



vision

Acquiring and Engineering for Net-Centric Space Systems

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June 21, 2007

5/21/2007

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Acquiring and Engineering for Net-Centric Space Systems

- The Problem is sometimes more than the obvious
- The untapped variable of *leadership*
 - Leadership & Management
 - Transformational & Transactional
 - Program level *software leadership* application
 - Applying *organizational design for success* in software
- Summary



Software Leadership Aspect in Acquiring National Space Systems

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The Problem

- What we know but often forget:
 - Developing software is a complex endeavor
 - Developing software is very people dependent
 - The combination of complexity and reliance on people is addressed principally through extensive processes
 - Execution of processes requires more than just *managing*

Software Errors – 1^{1 & 2}



Photograph reprinted courtesy of the United States Air Force

- Langley, F-22 pilot “stuck”
- No one knew what the key was to open the cockpit!
- Initially noted as a software bug. Later claimed to be a “loose screw”!
- Cost: Lots of red faces and \$1.3M in repairs to aircraft and cockpit replacement.¹

- Flight of F-22 crossing Intl. dateline had Nav-Console failures
- Longitude switched from 180° W to 180° E
- F-22’s escorted to Hawaii
- Completed original flight 10-days later²



Photographs reprinted courtesy of the United States Air Force

¹ Air Force Briefing April 10, 2006; <http://www.spaceref.com/news/viewsr.html?pid=20396>

² Air Force Portal February 17, 2007; <http://www.af.mil/news/story.asp?id=123041567>

Software Errors – 2¹

- Ariane Flt. 501, June 4, 1996
- Flight guidance software reused from Ariane 4
- One line of code thought to be at fault
- Cost \$1.2B
- No blame ascribed!¹



Photo: ESA - Launch of the first Ariane-5, 4 June 1996, from ELA-3 complex at Kourou, French Guiana.
[Image Date: 04-06-96] [96.09.006-004]



Photo: ESA - Debris raining down after self-destruct of Ar-501 on 4 June 1996. [Image Date: 04-06-96] [96.06.022-011]



Photo: ESA - Debris raining down after self-destruct of Ar-501 on 4 June 1996.
[Image Date: 15-07-96] [96.07.013-008]



A Startling Realization

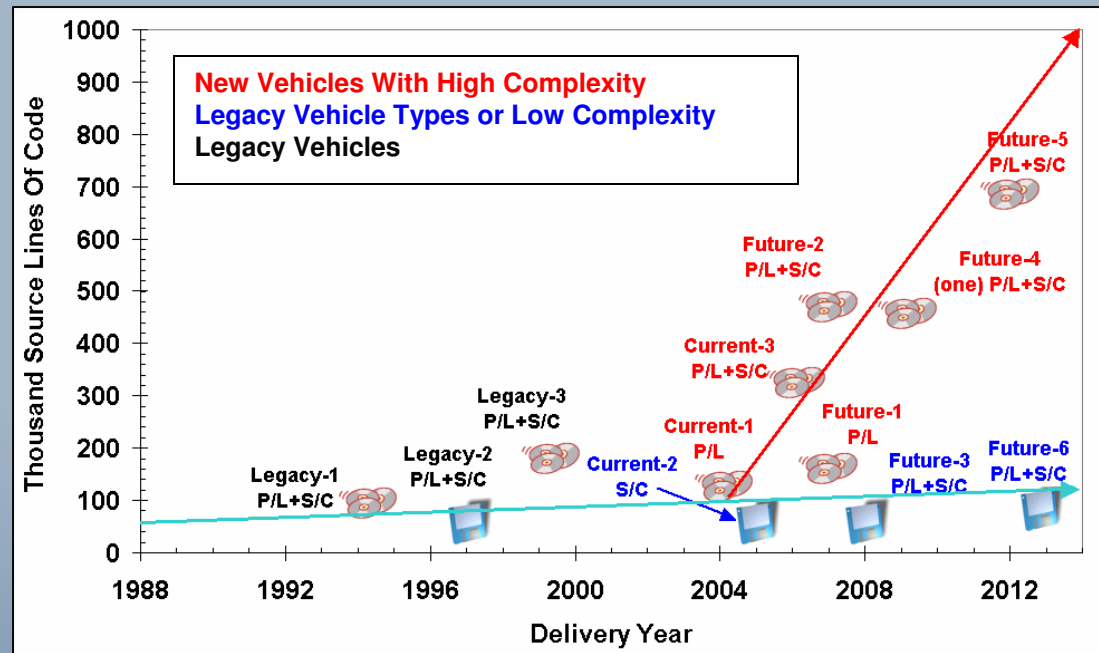
Navy Program

Director:

“So the only thing I can do without software is take a picture?”

