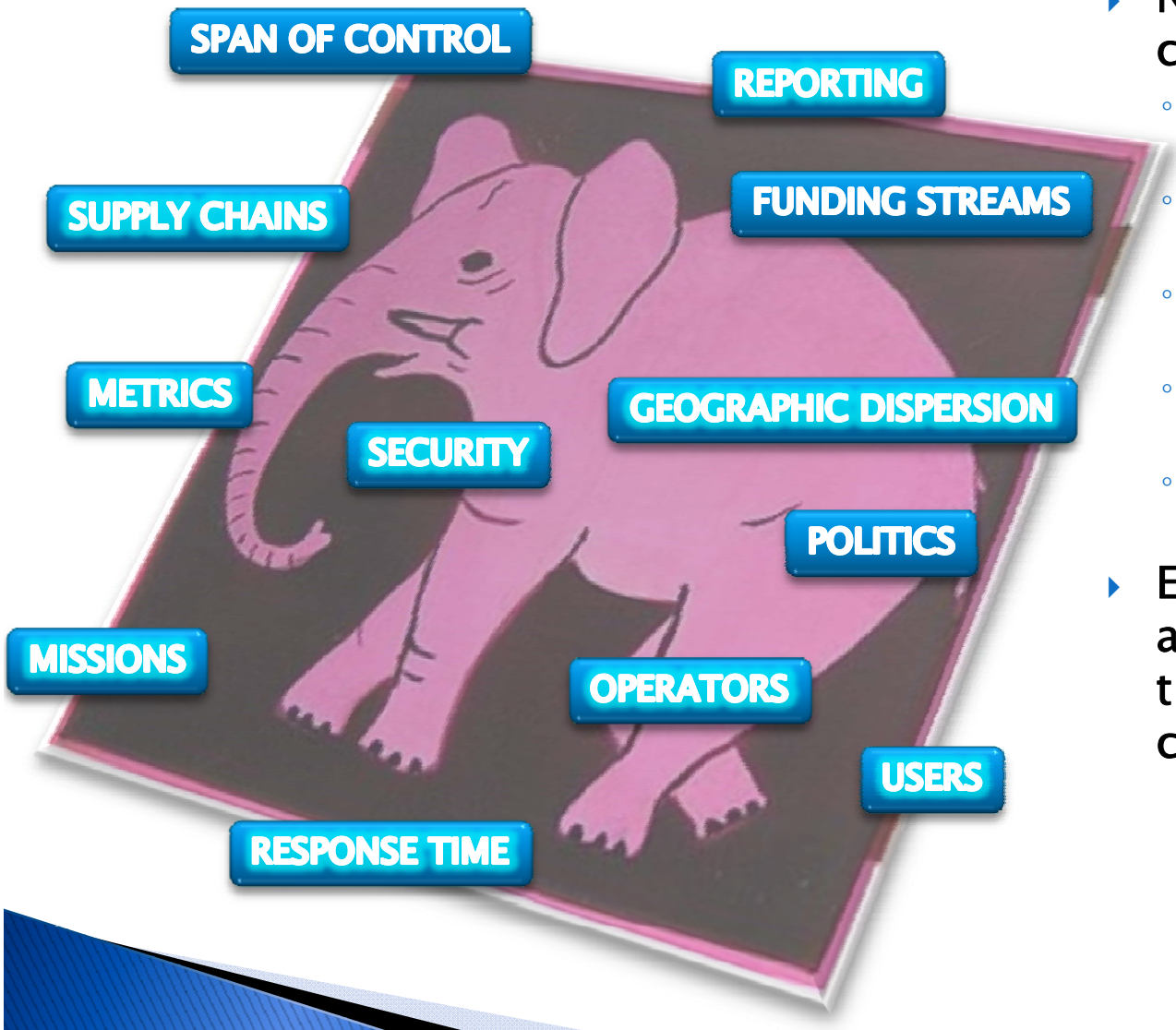
IMMOC Mission Objectives

- Overwatch:
  - Gather data from operational entities and presenting that information to stakeholders in some manner for the purposes of reporting
  - Aggregate and disaggregate data enabling data examination at arbitrary detail
  - Monitor all maintenance-relevant components at maintenance mission sites
    - Communications links
    - Facility status
    - Logistics systems
    - Mechanical systems
    - Computing systems
    - Financial systems
    - Maintenance operation systems
    - Personnel systems
  - Assemble the status data into a comprehensive picture (state of health)
  - Collect pertinent metrics
- Command and Control
  - Direction of maintenance actions throughout the integrated maintenance system.
  - Prioritize maintenance requirements across operational systems
  - Execute and direct baseline changes
  - Establish ad hoc and permanent logistics pathways
  - Analyze metrics for capacity and availability planning
  - Execute maintenance system optimization based on trend data

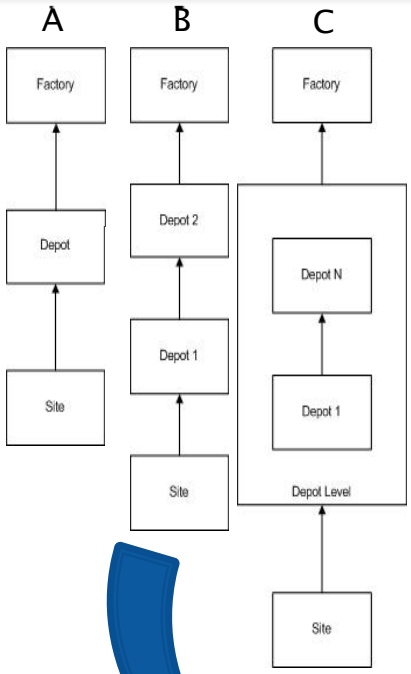
Isn't this obvious? (Maybe not…)



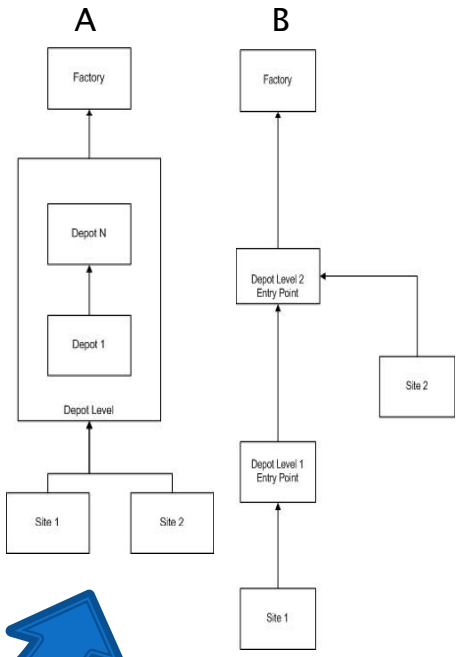
- Numerous challenges to consolidation
  - Financial
    - Good idea; I'm not paying for it!
  - Political
    - Whose district loses job?
  - User Expectations
    - I want it they way I'm used to it!
  - Control
    - Good idea; put me in charge!
  - Security
    - Do you really need to know?
- Each problem needs to be addressed in turn, and in the context of all challenges

