Air Force Vision for Systems Engineering

Systems and Software Technology Conference
Salt Lake City, UT
3 May 2006

Col Charles Bailey
Chief, Engineering & Technical Management Division
SAF/AQRE
703-588-7860
charles.bailey@pentagon.af.mil
Overview

- Historical Perspective
- Visions
  - Life Cycle Systems Engineering
  - Life Cycle Software Policy
- Challenges
Historical Perspective

“Systems Engineering is broken; go fix it.”

Attributed to Dr. James G. Roche, Secretary of the Air Force, Spring 2002

Lack of Systems Engineering has been cited as the cause of major defense acquisition program failures

... as evidenced by ...

cost overruns, schedule slips, mishaps, external criticism, instability in requirements and funding, poor acquisition strategies ...

Integrity - Service - Excellence
Historical Perspective
Air Force & DoD, 2003-2005

- Apr 03: SAF/AQ policy memo on incentivizing contractors for better SE
- Jan 04: SAF/AQ policy memo on revitalizing SE
- Feb 04: OUSD (AT&L) policy memo emphasizing the importance of SE
- Feb 04: Air Force Center for Systems Engineering (CSE) established at AFIT
- Mar 04: AT&L policy memo requiring acquisition programs to develop and submit a Systems Engineering Plan (SEP) at MS and KDP Reviews
- Sep 04: SAF/AQ/US policy memo on revitalizing software aspects of SE
- Sep 04: SAF/AQ and AFMC host AF Conference on Advancing SE
- Oct 04: AT&L policy memo establishing requirement for Chief Engineer position reporting to PEO
- Oct 05: SAF/AQ policy memo establishing SEP review and coordination process, and identifying responsibilities for PEO Chief Engineers to ensure robust SE processes are in place
- Dec 05: AFI 63-1201, Life Cycle SE, released to formal coordination
Disciplined Systems Engineering across the life cycle
Software policy framework, with corresponding life cycle perspective, across the AF enterprise
Challenges

- How to implement / facilitate the Life Cycle SE and software visions
- Balancing depth and breadth of policy coverage across diverse communities (warfighter, HSI, CIO, ESOH, safety, et al)
- Collaboration with industry and academia
- Consistent SE application across domains (air, space, weapons, C2, IT)
- SE for Systems of Systems (responsibilities, etc.)
- Measures / metrics
- Better preparing SE practitioners (SEP writing, etc.)
Air Force SE Vision --
Life Cycle Systems Engineering

Systems and Software Technology Conference
Salt Lake City, UT
3 May 2006

Mr. Jeff Loren
MTC Technologies, Inc. (SAF/AQRE)
703.588.7845
jeff.loren@pentagon.af.mil
Overview

- SE Throughout the Life Cycle
- SE Prior to Milestone/Key Decision Point A
- Early SE Pilots
- Summary
SE Throughout the Life Cycle

Milestones / KDPs

<table>
<thead>
<tr>
<th>Phases</th>
<th>Capability Planning</th>
<th>Concept Refinement</th>
<th>Technology Development</th>
<th>System Development &amp; Demonstration</th>
<th>Sustainment Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milestones</td>
<td>KDPs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algorithms</td>
<td>Integration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net-Ready</td>
<td>Data Link</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lethality</td>
<td>Airframe</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Consequence

Likelihood

1. Algorithms
2. Integration
3. Net-Ready
4. Data Link
5. Lethality
6. Airframe

PEACEKEEPER
# SE Planning in Sustainment

## OSS&E Plan

<table>
<thead>
<tr>
<th>Life Cycle Phases</th>
<th>Capability (Developmental) Planning</th>
<th>Acquisition</th>
<th>O&amp;S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milestones / KDPs</td>
<td>CD</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Universe of Technologies</td>
<td>6.1 Basic Research</td>
<td>6.2 Applied Research</td>
<td>6.3 Advanced Research</td>
</tr>
<tr>
<td>Foundational Warfighter Needs</td>
<td>Technical Knowledge Base</td>
<td>Program “Maturity”</td>
<td>Historcial Boundaries of “Acquisition SE”</td>
</tr>
<tr>
<td></td>
<td>Intel</td>
<td>P3I Activities</td>
<td>OSS&amp;E</td>
</tr>
<tr>
<td></td>
<td>JCIDS/Rqmts Process; AoAs</td>
<td>Other Mods</td>
<td></td>
</tr>
</tbody>
</table>