Anon.

“Actually, sir we only have digital cameras.”



P/L = payload
 S/C = spacecraft

> ~60 KSLOC
 <= ~60 KSLOC

Buettner & Arnheim. (2006, October). *The Need for Advanced Space Software Development Technologies*. Proceedings of the 23rd Aerospace Testing Seminar.



“Target-Rich Environment”

- There are multiple variables that impact on whether software is developed in a sufficient or insufficient way
- One such variable dynamic has received virtually no attention – the dynamic relationship of *leadership & management*
- This is true whether viewed from the acquirer or the developer perspective
- Focus of this presentation is on *leadership in software*



The Interaction of the Air Force Legacy & Today's Environment of Change – 1

- Since its establishment, the clarity of the *roles* and *responsibilities* of the Officer Corps in the Air Force has had a rich history upon which to draw
- That legacy, although showing its age while coping with envisioning the future of the Air Force's service to the Nation, is still strong & viable



The Interaction of the Air Force Legacy & Today's Environment of Change – 2

- While the *operational* arm of the Air Force has maintained a tightly vectored focus on their *roles and responsibilities*, that remain largely steady-state, the *acquisition* arm of all of the Military Services have been under the tensions of fundamental change
- What has dramatically changed, especially in the past two decades, has been the *real-world* environment of today's *Major Defense Acquisition Programs*

This is certainly not news to senior leadership!



A Simple/Straight-Forward Question is “What happened?”

- The *operational* segments of the respective Military Services have continued on a path of building on their respective Title 10 responsibilities
- The *acquiring & procuring* segments of the Services have been *dramatically consolidated* resulting in “dramatic shifts” from past *execution competencies & capabilities*
- Moreover, the overall acquisition environment has had to perform a major *paradigm shift* in order to address the rapid growth in automation that has evolved into the digital/networked era of today
- As one coping mechanism the rubric of *doing more with less* has become a blind mantra

This actually may be news to some senior leadership!



This Raises Fundamental Questions of Mission Effectiveness

- Why is it that when software professionals present a reasoned case, to acquisition program managers, for the inclusion of well-documented software-related practices, mechanisms, specifications, & standards in an acquisition program; that these are frequently watered-down, delayed, or often ignored completely?
- How can we be effective in our *roles & responsibilities* if this is the acceptable acquisition program environment?



Where to Begin?

- Positions necessitating *leadership* are found throughout organizations
- Many engineering disciplines have such positions already identified and filled; e.g. systems engineering
- That is not the case in the discipline of software

First steps to address this situation are being demonstrated!



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Addressing Four Complementary Leadership Approaches

- Address the issues associated with acquisition program *leadership and management*
- Address *Transformational & Transactional* leadership styles
- Address *software leadership* at the acquisition program
- Address *organizational design for success* in software



Leadership Approach #1

- Address the issues associated with acquisition program *management* and *leadership*
- Address *Transformational & Transactional* leadership styles
- Address *software leadership* at the acquisition program
- Address *organizational design for success* in software



Management & Leadership

- Guidance provided throughout the acquisition “school” system, is principally linked to *managing* controllable issues using a host of established and “tested” mechanisms, tools, and techniques – this narrow interpretation has been enabled during Acquisition Reform
- Modern *leadership* training, on the other hand, focuses on the variability of the situation with two leadership styles;
 - Leadership tied to a *transaction* – where the leader desires a particular action and rewards someone when that action is completed – known as *transactional leadership*
 - Leadership tied to a *transformation* of the followers – where the leader provides guidance and encouragement for a follower to grasp *innovative concepts* and develop their own leadership talents – known as *transformational leadership*



Leadership Approach #2

- Address the issues associated with acquisition program *management and leadership*
- Address *Transformational & Transactional* leadership styles
- Address *software leadership*
- Address *organizational design for success in software*