Maintenance System Evolution

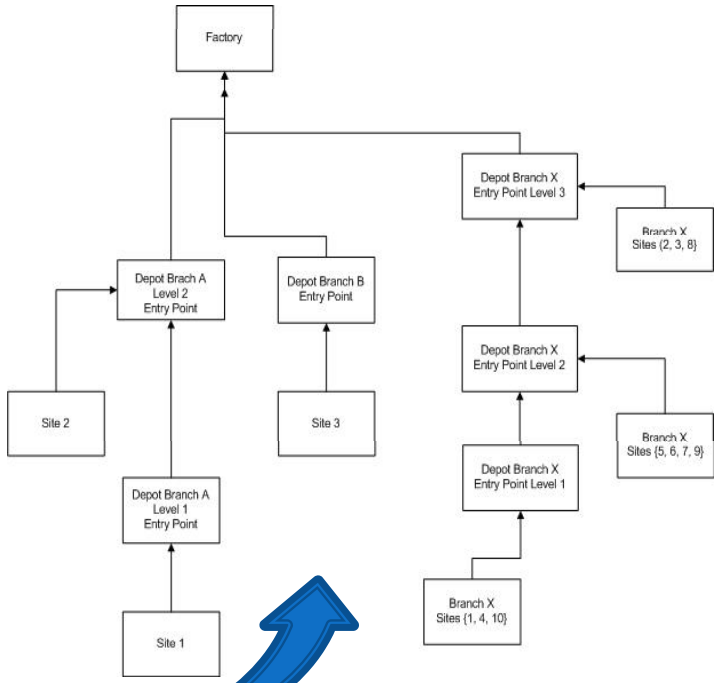
Integrated Maintenance Evolution to an n-Tiered Chain



Multi-Site Extensions to the Integrated Maintenance Chain



Evolution of Multi-Site Maintenance Chains To Multi-Depot Chains



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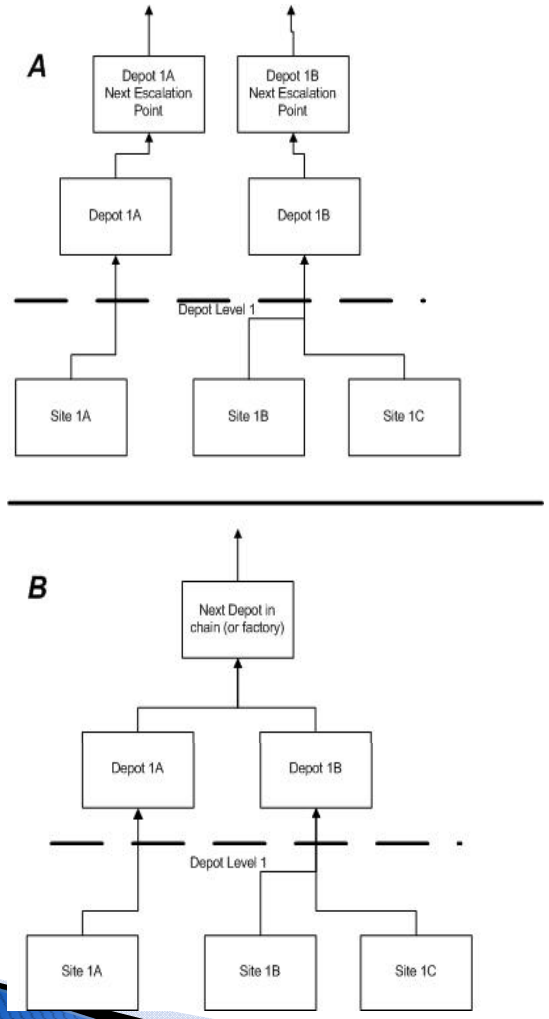
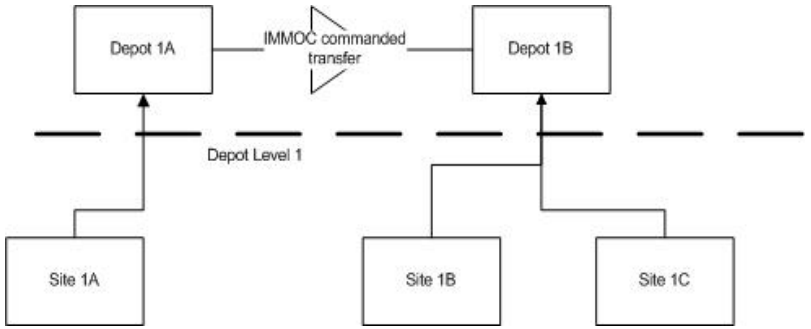
IMMOC Command and Control

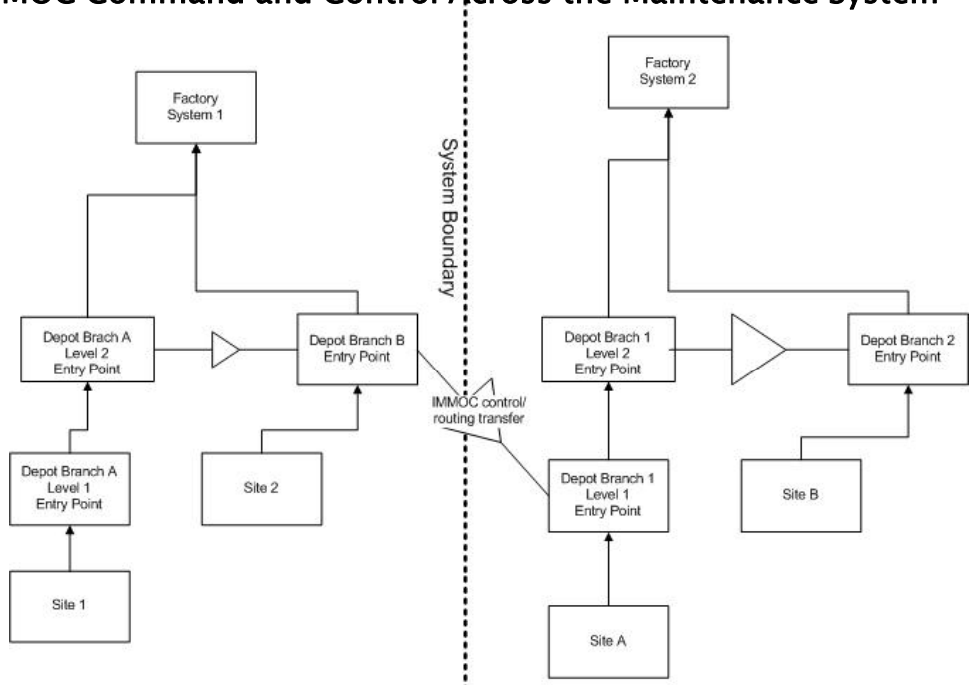
Lack of Centralized Control Prohibits Horizontal Work Shifts and Mandates Escalation