**Expanded Boundaries of SE Efforts**
SE Planning in Acquisition

**SEP**

<table>
<thead>
<tr>
<th>Life Cycle Phases</th>
<th>Capability (Developmental) Planning</th>
<th>Acquisition</th>
<th>O&amp;S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milestones / KDPs</td>
<td><strong>CD</strong></td>
<td><strong>A</strong></td>
<td><strong>B</strong></td>
</tr>
<tr>
<td>Universe of Technologies</td>
<td>6.1 Basic Research</td>
<td>6.3 Advanced Research</td>
<td>P3I Activities</td>
</tr>
<tr>
<td></td>
<td>6.2 Applied Research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundational Warfighter Needs</td>
<td>Technical Knowledge Base</td>
<td>Program &quot;Maturity&quot;</td>
<td>Historical Boundaries of “Acquisition SE”</td>
</tr>
<tr>
<td></td>
<td>Intel</td>
<td>JCIDS/Rqmts Process; AoAs</td>
<td>OSS&amp;E</td>
</tr>
</tbody>
</table>

Expanded Boundaries of SE Efforts

Other Mods

TIME

DEMIL & DISPOSAL
## SE Planning in Pre-Acquisition

--- to be added ---

<table>
<thead>
<tr>
<th>Life Cycle Phases</th>
<th>Capability (Developmental) Planning</th>
<th>Acquisition</th>
<th>O&amp;S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milestones / KDPs</td>
<td>CD</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Universe of Technologies</td>
<td>6.1 Basic Research</td>
<td>6.2 Applied Research</td>
<td>6.3 Advanced Research</td>
</tr>
<tr>
<td>Foundational Warfighter Needs</td>
<td>Technical Knowledge Base</td>
<td>Program “Maturity”</td>
<td>Historical Boundaries of “Acquisition SE”</td>
</tr>
<tr>
<td></td>
<td>Intel</td>
<td></td>
<td>OSS&amp;E</td>
</tr>
<tr>
<td></td>
<td>JClDS/Rqmts Process; AoAs</td>
<td></td>
<td>Other Mods</td>
</tr>
</tbody>
</table>

**Expanded Boundaries of SE Efforts**
**Broad Interest in Pre-Acquisition Systems Engineering**

<table>
<thead>
<tr>
<th>Congress</th>
<th>OSD</th>
<th>USAF</th>
</tr>
</thead>
<tbody>
<tr>
<td>- GAO reports (GAO-06-110, Nov 2005 “Better Support of Weapon System Program Managers Needed to Improve Outcomes”; several others)</td>
<td>- Policy coming -- AT&amp;L calls it the “grey box”</td>
<td>- Ad hoc and non-uniform application across MAJCOMs and Centers</td>
</tr>
<tr>
<td></td>
<td>- DDR&amp;E sees it as the big “E” in DDR&amp;E</td>
<td>- Quality of SEPs at MS/KDP A and B lacking rigor (and sometimes content)</td>
</tr>
<tr>
<td></td>
<td>- QDR language directs more linkage of concepts to Joint needs</td>
<td>- AFSO21 creates opportunities for enterprise re-engineering</td>
</tr>
</tbody>
</table>
Integrated Defense Acquisition, Technology, & Logistics Life Cycle Management Framework

**SE Throughout the Life Cycle**

**Pre-Acquisition Focus**

- **Phase A** - Preliminary Design
  - System Development & Demonstration
  - System Integration
  - System Demonstration

- **Phase B** - Complete Design
  - Production & Deployment Phase
  - Concept Refinement Phase
  - Technology Development Phase

- **Phase C** - Build & Operation
  - Small qty system model
  - Large qty, production focus model

- **Phase D** - Operations & Support Phase
  - MS/KDP A
  - MS/KDP C
  - MS/KDP B
  - FRP

**Pre-KDP A** - Concept Studies
- Concept Refinement Phase
  - Refine/REV concept, Devise Technology Development Strategy
Disciplined SE Required During Two Pre-Acquisition Activities

SE used during development of all concepts that feed an AoA

SE used on selected concept from the AoA or spirals to existing programs
Early SE Documentation

Two new SEP-like documents required from Centers

Pre-CD “C-SEP” (Concept SEP)
- Essentially a CONOPS between AFRL/XR and Product Center XR
- Lays out trade study process, decision criteria, methodology for populating knowledge base
  - Mission Needs Analysis and Mission Solution Analysis from AFSPC Integrated Planning Process generated 71 concepts for Operationally Responsive Space (ORS)
- Describes how SE processes translate “requirements” into concept designs / approaches that feed a specific AoA
- Describes how operational architectures drive these translations

