Incorporating Systems Engineering

Using CMMI to Bring Disciplines Together

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Barriers to Integration

• Historically different backgrounds and focus
  -- Hardware, software, systems
  -- Legacy hardware development organizations evolving to software and systems

• Stovepiping -- separate functional groups / disciplines
  -- Competitive in some organizations (hardware, software, ‘ilities’, test)
  -- Organization culture has influence
  -- ‘Matrix’ organization
CMMI-Based Process Improvement

**Software has been focus of improvement for years**

- Legacy of using SW-CMM to stimulate:
  -- More effective management methods
  -- Proactive use of defined processes
  -- Collection, analysis, and use of metrics in management and technical coordination
  -- Leading to Fact-based management

**Systems engineering focus in recent years**

- Recognized engineering discipline
  -- Engineering technology focus
  -- Project coordination and discipline interfaces
  -- May direct use of engineering processes, methods, and tools

- Legacy of hardware engineering methods and standards
Best Practice at Raytheon Integrating Disciplines for CMMI-Based Improvement

Topics in presentation
- Process focus – multiple disciplines perspective
- Integrating appraisal team disciplines/expertise for effective appraisals
- Planned evolution of CMMI knowledge
- Planned role of the CMMI Expert Team
- Moving organizations/sites to CMMI
  -- Drawing on CMMI expertise
  -- Integrating disciplines together
- Common site’s CMMI strategy
- Typical appraisal cycle
- Lessons learned
Process Focus

**Hardware engineering**
- Long history of systematic design, prototype, and model development
- Defined documentation methods and control
- Mil standards
- Commonly understood management approach

**Software engineering**
- 2-3 decades of defined design and development
- Defined documentation
- DoD standards and SW-CMM
- Recently disciplined management approach

**Systems engineering**
- Recently acknowledged discipline
- DoD standards and INCOSE, EIA 731
- Recently defined management approach
Early CMMI appraisals

- For Raytheon pilots:
  - Select team members with complementary backgrounds
    (Typical 10-11 person team: 5 each SE and SW in addition to team leader)
  - Systems engineering background from multiple organizations across company, including 4 EIA 731 team leaders
  - Software engineering background from multiple organizations across company, including 5 IPI Lead Assessors
  - Site representatives, one each for SE and SW

- Each subsequent pilot appraisal:
  - Add 2-3 new team members, typically from both disciplines, ensuring gradual growth of expertise with CMMI
  - Include team members with complementary backgrounds and experience

- Completion of 4 pilots -> 18 experienced team members, most with team experience in multiple appraisals
Planned Evolution of CMMI Knowledge

Team expertise
- Selected team members’ experience 3-4 CMMI appraisals by 12/2001
  -- Geographically diverse sites assessed
  -- Experts’ background half SE and SW; some multiple disciplines; most both technical and management; from multiple site locations:
    * East coast, central US, west coast
  -- Provide guidance to own site in its CMMI-based improvement efforts

- Each subsequent CMMI appraisal:
  -- Continue to add 2-3 new team members, typically from both disciplines, ensuring continuing growth of expertise with CMMI
  -- Include team members with complementary backgrounds and diverse experience

- Establishment of CMMI Expert Team (CET)
  -- Guidance and mentoring CMMI deployment at multiple locations
  -- Extensive SE background and knowledge
Planned Role of CMMI Expert Team (CET) (1 of 2)

**Team expertise and leadership**

- CET members becoming Lead Appraisers, may be model instructors
  - Experts’ background both SE and SW; some multiple disciplines; most both technical and management
  - Experts from multiple, diverse organization/site locations:
    - East coast, central US, west coast
  - Provide guidance to multiple organizations/sites in their CMMI-based improvement plans and deployment

- Develop and maintain CMMI calendar
  - Planned appraisals – includes team leader, team members, and schedule
  - Balance availability of team members to ensure sufficient experience, growth, discipline and site representation
  - Plan and schedule workshops to support future appraisal plans
  - Communicate upcoming CMMI-related events

- Collect, analyze, and communicate lessons learned
Planned Role of CMMI Expert Team (CET)

Team roles and functions

• Develop and provide workshops and training
  -- CMMI assessment workshop – includes team training and approach to Raytheon appraisals
  -- CMMI deployment and site coordination workshop – provides transition approach, overview of lessons learned, approach to planning and preparing for appraisals

• May be assigned particular organizations to provide mentoring
  -- Typically, work collaboratively conducting site visits and providing recommendations
  -- May help develop organization/site CMMI deployment plans
Moving Organization/Site to CMMI –
Draw on CMMI Knowledge & Expertise
Work with CMMI mentors, integrating disciplines together

CMMI Training & Expertise

Site Knowledge
- CMMI model & site processes
- CMMI relationship to site goals
- Current strengths and weaknesses

Sr Management Sponsorship
- Commitment to integrated SE-SW-PM processes
- Regular reviews per CMMI guidelines

Process Improvement Leadership
- Focus on CMMI in processes
- Strong SE & SW background
- Include specialty engr & HW
- Project deployment supported by process group