IMMOC-Directed Maintenance Action Rerouting



IMMOC Command and Control Across the Maintenance System



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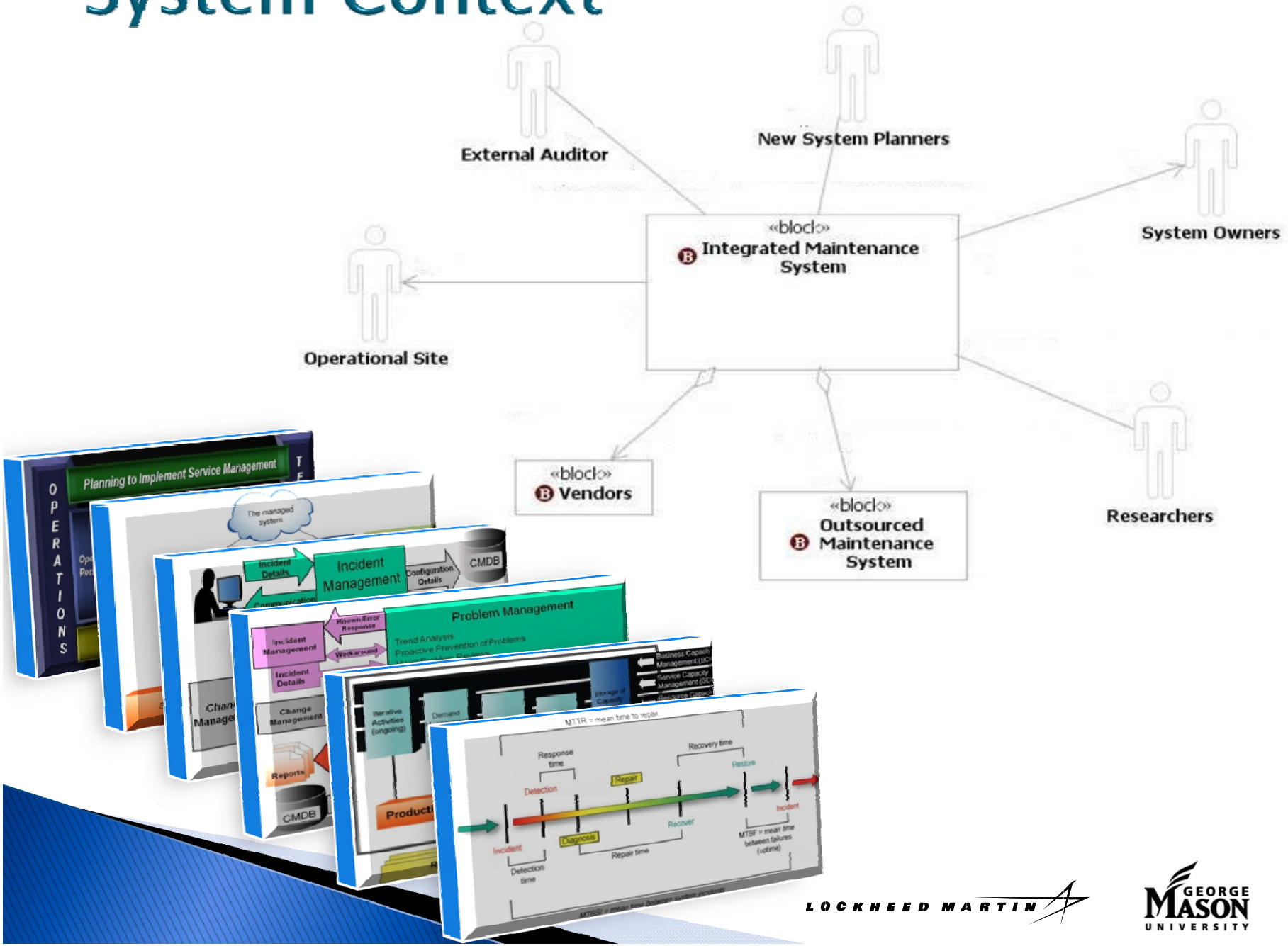
System Context