Milestone / KDP A “A-SEP” (Alternative SEP)
- Developed by SPO Cadre (probably Product Center XR) for selected alternative
  - e.g., Affordable Responsive Spacelift [ARES] Hybrid Launch Vehicle for ORS
- TDS will probably constitute 75% of the “meat” in this document
- Identifies how knowledge base will be further populated as the concept matures
- Approvals: Center Chief Engineer, PEO, SAF/AQ/US
  - Also OSD for ACAT ID

Approvals: Center Chief Engineer, PEO, SAF/AQ/US
- Also OSD for ACAT ID


**Early SE Pilots**

Utilize pilots to scope policy

- AFSPC nominated Advanced Infra-Red Satellite System (AIRSS) (Pre-MS/KDP B spiral to SBIRS program)
- AFMC nominated Very Small Missile (AAC)

Incorporate new Pre-A SE policy into existing SE policy

- Collect Lessons Learned; identify resources required to implement
Disciplined Pre-A SE policy will:

- Flow Joint needs through concepts into programs
- Link operational architectures to concepts to programs
- Build technical knowledge base that migrates with concepts to program
- Facilitate better decision-making at MS/KDP A and B
- Integrate the “illities” up front into concept definition

Disciplined Pre-A SE policy will not:

- Provide guidance idea generation
- Direct conduct of AoAs or EoA studies
- Guide overall capabilities integration activities
Disciplined SE is needed throughout the life cycle
Pre-acquisition SE is an investment that will buy down risk in later phases of the program
SMC and AAC have identified pilot efforts to scope pre-acquisition SE policy
Lessons learned will be rolled into final policy and released under Increment 2 of SE AFI (63-1201)

**ULTIMATE RESULTS**

- Better technical planning, better integrated
- More confidence in programs entering acquisition
"We demand rigidly defined areas of doubt and uncertainty!"

Douglas Adams, *The Hitchhiker’s Guide to the Galaxy*
Air Force Software Policy Vision

Systems and Software Technology Conference
Salt Lake City, UT
3 May 2006

Mr. Ernie Gonzalez
SAF/AQRE (SAFTAS A-Team)
703-588-7846
ernesto.gonzalez@pentagon.af.mil
Outline

- Development of AF software (S/W) acquisition policies
- Development of S/W policies across the AF
FY03 National Defense Authorization Act
Section 804
Air Force Implementation

- OSD & Services establish documented processes for:
  - S/W Acquisition Planning
  - Requirements Development and Management
  - Project Management and Oversight
  - Risk Management
- Metrics for performance measurement and continual process improvement
- Ensure that key program personnel have an appropriate level of experience or training
- Ensure adherence to established processes and requirements relating to the acquisition of S/W

Improve Air Force S/W management and processes as an integral part of SE and Capability Acquisition
Air Force Acquisition Policy – Integrating S/W into SE processes

Policy Memo Focus Areas
- High Confidence Estimates
- Realistic Program Baselines
- Risk Management
- Capable Developer
- Developer Processes
- Program Office Processes
- Earned Value Management
- Metrics
- Life Cycle Support
- Lessons Learned

Program Executive Officers (PEOs) Apply and Tailor As Necessary

SAF/AQ/US Policy Memo 04A-003, 20 Sep 2004:
Revitalizing the Software Aspects of Systems Engineering

Program Executive Officers (PEOs) Apply and Tailor As Necessary

Focus Areas
- High Confidence Estimates
- Realistic Program Baselines
- Risk Management
- Capable Developer
- Developer Processes
- Program Office Processes
- Earned Value Management
- Metrics
- Life Cycle Support
- Lessons Learned

Jul 05 – implemented in AFI 63-101 (Capabilities Based Acquisition System)

Being incorporated in AFI 63-1201 re-write (Life-cycle SE)
Need to Address S/W Policy and Guidance Across Air Force

- **Current state**
  - No overarching S/W policy and guidance
  - Current S/W policies defined by functional elements
    - Difficult to know & comply with all policies
    - Conflicting, redundant policies

- **Where we need to be**
  - Identify S/W issues across AF needing AF guidance
  - Define purpose and scope for AF S/W policies
  - HAF S/W stakeholders collaborate to
    - Jointly address AF-wide S/W issues
    - Develop, promulgate *appropriate* AF S/W policies
Overarching S/W Policy – Must support all activities across AF

