Software Acquisition in the Age of Cyber Warfare

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Overview

- AF Cyber Professional Roadmap
- Proposed framework establishing baseline education for cyber developers
- Identify systems and software characteristics necessary for employment in the cyber domain
- Identify future system and software challenges within the context of the cyber domain
AF Cyber Professional Roadmap

- Describes AF way ahead in developing cyberspace professionals
- Describes core and enabling cyber competencies
- Describes development of officer and enlisted AFSCs; outlines Reserve & civilian
- Describes training and education
Force Development Roles

- Cyber Operators
- Cyber Specialists
- Cyber Analysts
- Cyber Developers

Not limited to the 17D career field!
Cyber Developers

- “Design, develop and document solutions that can be tactically employed by cyberspace forces to meet combatant commander requirements.”

- “They have in-depth expertise with the software or hardware technologies to which they are assigned, appropriate computer programming experience and expertise, and sound problem solving skills.”
Cyber Developers

- “They apply current technologies, sound engineering techniques, and proven TTPs in their work.”

- “Developers for long-term projects should have experience in cyberspace operations and/or as cyberspace operators.”
Cyber Developers

- Cyber Operator Educ/Exp
- Cyber Developer
- Engineering Educ/Exp
Cyber Developers

Skill Set:
- Design, engineer & problem-solving
- Computer programming & development
- Documentation

Experience:
- Cyberspace operations
- Cyber TTPs
- Engineering techniques
- Current technologies

Two Questions:
1. Is this necessary and complete?
2. How do we get there?
Once upon a time…

…in a combatant command far, far away…

- Need for an enterprise network management tool
- Suite of COTS tools integrated to provide a common operating picture of the network
- Project managed by J6 Communications Directorate (NetOps, Engineering)
- Versions 1 and 2 delivered with serious shortfalls
- Version 3 in danger of repeating past mistakes
Plenty of mistakes…

- CONOPS focused on a specific solution rather than a needed set of capabilities
- No competition for contract
- Failure to include all stakeholders
- No requirements document
- No acceptance test plans
- Little documentation on implementation/integration
- No data rights
- Over budget, behind schedule
- No authorization to operate (ATO)
Clearly network management falls within cyber operations.

The command was developing tools to assist in the management of the cyber domain, so a cyber developer would be appropriate.

Given this case study, would the cyber developer, given the previous description, fare any better?
Skill Set:
- Design, engineer & problem-solving
- Computer programming & development
- Documentation

Experience:
- Cyberspace operations
- Cyber TTPs
- Engineering techniques
- Current technologies

1. Is this necessary and complete?
Cyber Developer
Educational Framework

- **Blended Approach**
  - Project Management
  - Engineering
  - Cyber Concepts
Cyber Developer Educational Framework

Identified by Cyber Roadmap; Focused on Tactical Projects

Cyber Operator* Educ/Exp

Engineering Educ/Exp

Cyber Developer

Project Management Educ/Exp

*May Substitute Specialist or Analyst Depending on Goals

Primarily Acquisition Career Field Domains; Focused on Large Projects/Programs
Cyber Concepts

- Relation between operations and technology
  - How operations depend on technology, vice versa
  - How technology exploits impact operations

- DoD and AF Enterprise Systems
  - System Integration Interfaces
  - Multi-Layered Defense

- Cyber Exploit/Defense Tools & Techniques

- Cyber Law & Policy

Operator-Centric
Why Cyber Concepts?

- Need to understand the environment
  - Understand how the tool hooks into environment
  - Understand the constraints, limitations, law

- Need to understand the operator
  - Accurately capture requirements
  - How will the tool be used?

- Need to understand impact on operations
  - What capabilities does the tool provide?
  - Can we save money, manpower, time?
Engineering

- Requirements Elicitation & Analysis
- Architect & Design
- Implement / Manufacture
- Test & Evaluate
- Deploy / Install
- Documentation / Technical Writing

System/Software Development Lifecycle-Centric
Why Engineering?