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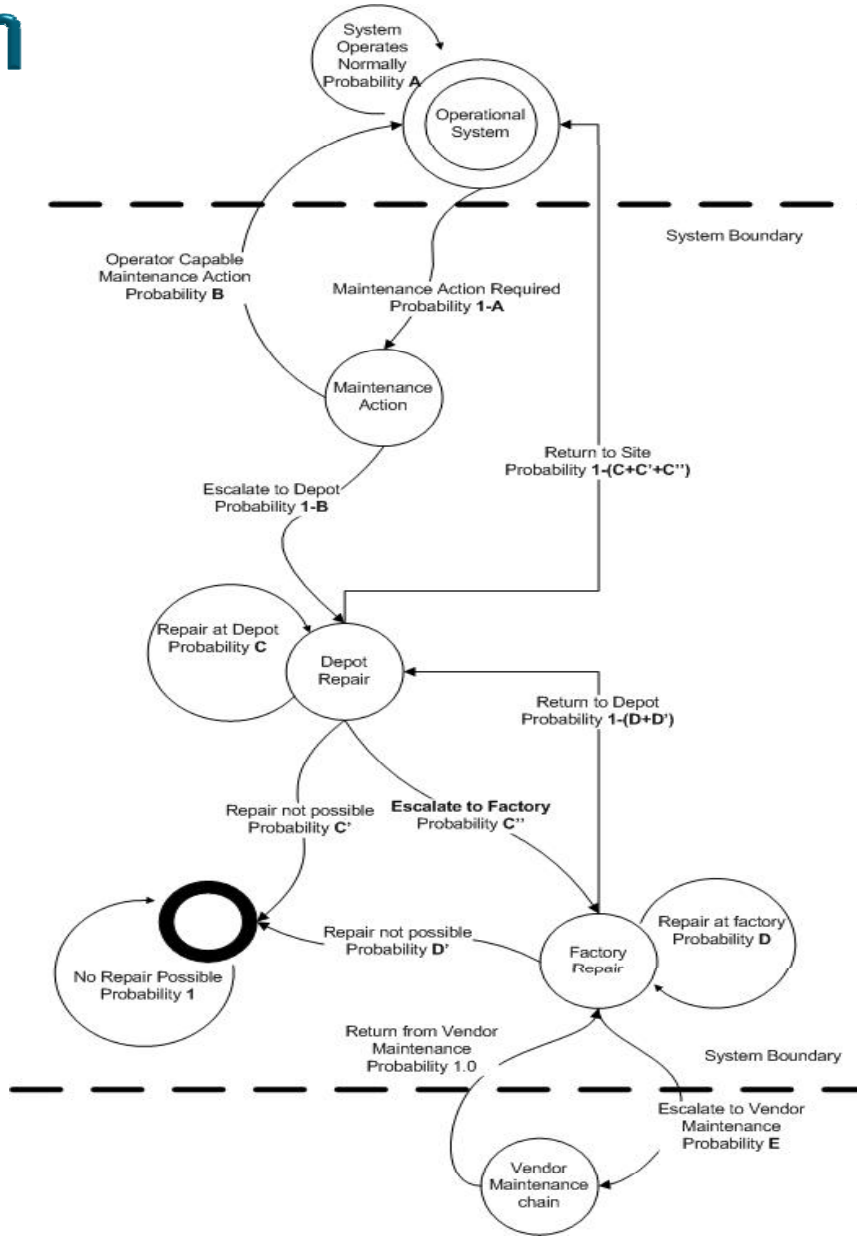
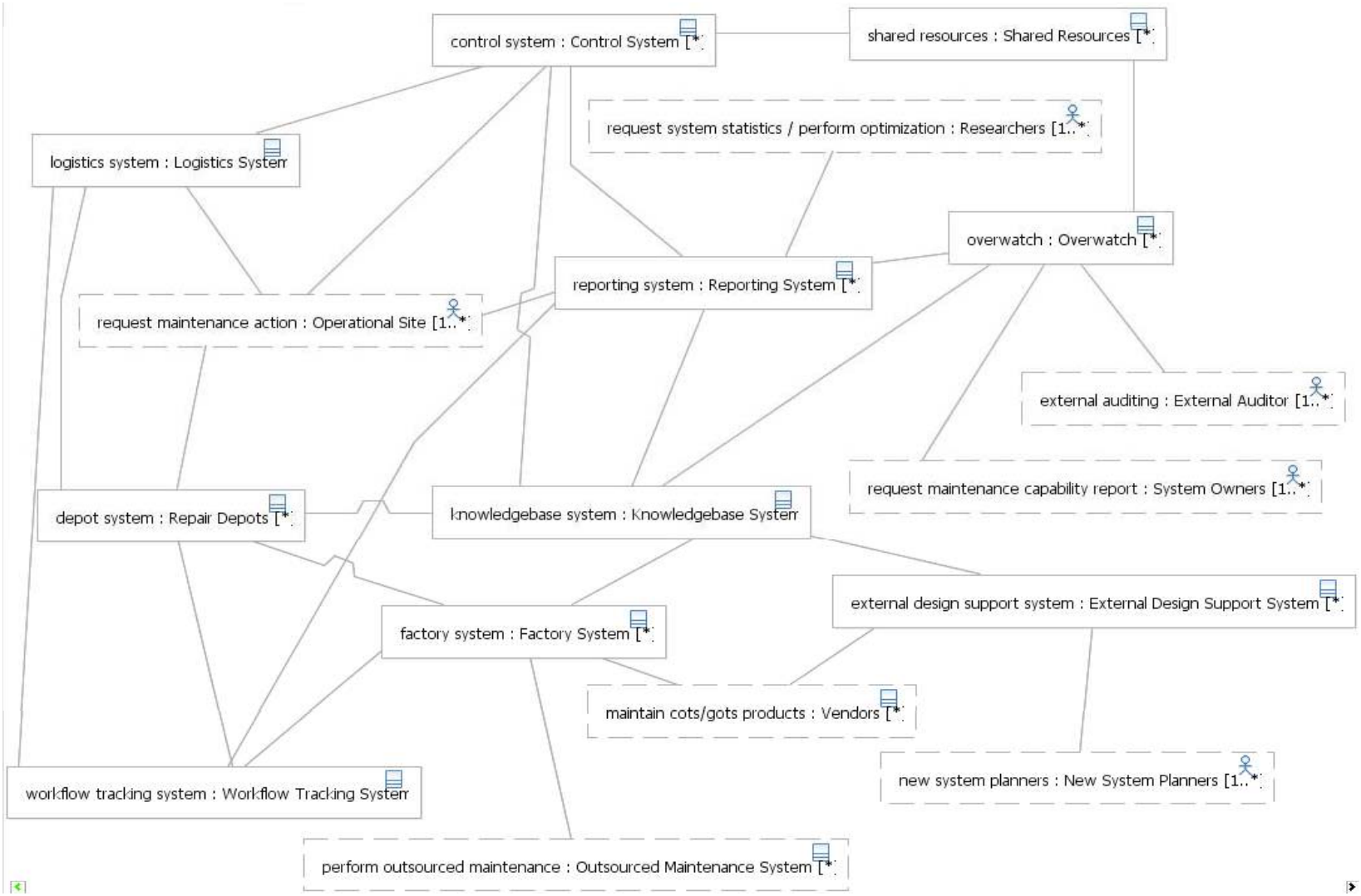
Maintenance System

- Probabilistic model of maintenance actions relative to the operational state
  - Operational perspective: maximize A (system remains operational)
  - Maintenance perspective: minimize 1-B (return to operations via site maintenance)
  - Need to examine cost factor of E (vendor escalation)
- Common frame of reference for study