Project Management
- Benefits from integrated processes
- Higher probability of new contracts
- Collaborative project team environment

Assessment Coordination
- Planning & assessment coordination with multidisciplinary teams; develops site expertise
- Benefits from lessons learned
- Assessment preparation supported by team leader and process group

Raytheon resources (CET)

Site Mentoring

CMMI Training

Site Process Group

Management Awareness

Process Improvement

Projects Awareness

Kickoff Meeting

Assessment Team Members

Knowledgeable CMMI resources from across company
Core site knowledge & CMMI deployment implementation

Assessment Team Members

Raytheon resources (CET & other resources)
Moving Organization/Site to CMMI -- Integrating Multiple Disciplines Together

The most effective organizations

• Provide and effectively use integrated CMMI steering team
  -- Active sponsorship at organization/site executive level
  -- Most senior level key individuals: program management, business area management, engineering and QA and supply chain management
  -- Direct involvement of key managers responsible for product lines and projects

• Integrate their process group
  -- Typically, work collaboratively defining process improvement plans and guiding/supporting action teams and projects
  -- Provide synergy between other process imperatives
    * Six Sigma, ISO 9000, other company or organizational improvement activities
  -- Ensure active involvement of program management and supporting discipline representatives
Strategy: Ensure success in software engineering at CMM Level 3+ and SE CMMI Level 2, before added effort dedicated to integrating SE and SW for CMMI deployment moving to Level 3.

**PHASE 1 - Parallel**
- SW CMM PBA
- SW CMM IPI or SCE
- Actions

**PHASE 2 - Integrated**
- SE CMMI PBA
- SE CMMI SCAMPI
- Actions

- SW & SE CMMI PBA
- SW & SE CMMI SCAMPI

- Attain Level 2+ rating
- Attain Level 3+ rating -- upgrade for CMMI SW & SE
- Not Level 3+ -- more work to do on SW
Typical Appraisal Cycle

Approach that facilitates evolving improvements

**Project leader**
- Identifies gaps
- Takes actions to fill gaps
- Works closely with project personnel – both SE & SW

**Verification & Mentoring**

**Project Self-Appraisal**

**Process group**
- Reviews identified gaps and actual practices (Class C)
- Works closely with project leader and key personnel

**Early Appraisal (Class B)**
- May focus on individual project
- Provides in-depth feedback and recommendations to project and org

**SCAMPI (Class A)**
- Focuses on multiple projects
- Provides rating and in-depth feedback / recommendations to projects and org

**Intermediate Appraisal (Class B)**
- Focuses on 2-4 projects
- Provides in-depth feedback and recommendations to projects and org

**CMMI Focus Review**

**CMMI PBA**
Effective Approaches on Programs
*Bringing people together to work collaboratively*

- **Integrating project planning**
  - *Integrated program plans & schedules*
  - *Multiple disciplines & supporting functions*

- **Integrating development of requirements, architecture, and design**
  - *Systems engineering leadership, with multiple engineering discipline collaboration*

- **Defining common metrics**
  - *Metrics defined to provide equivalent information*
  - *Provide insights and support effective management of programs and org functions*

- **Integrating disciplines in process group**
  - *Collaboration between groups and functions, providing better synergy and more effective process improvement*

More effective management
*Better control of programs*
Some Lessons Learned

Benefits

• Integrating disciplines in CET allows collaboration in planning and support for organizations/sites
  -- Draws from past lessons learned and apply best practices
  -- Assists organizations in understanding how to plan for their CMMI-based improvements
  -- Provides extensive knowledge of CMMI in a collaborative team working together -> effective understanding across multiple sites
  -- Builds understanding of what works well and what does not

• Integrating disciplines in appraisal teams leads to greater understanding
  -- Provides cross-fertilization of past experience and discipline expertise
  -- Application of CMMI in various organization/project/discipline implementations
  -- Provides insights, allowing team members to return to own sites with broader knowledge
  -- Can provide lessons learned to organization, based on real experience, which helps future understanding and improvements

• Integrating disciplines in process group leads to synergy and knowledge sharing -> more effective deployment
Some Lessons Learned

**Inhibitors**

- Knowledge gained in past process improvement efforts may not be accepted by other disciplines
  -- Quite different appraisal methods can contribute to resistance
  -- When past improvement efforts have been undertaken separately, resistance to working collaboratively has been observed
  -- May take extended work together to overcome barriers

- Organizations with limited collaborative or team environments may experience greater difficulty
  -- Past ‘stovepiping’ can lead to barriers or undermining
  -- Competition between organizational entities (e.g., with separate discipline management) can inhibit cooperation
  -- More difficult to deploy CMMI
    * The “I” may be difficult to achieve
Significant Lessons

Always most important – must retain focus on value of the improvements, not just the evidence or achieving success in assessments

Aim for the benefits to the entire organization

CMMI provides an environment that encourages collaboration that can be effectively applied in implementing the CMMI-based improvements themselves