- Demonstrated best practices on maximizing quality while minimizing cost
  - Quality is really important here because tool failures may cost lives, treasure and reputation
  - We’re entering an era of fiscal constraint

- Need to demonstrate success before putting it on the network… too many people impacted
Cyber Engineering

- Understanding taxonomy of exploits
  - Buffer overflows
  - Race conditions
  - Virus replication, polymorphism
  - Data hiding
  - Authentication on untrusted client
  - Unsecure communications
  - Spoofing
  - Social engineering
Project Management

- Developing and tracking milestones
- Measuring projects against a set of metrics
- Tracking resources (funding, man-hours, etc)
- Monitoring & Controlling
- Documentation & Reporting
- Decision-Making Reviews

*Acquisition Lifecycle-Centric*
Why Project Management?

- Big or complex projects take time/resources
  - Need a means of deconstructing workload and tracking progress
  - Military cyber developers are by definition are transient; may not see to completion

- Need for not only technical metrics, but programmatic metrics
  - Metrics assist decision-making
  - How do we know that we’re successful?
Cyber Developer
Educational Framework

Majority of “avoidable” issues are programmatic

Cyber Operator Educ/Exp

Engineering Educ/Exp

Difficult to develop or interface with contractors

Project Management Educ/Exp

Failure to understand cyber domain
Back to our story…

- CONOPS focused on a specific solution rather than a needed set of capabilities  
  Cyber/PM issue
- No competition for contract  
  PM issue
- Failure to include all stakeholders  
  PM issue
- No requirements document  
  Cyber/Engineering issue
- No acceptance test plans  
  Engineering issue
- Little documentation  
  Engineering issue
- No data rights  
  PM issue
- Over budget, behind schedule  
  PM issue
- No authorization to operate (ATO)  
  PM issue
So how do we build them?

- Or more appropriately, how get fully qualified cyber developers in the needed positions
  - Investment in people (Education & Experience)
  - Tracking and vectoring people
  - Retaining people

- If we’re serious about supporting cyber operations, then we’ll need cyber developers
Education & Training Sources

- Engineering
  - Undergraduate/Graduate Degree Programs
  - Industry Standard Professional Continuing Education (PCE) & Certification
    - IEEE Certified Software Developer Professional
    - INCOSE Certified Systems Engineering Professional
  - Department of Defense PCE
    - Defense Acquisition University
    - Software Professional Development Program
  - Vendor/Technology PCE & Certification
    - Cisco Certified Network Associate/Professional
    - Microsoft Certified Systems Engineer
## Most Desired Education Areas

Respondents were asked to choose up to 5 topics.

<table>
<thead>
<tr>
<th>Response</th>
<th>Personally</th>
<th>Score</th>
<th>Boss</th>
<th>Score</th>
<th>Coworker</th>
<th>Score</th>
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<td>171</td>
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<td>3</td>
<td>331</td>
<td>2</td>
<td>419</td>
<td>3</td>
</tr>
</tbody>
</table>

Score = # of standard deviations above mean
Special Emphasis On…

- Requirements development
- Acceptance test development
- Technical writing and documentation
- Software maintenance
- Resources available for engineering software
Entry point for SPDP students

**SPDP**

**SW Acquisition Track**

- **SWE 301**
  - SW Project Management

- **SWE 310**
  - Requirements

- **SWE 320**
  - Design

- **SWE 330**
  - Construction

- **SWE 340**
  - Testing

- **SWE 350**
  - Sustainment

**Knowledge and Experience Exchange**

**SW Engineering (Development) Track**

- **SWE 410**
  - Requirements

- **SWE 420**
  - Design

- **SWE 430**
  - Construction

- **SWE 440**
  - Testing

- **SWE 450**
  - Sustainment

**Current Topics**

- **SWE 399**
  - Current Topics

- **SWE 499**
  - Current Topics

**Certified**

**Current Knowledge-focus**
Partition management and engineering concerns across 2 tracks

Manageable 3-week distance learning courses
- 18-24 hrs per “track” course
- 2-8 hrs for special topics