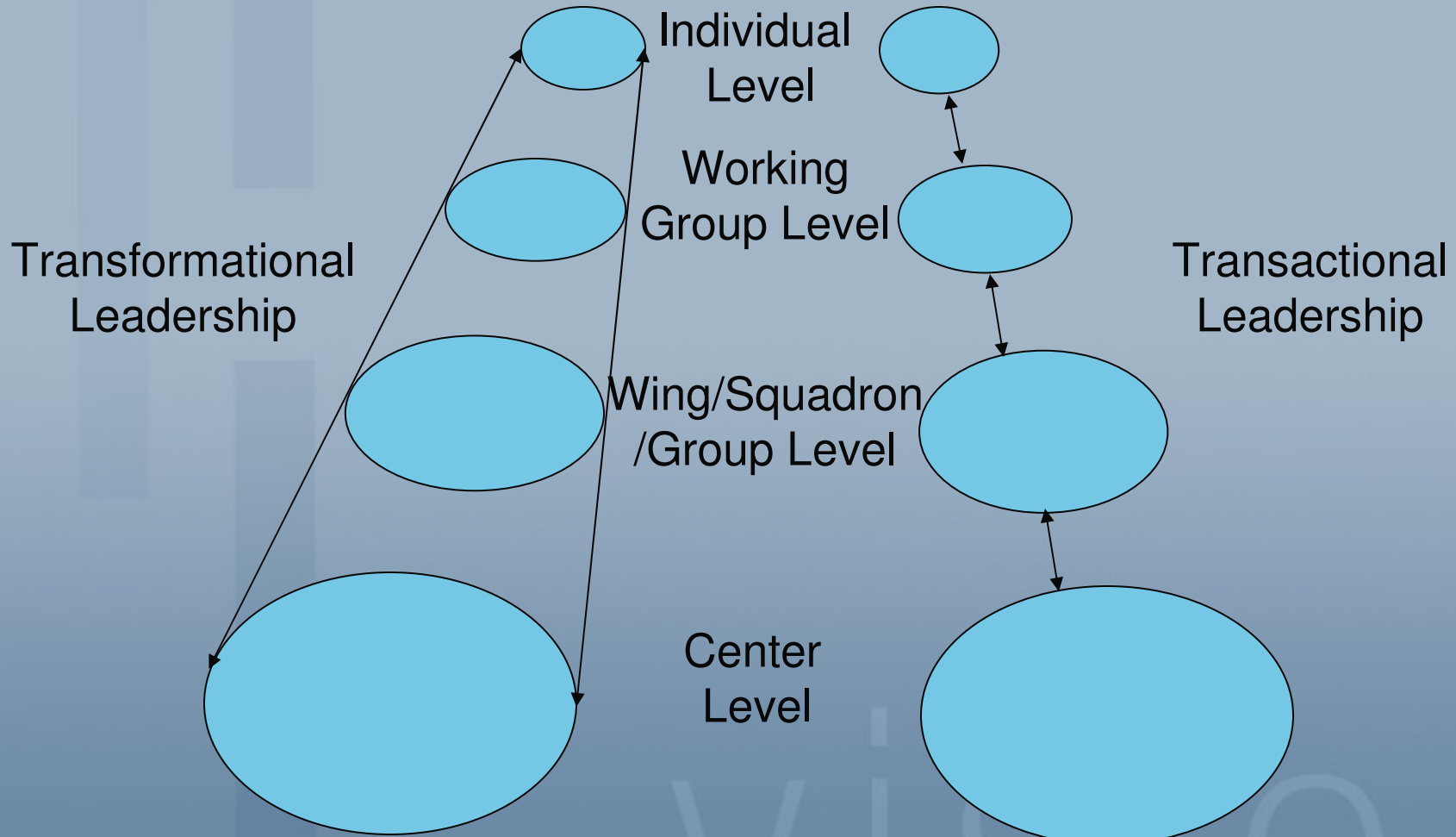
The Importance of Differentiating Between the Two Leadership Styles

- *Focusing on Transactions* in a situation accomplishes that individual transaction but requires continued leadership attention for each subsequent or similar, transaction-based, situation
- *Focusing on Transformation* grows subordinate leadership qualities so that subordinates in similar situations *impact* on the situation and expand on their leadership decisions

Is it possible to truly differentiate between the two?



Real-World Model – Transformational & Transactional Leadership ¹



¹ Adapted from Bass, B. M., Avolio, B. J., Jung, D. I., & Berson, Y. (2003). Predicting unit performance by assessing transformational and transactional leadership. *Journal of Applied Psychology, 88*(2), 207-218.