Tier-1 System Decomposition



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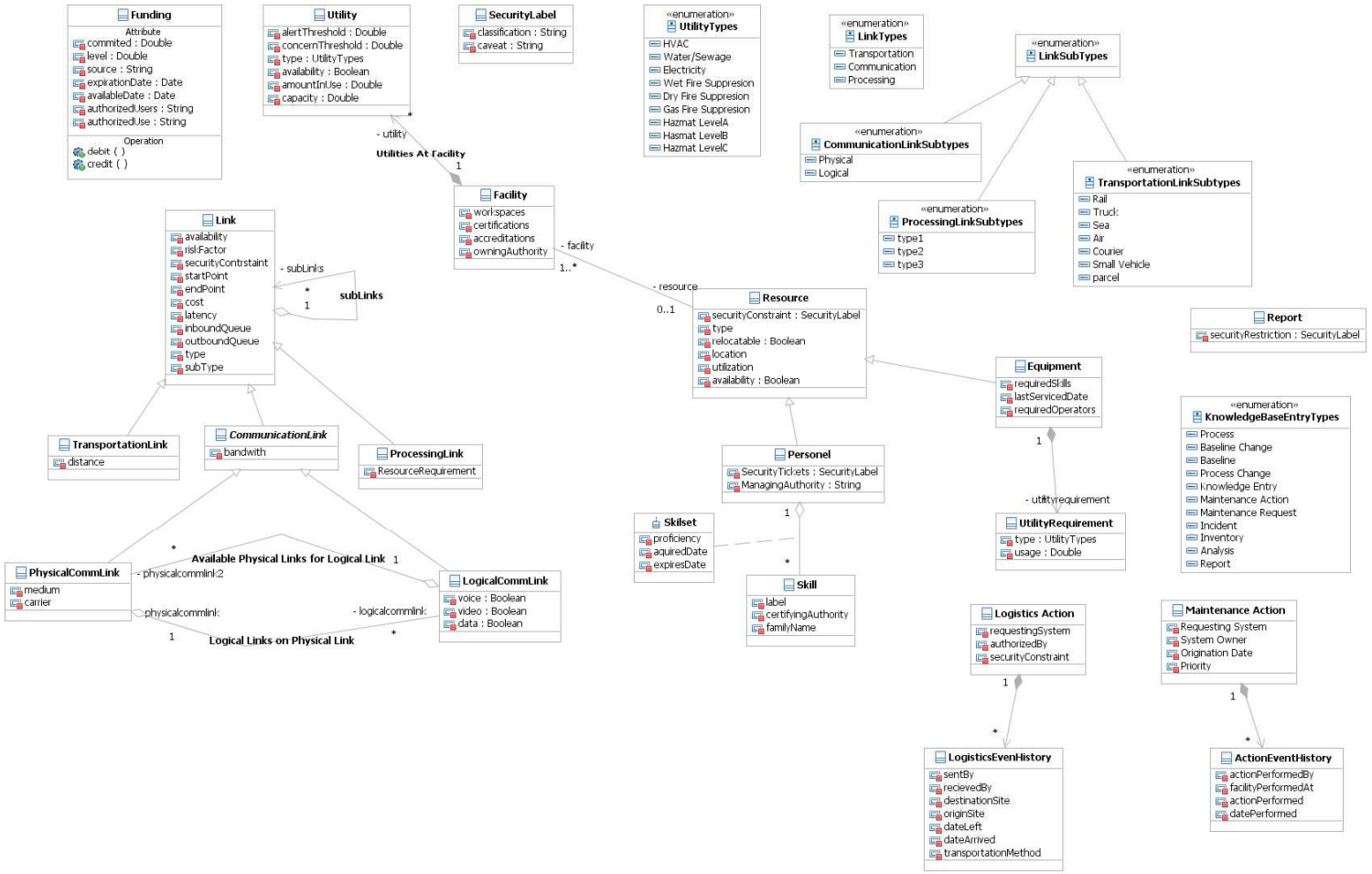
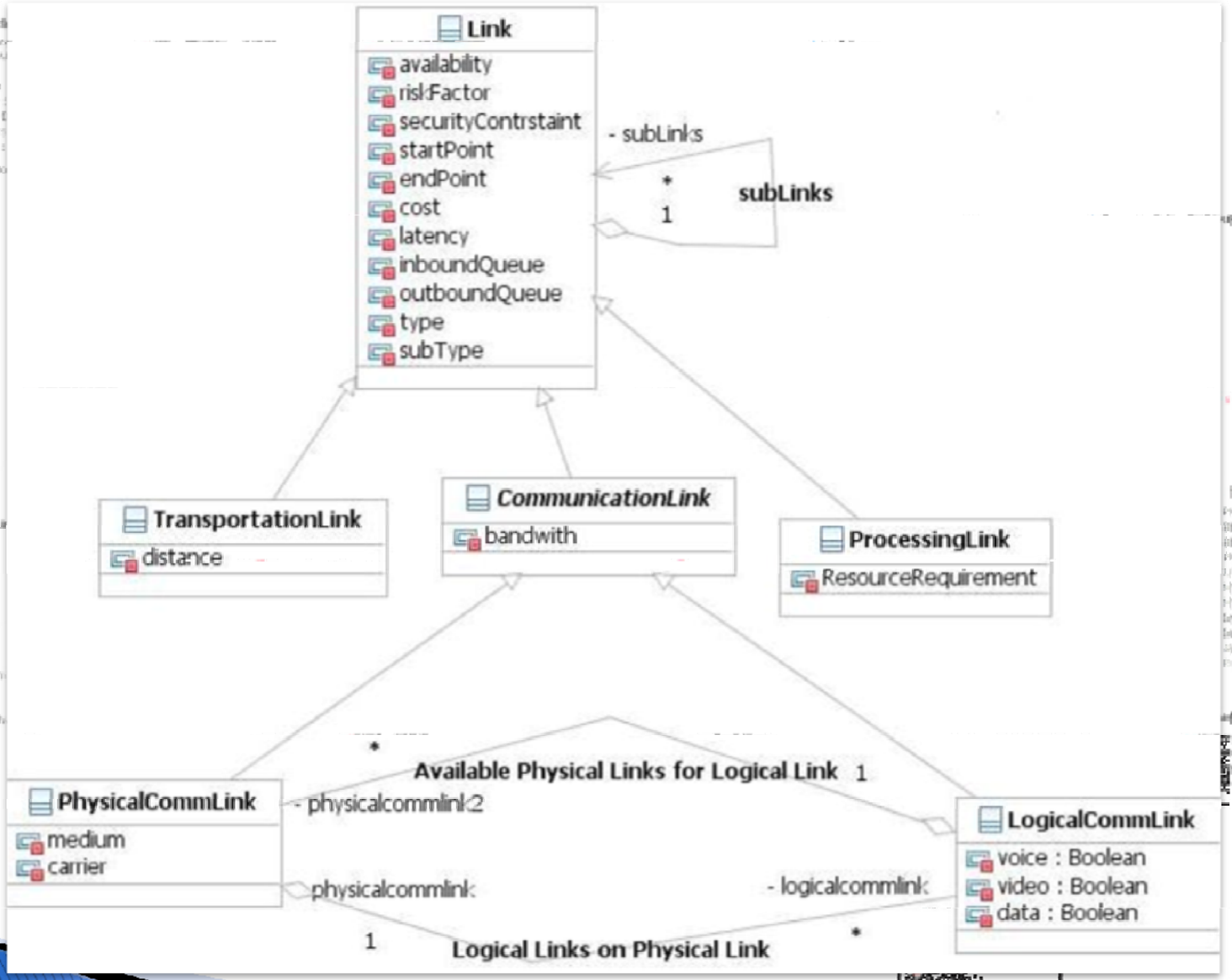
IMMOC Data Model

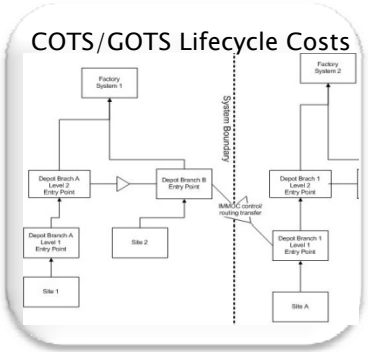


IMMOC Data Model

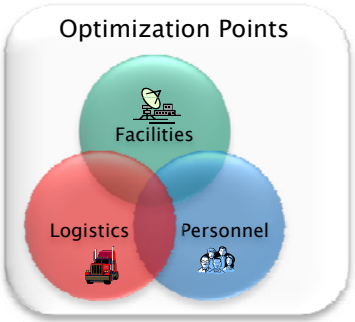


Conclusions

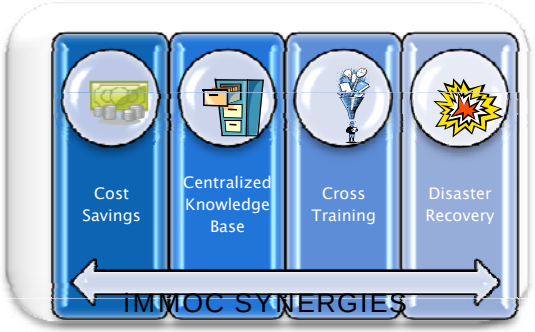
Relative value of Overwatch and Command & Control in the integrating maintenance segments