AF Implementation of Industry Standards; Best Practices
Education & Training Sources

- Project Management
  - Industry Standard PCE & Certification
    - PMI Project Management Professional
  - Department of Defense PCE
    - Defense Acquisition University
    - AFIT School of Systems & Logistics
## Organizational Attributes

<table>
<thead>
<tr>
<th>Organizational Attribute (# Respondents)</th>
<th>Not Exhibited / Poorly</th>
<th>Satisfactorily / Exemplary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishing accurate performance, cost, and schedule baselines (821)</td>
<td>63%</td>
<td>37%</td>
</tr>
<tr>
<td>Educating stakeholders as to their role in software acquisition/development (811)</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>Capturing lessons learned (811)</td>
<td>56%</td>
<td>44%</td>
</tr>
<tr>
<td>Disseminate lessons learned to external organizations (810)</td>
<td>74%</td>
<td>26%</td>
</tr>
</tbody>
</table>
Special Emphasis On…

- CONOPS development
- How to schedule and allocate resources
- How to measure and analyze project progress metrics
- Working with stakeholders
- Resources available for managing software-intensive projects
## External Certification

<table>
<thead>
<tr>
<th>Certification</th>
<th># Certified (All Career Fields)</th>
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<tr>
<td>Project Management Professional (PMP)</td>
<td>38</td>
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<tr>
<td>IEEE Certified Software Development Professional (CSDP)</td>
<td>6</td>
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<tr>
<td>IEEE Certified Software Development Associate (CSDA)</td>
<td>4</td>
</tr>
<tr>
<td>Engineering License w/ Software Engineering Specialization</td>
<td>10</td>
</tr>
<tr>
<td>ASQ Certified Software Quality Engineer</td>
<td>4</td>
</tr>
<tr>
<td>INCOSE Certified Systems Engineering Professional</td>
<td>5</td>
</tr>
</tbody>
</table>

At Best, Only 67 (7.8%) of Respondents Indicate Having External Certifications

AFIT School of System & Logistics - Software Engineering Study, April 2010
Education & Training Sources

- Cyber Concepts
  - Graduate Degree Programs
  - Industry Standard PCE & Certification
    - Certified Information Systems Security Professional
    - Security+
  - Department of Defense PCE
    - AFIT Cyber 200/300 Courses
    - Cyber Warfare IDE Program
Special Emphasis On…

- Enterprise Integration (Active Directory, PKI)
- Security Integration (Firewall, IDS, Antivirus)
- Parallel Processing
- Networking and Bandwidth Sensitivity
- Service Oriented Architecture
- Digital Forensics
- Integrated COTS/GOTS

Consider these as system/software characteristics for operating in the cyber domain.
So how do we build them?

- Or more appropriately, how get fully qualified cyber developers in the needed positions
  - Investment in people (Education & Experience)
  - Tracking and vectoring people
  - Retaining people

- If we’re serious about supporting cyber operations, then we’ll need cyber developers
Tracking & Vectoring

- Tracking
  - Acquisition Record
  - Cyber Record
  - Special Experience Identifiers (SEI) for Certs

- Vectoring
  - Code assignments providing or requiring development experience
  - Professional development and mentorship
  - Education with Industry program
  - Cyber assignments
So how do we build them?

- Or more appropriately, how get fully qualified cyber developers in the needed positions
  - Investment in people (Education & Experience)
  - Tracking and vectoring people
  - Retaining people

- If we’re serious about supporting cyber operations, then we’ll need cyber developers
Retaining People

- Some years a significant challenge!
- Build a solid community of cyber developers
  - Promote “Source Forge” type of portal and invite cyber developers to participate in projects
  - Introduce online TTP sites to promote development education for cyber developers and contractors
- Alternate assignments between cyber operations and development
Summary

- Cyber Developer Education Framework
- System/Software Characteristics for Cyber Domain
- Future Challenges

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