A Short List of Benefits & Barriers

■ Transformational

- Builds subordinate capabilities & potential through experiences
- Builds understanding, morale, & trust
- Encourages multi-linear capability focusing on maintaining or reducing schedules
- Fundamentally net-centric aware
- Enables perception of value to overall mission success and effectiveness
- Provides capacity for transfer of knowledge
- Requires trust
- Requires appropriate training

■ Transactional

- Maintains subordinate levels & grows individual experience
- Focuses on "wait for direction" work ethic
- Encourages linear actions focusing on extending planned schedules
- Fosters point-to-point solutions
- Limits perception of value to overall mission success and effectiveness
- Provides individual with narrow experience profile
- Does not encourage trust
- Does not require much training to maintain competency



Leadership Approach #3

- Address the issues associated with acquisition program *management and leadership*
- Address *Transformational & Transactional* leadership styles
- Address *software leadership* at the acquisition program level
- Address *organizational design for success* in software



A Radical New Idea!

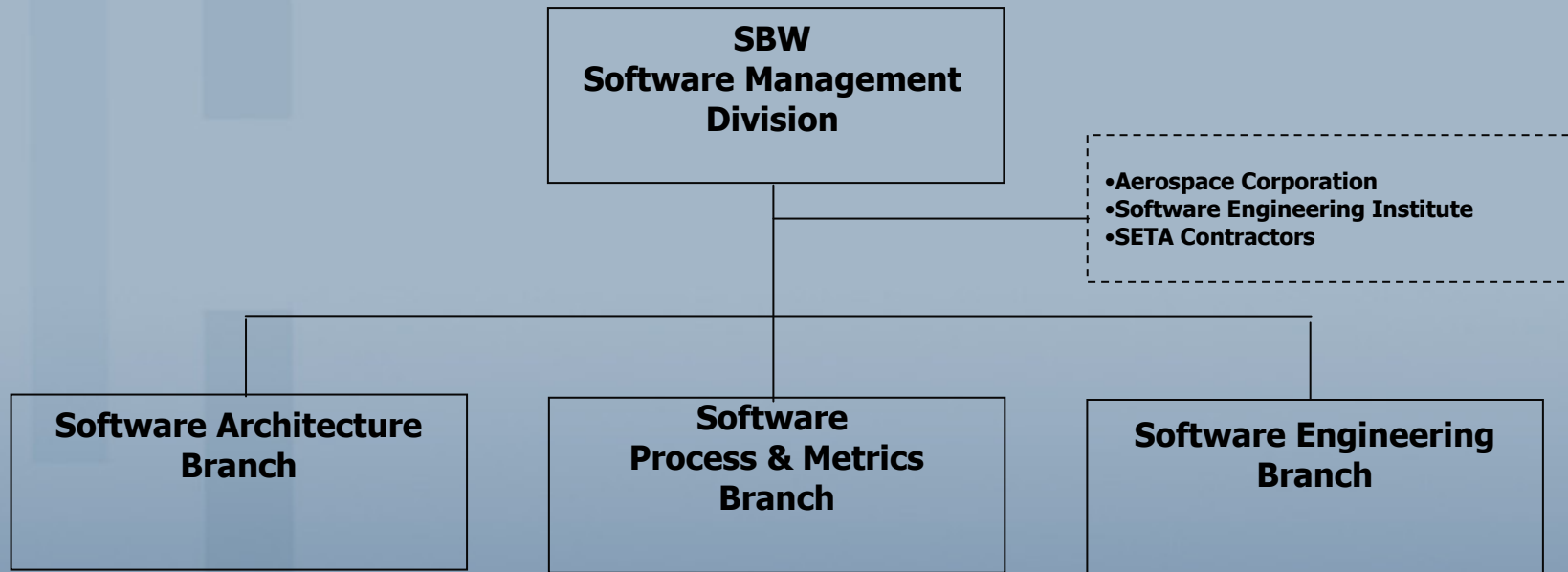
■ Recommendation

“1. Institute, during the conceptual stage of a system acquisition, a formal organization with responsibility for developing and communicating alternative concepts for the role of software technology”¹

¹ Glaseman, S. (1982). *Comparative studies in software acquisition*. Lexington, MA: LexingtonBooks.