<table>
<thead>
<tr>
<th>SAF/AQ &amp; SAF/US (Acquisition)</th>
<th>SAF/XC (Warfighting Integration/CIO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Policy &amp; Guidance for Acquisition Programs</td>
<td>- Implements CCA</td>
</tr>
<tr>
<td>- Program Execution &amp; Oversight for formal acquisition programs</td>
<td>- Interoperability &amp; interconnectivity</td>
</tr>
<tr>
<td>- Space, non-space, AIS</td>
<td>- Policy and guidance</td>
</tr>
<tr>
<td>- Policies</td>
<td>- Standards and architectures</td>
</tr>
<tr>
<td>- DoD 5000</td>
<td></td>
</tr>
<tr>
<td>- NSS AP 03-01</td>
<td>- Program Execution &amp; Oversight for non-acquisition IT programs &amp; procurements</td>
</tr>
<tr>
<td>- AF 63-XXX</td>
<td>- Policies</td>
</tr>
<tr>
<td></td>
<td>- DoD 5200, 8500</td>
</tr>
<tr>
<td></td>
<td>- AF 33-XXX</td>
</tr>
</tbody>
</table>
Overarching S/W Policy – Must support all activities across AF

SAF/AQ & SAF/US
(Acquisition)

- Policy & Guidance for Acquisition Programs
- Policies
  - DoD 5000
    - NSS AP 03-01
  - AF 63-XXX

SAF/XC
(Warfighting Integration/CIO)

- Implements CCA
- Interoperability & interconnectivity
- Oversight for non-acquisition IT programs & procurements
- Policies
  - DoD 5200, 8500
  - AF 33-XXX

This is a “legacy” construct – “WE” no longer have “us” and “them”
Overarching S/W Policy – Must support all AF domains

SAF/AQ & SAF/US Oversight
- Policy & Guidance for Acquisition Programs
- Program Execution & Oversight for formal acquisition programs
- Space, non-space, AIS Policies
- DoD 5000
- NSS AP 03-01
- AF 63-XXX

SAF/XC Oversight
- Warfighting
- Interoperability & interconnectivity
- Policy and guidance
- Standards and architectures
- Program Execution & Oversight for non-acquisition IT programs & procurements
- Policies
- DoD 5200, 8500
- AF 33-XXX

SAF/AQ & SAF/US Oversight

SAF/XC Oversight

SAF/AQ & SAF/US Oversight

SAF/XC Oversight

SAF/AQ & SAF/US Oversight

SAF/XC Oversight

SAF/AQ & SAF/US Oversight

SAF/XC Oversight

SAF/AQ & SAF/US Oversight

SAF/XC Oversight
# Overarching S/W Policy –
Must support all AF domains and all AF systems

<table>
<thead>
<tr>
<th>SAF/AQ &amp; SAF/US Oversight</th>
<th>SAF/XC Oversight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Warfighting</strong></td>
<td></td>
</tr>
<tr>
<td>Flt Ctrl Computers</td>
<td>Exp Combat Spt Sys (ECCS)</td>
</tr>
<tr>
<td>Inertial Nav System</td>
<td></td>
</tr>
<tr>
<td>Wpns Stores Mgt</td>
<td>SBIRS</td>
</tr>
<tr>
<td>Tactical Data Links</td>
<td></td>
</tr>
<tr>
<td>Jt Tact Radio Sys</td>
<td></td>
</tr>
</tbody>
</table>

| **Business**                |                  |
| AF Portal                   | Medical Logistics (MEDLOG) |
| Virtual Persl Serv Center   | Security Forces MIS |

| **Infrastructure**          |                  |
| Global Transptn Network     | Defense Message System |
| Air & Space Ops Center      |                  |
| GCSS-AF                     |                  |
Disciplined LC Framework for AF S/W Policy – A SAF/AQR & SAF/XC Top Priority

- **Purpose:** establish framework and mechanism for the joint development & promulgation of appropriate AF S/W policies

- **Near & Mid Term**
  - Develop software Life Cycle (LC) framework
    - Define LC phases common to all S/W
    - Identify unique elements within different S/W domains
  - Conduct S/W LC framework gap analysis
  - Develop S/W Policy Framework – Identify & prioritize areas in S/W LC needing AF S/W policies

- **Long Term – institutionalize process**
  - Determine appropriate policy documents for AF guidance
  - Leverage existing venues (e.g. SSTC) for information exchange

- Optimize value and ease of use of AF S/W Policies
- Encourage using cross-cutting disciplines in S/W LC