Commercial and Government off the Shelf component lifecycle cost impacts

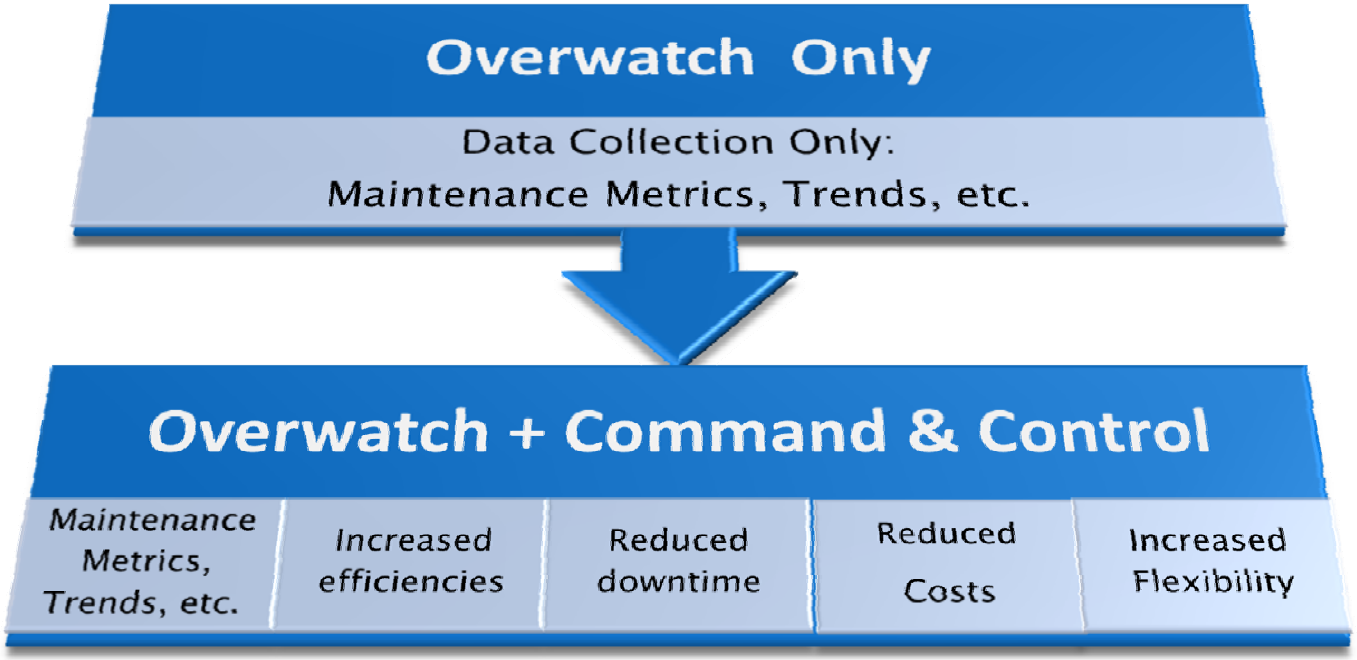


Optimization factors regarding the integrated maintenance system



Synergies of integrated maintenance implementation

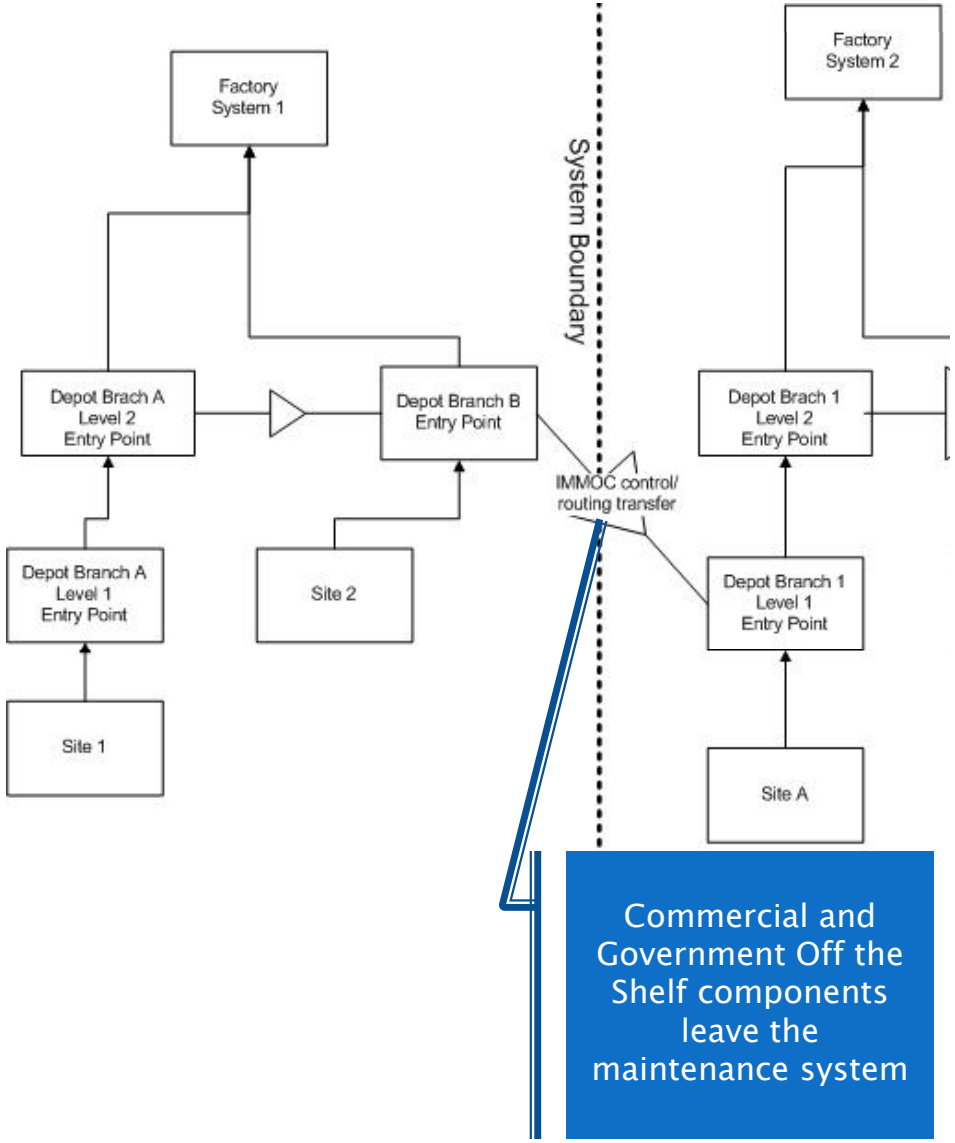
Command & Control is Necessary



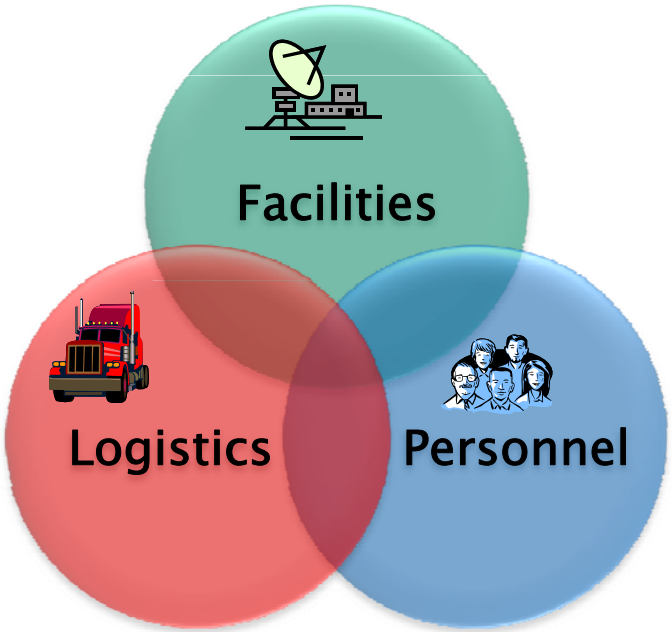
- Overwatch does not justify the new system
  - Does not allow for optimization
  - Does not allow for dynamic maintenance
- Command & Control provides the additional functionality to justify the system and enable synergies between components
  - Dynamic maintenance scheduling based on priorities and cost