Example – Space Radar (SR) Software Organization 2004-2005



Internal Software Credentials:

- 1 Phd & 2 Phd Candidates
- 5 Masters Degrees
- 5 Software Engineers
- 3 Electrical Engineers
- 3 Senior Software Acquisition Expertise
- Over 95 years of software engineering and acquisition experience



Example – SR Program Software Cost Re-Estimation

- Initial estimates were developed using *transactional* approaches for each mission segment yielding a large estimate that included masked duplications
- The *transformational* approach identified *net-centric* design alternatives that led to a large percentage reduction in total software development effort predicted

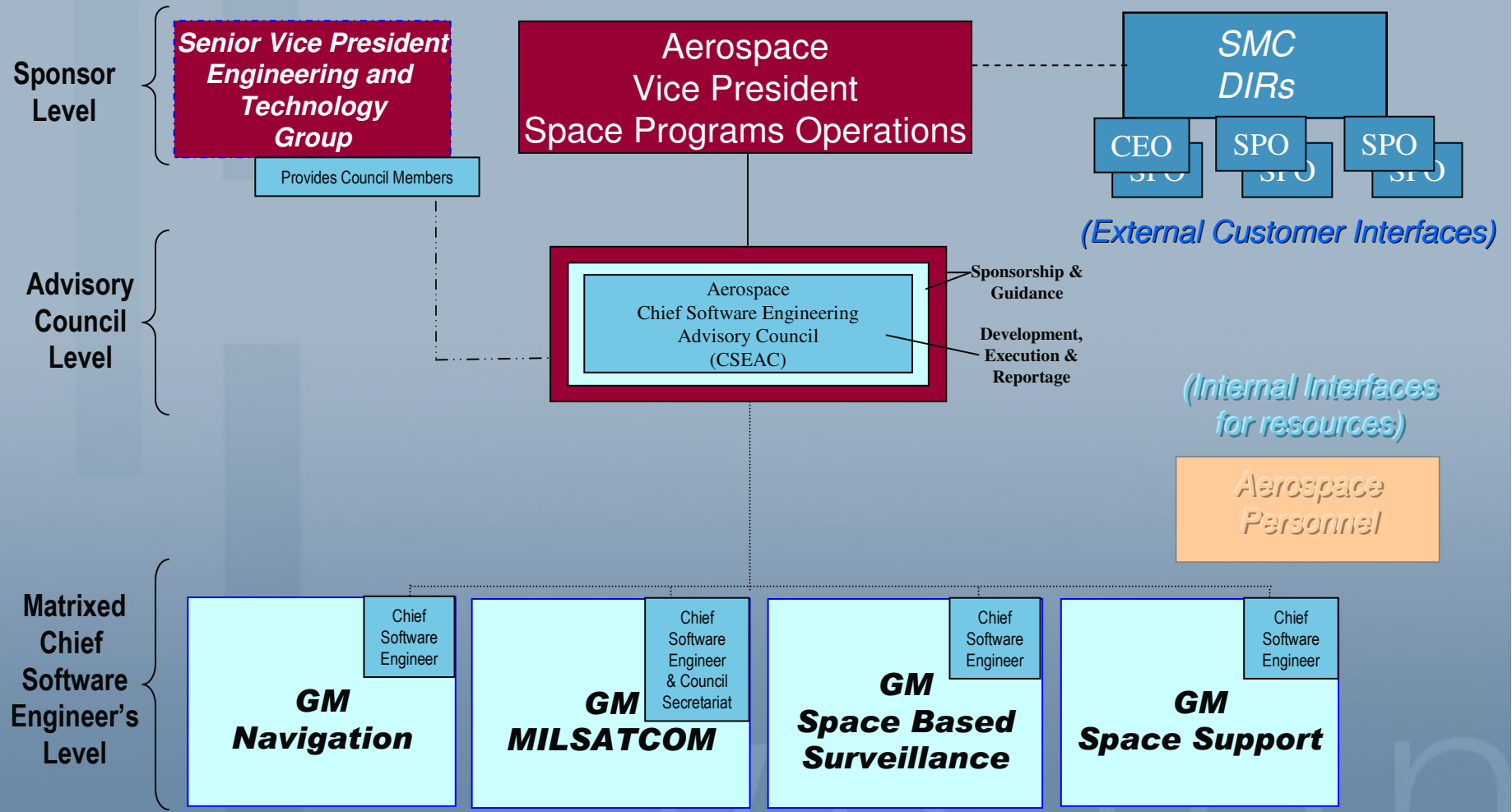


Leadership Approach #4

- Address the issues associated with acquisition program *management and leadership*
- Address *Transformational & Transactional* leadership styles
- Address *software leadership* at the acquisition program
- Address *organizational design for success* in software

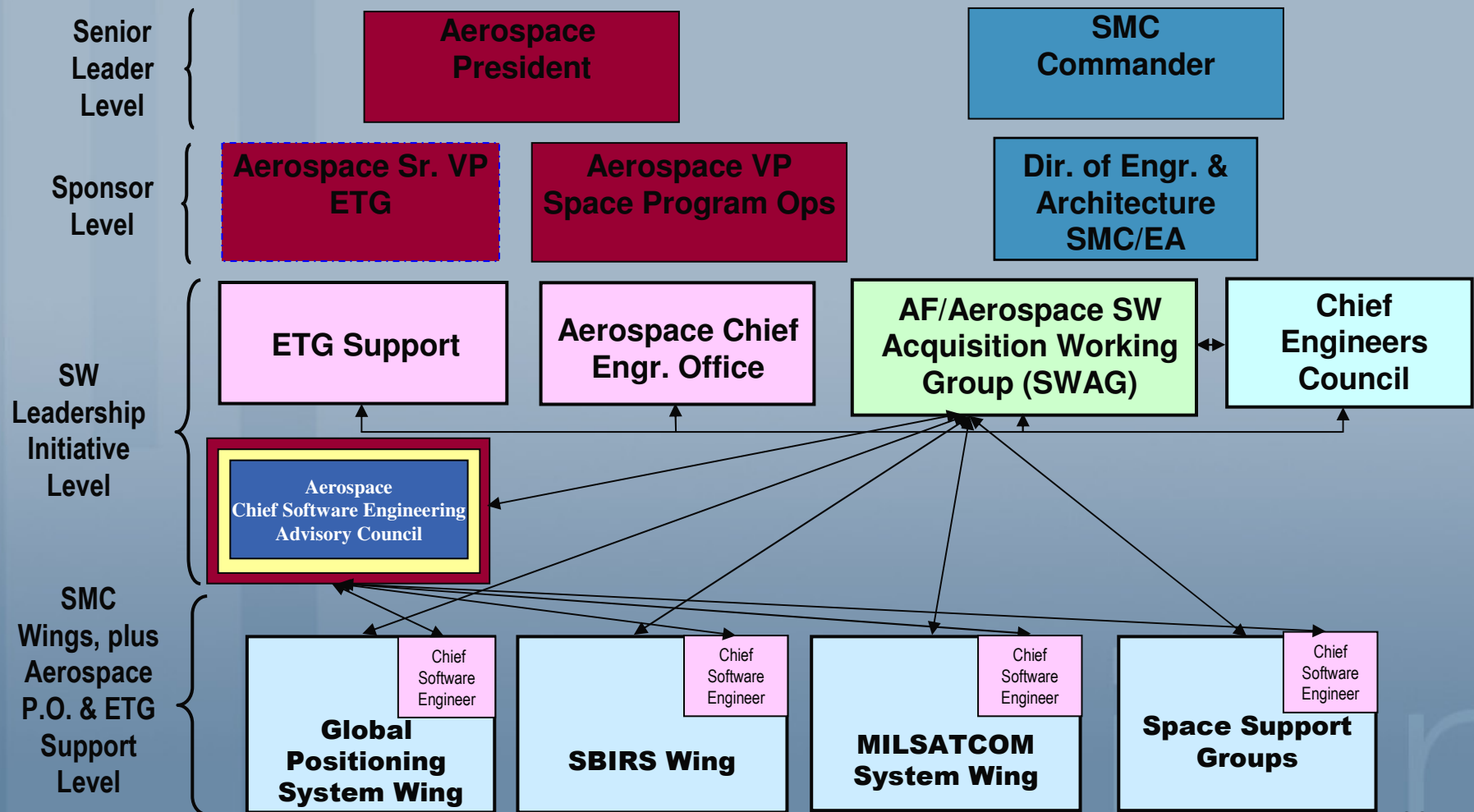


Example – Aerospace Chief Software Engineering Advisory Council Structure – 2006





Example – Air Force/Aerospace *Software Leadership Initiative* - 2007





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Summary

- It is a trite conclusion yet one that bears heed that current software developments are approaching complexity levels that may prove beyond current management skills
- Software acquisitions have been principally managed as clusters of discreet *transactions* in the past
- Software leadership encourages a *transformational* capability that adds robustness to the software discipline and strength to the acquisition program
- It is still too early to maintain how such a fundamental change will impact on software acquisitions but such an approach warrants serious application and study



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