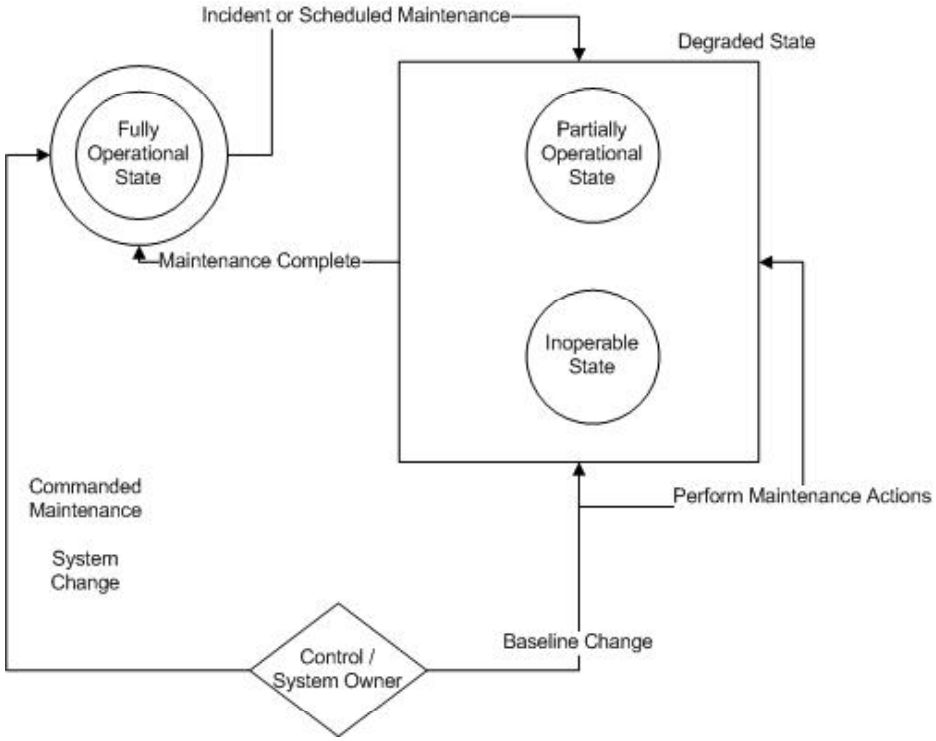
COTS/GOTS Costs not Optimal

- COTS/GOTS software
  - Defects are systemic and cannot be fixed or replaced with equivalent components
- COTS/GOTS hardware
  - Upgrades to firmware and drivers without notifying purchasers
- Maintenance and production cycle
  - Outside the maintenance and production cycle of the operational and maintenance systems
- Upgrades driven by market forces, not mission needs



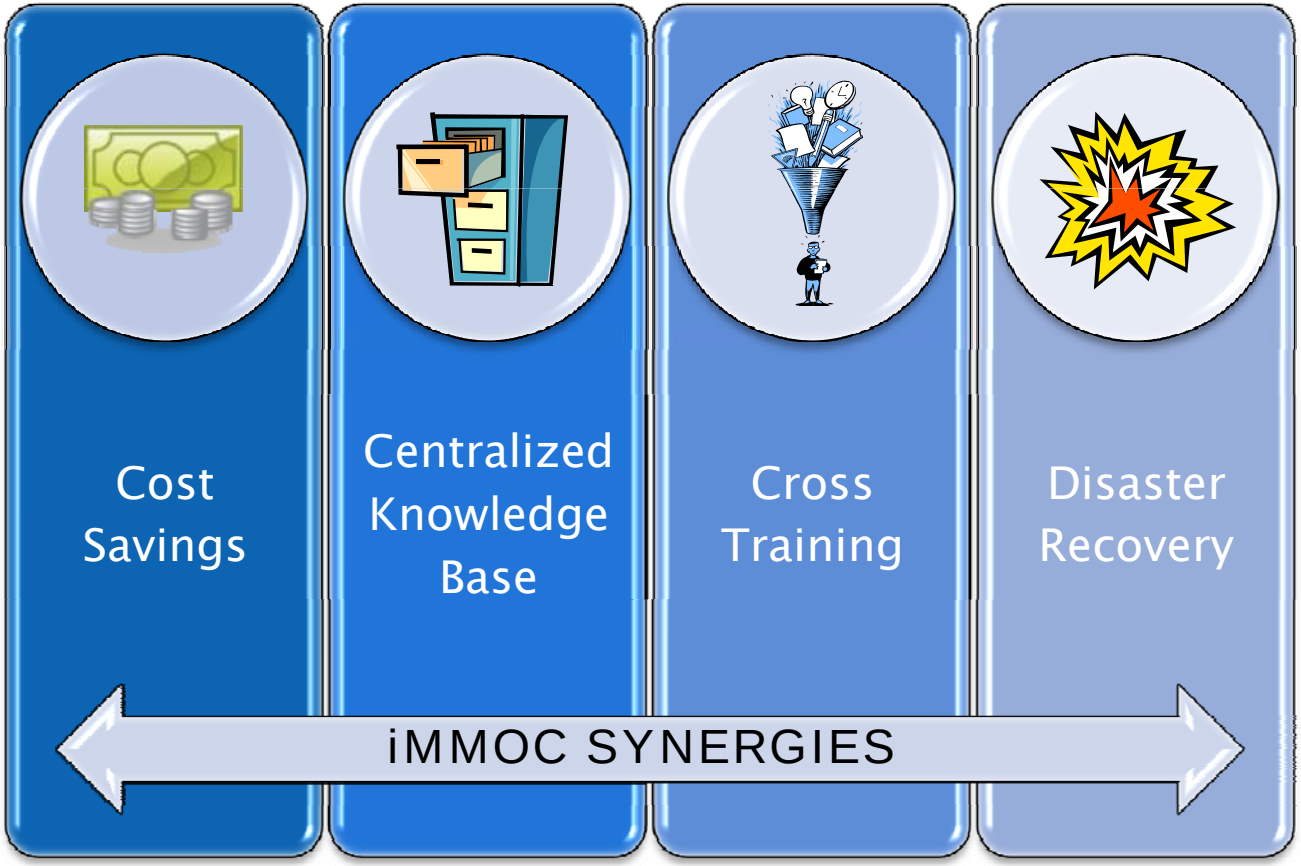
Non-Trivial Optimization





- Three variables for optimization
  - Interdependent multi-attribute optimization problem
  - Optimization of staff, facilities, or logistics requires awareness of political factors, not easily quantifiable
- Maintenance system behavior optimization geared towards service level delivery and scalability

Synergies: Capabilities via Integration



The Way Forward…

- Engage in a study of COTS/GOTS costs
- Develop a stochastic model
  - Space-based system incident occurrence
  - Personnel attrition in the maintenance chain
  - Likelihood of problem or incident resolution at a particular level of the maintenance chain
- Also model:
  - Communications infrastructure costs
  - Computing resources
  - Integer optimization for the number of maintenance sites
  - Suitability of locations for maintenance sites
- Feasibility study of merging maintenance funding streams

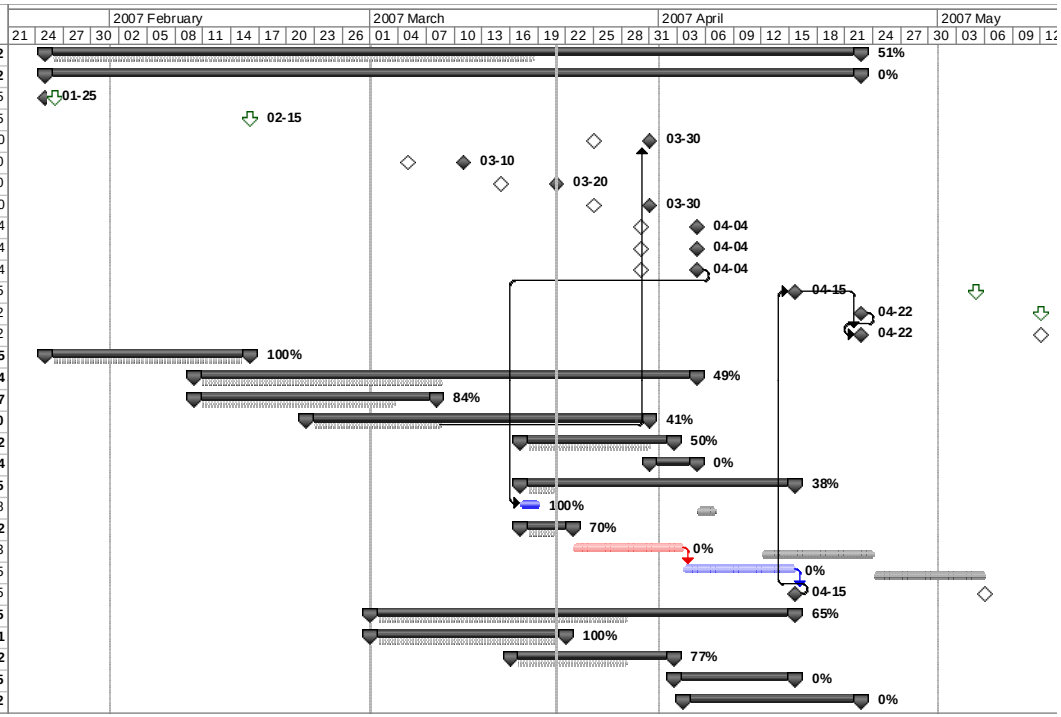
Acknowledgements

- Lockheed Martin Corporation
  Information Systems & Global Services
  Mission & Combat Support Systems
  - Mr. David Dumont – Sr. PM: Operations & Systems Evolution Support
  - Mr. Paul Packard – Chief Engineer, Operations & Systems Evolution Support
  - Ms. Yolanda Lee – Project Engineer: Operations & Systems Evolution Support
- George Mason University
  - Dr. Kathryn Laskey
  - SEOR Department
- OR-680 Class
- Friends, Family, and Pets
- Hannah – who believed in us

Backup

Project Schedule

ID	Task Name	Duration	Start	Finish
1	**IMMOC-SSD Project**	**87.75 days**	**Thu 07-01-25**	**Sun 07-04-22**
2	**Milestones**	**87.75 days**	**Thu 07-01-25**	**Sun 07-04-22**
3	Project Started	0 days	Thu 07-01-25	Thu 07-01-25
4	iMMOC-SSD Proposal Delivered	0 days	Thu 07-02-15	Thu 07-02-15
5	Study Requirements Document Delivered	0 days	Fri 07-03-30	Fri 07-03-30
6	Architecture Diagrams Review 1 Conducted	0 days	Sat 07-03-10	Sat 07-03-10
7	Architecture Diagrams Review 2 Conducted	0 days	Tue 07-03-20	Tue 07-03-20
8	Architecture Diagrams Delivered	0 days	Fri 07-03-30	Fri 07-03-30
9	Schedule Updated	0 days	Wed 07-04-04	Wed 07-04-04
10	Updated Schedule Delivered	0 days	Wed 07-04-04	Wed 07-04-04
11	Draft Study Delivered	0 days	Wed 07-04-04	Wed 07-04-04
12	Final Study Delivered	0 days	Sun 07-04-15	Sun 07-04-15
13	Final Presentation Delivered	0 days	Sun 07-04-22	Sun 07-04-22
14	Project Completed	0 days	Sun 07-04-22	Sun 07-04-22
15	**Task 1: Project Proposal Delivered**	**22 days**	**Thu 07-01-25**	**Thu 07-02-15**
43	**Task 2: Draft Study**	**54 days**	**Sat 07-02-10**	**Wed 07-04-04**
44	**Task 2a: Requirements Document**	**26 days**	**Sat 07-02-10**	**Wed 07-03-07**
51	**Task 2b: Overwatch Architecture Diagrams**	**37 days**	**Thu 07-02-22**	**Fri 07-03-30**
69	**Task 2c: Create Draft Study Document**	**16.5 days**	**Sat 07-03-17**	**Mon 07-04-02**
73	**Task 2d: Update Schedule**	**5 days**	**Sat 07-03-31**	**Wed 07-04-04**
76	**Task 3: Final Study**	**29.75 days**	**Sat 07-03-17**	**Sun 07-04-15**
77	Create Final Study Work Package 1	2 days	Sat 07-03-17	Sun 07-03-18
78	**Final Study Work Pakackage 1**	**5.75 days**	**Sat 07-03-17**	**Thu 07-03-22**
85	Create Final Study Work Package 1	12 days	Thu 07-03-22	Tue 07-04-03
86	Create Final Study Work Package 1	12 days	Tue 07-04-03	Sun 07-04-15
87	Final Study Created	0 days	Sun 07-04-15	Sun 07-04-15
88	**Task 4: Web Site**	**45.75 days**	**Thu 07-03-01**	**Sun 07-04-15**
89	**Web Site Design Completed**	**21 days**	**Thu 07-03-01**	**Wed 07-03-21**
94	**Draft Web Site Pages Created**	**17.5 days**	**Fri 07-03-16**	**Mon 07-04-02**
99	**Final Web Site Pages Created**	**13.25 days**	**Mon 07-04-02**	**Sun 07-04-15**
104	**Task 5: Final Presentation**	**19 days**	**Tue 07-04-03**	**Sun 07-04-22**



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Team Roles and Responsibilities

Team Member	Role	Responsibility
David Dumont M&CSS LM IS&GS	Project Sponsor	Primary project sponsor Approve/reject project concept Approve/reject project scope Approve/reject project work products
Yolanda Lee M&CSS LM IS&GS	Project Sponsor	Secondary project sponsor Approve/reject project concept Approve/reject project scope Approve/reject project work products
Dr. Katherine Laskey SEOR GMU	Project Advisor	Validate project sufficiency and appropriateness Grade progress
Joshua Icore	Project Team Member	Project and schedule management Document control and CM Mission analysis Sponsor Liaison
Mark Icore	Project Team Member	Architecture Data analysis Modeling Tool selection and training
Capt. Scott Sweeney, USAF	Project Team Member	Mission analysis Requirements analysis Website