WE DEVELOP, ACQUIRE, FIELD AND SUSTAIN SYSTEMS IN FOUR MAJOR MISSION AREAS

**Space Superiority**
- Space Situation Awareness
- SBSS
- Space Fence
- Defensive Counter Space
- Offensive Counter Space

**Space Support**
- Launch Systems
- Spacelift Range
- Sat Control & Network

**Force Application**
- Conventional Missiles
- Prompt Global Strike

**Space Force Enhancement**
- Milstar/AEHF/EPS (Comm)
- DSCS/GBS/WGS (Comm)
- GPS (Navigation)
- DSP/SBIRS (Surveillance)
- DMSP/DWSS (Weather)
- NUDET (Nuclear Detection)

*Developing, Delivering, and Supporting Military Space and Missile Capabilities to Preserve Peace and Win Conflicts*
Space System Development

- Launch is a “one-strike-and-you’re-out” business
- Spacecraft must work by remote control for 15 years
  - Hostile environment
  - “Small” failures can cripple or end mission

No “flight Testing” and No Service Calls in Space Mandates Unique, High-Confidence Mission Assurance Culture

Titan IV-A A-20

Delta III
Balanced Technical Practices

Specs & Standards

Right Sized –
Not the “Gold Standard”
Tailored Application

Effective technical practices balanced with cost & schedule

“Optimization” of Technical practices based on data and proven experience

Reliable Products & Supply Base
Decision Analysis/Risk Mgmt

Include commercial data/practices where available and applicable
# Functional Areas of SMC Standards

## STANDARD PRACTICES
- Program/Subcontract Management
- Systems Engineering
  - Architecture Development
  - Design Reviews
  - Configuration Management
- Quality Assurance
- Logistics
- Manufacturing /Production Management
  - Parts Management (non-space)
  - Parts Management (space)
- Risk Management
- System Safety
- Occupational Safety and Health
- Reliability/Availability

## Subsystem/Component Standards
- Electrical Power, Batteries
- Electrical Power, Solar Cells/panels
- Electromagnetic Interference & Control
- Environmental Engineering; Cleanliness
- Human Systems Integration
- Interoperability
- Maintainability
- Mass Properties
- Moving Mechanical Assemblies
- Ordnance
- Pressurized Systems & Components
- Information Assurance/Program Protection
- Software Development
- Structures
- Survivability
- Test, Space & Ground

*Industry consensus standards developed or adopted for use on SMC contracts*
Government-Industry Partnership

- Mutual-benefit stipulations:
  - Must meet both party’s needs and objectives
  - Potential teaming partners must have existing experience with subject matter of document and existing infrastructure for publishing standards
  - Content of documents must be consistent with government needs

Example from prior SMC effort

Successful partnership REQUIRES commitment from both parties

Source: AIAA Standardization Activity Kick-off Meeting, 24 March 2009
“Technical standards provide the corporate process memory needed for a disciplined systems engineering approach and help ensure that the government and its contractors understand the critical processes and practices necessary to take a system from design to production, and through sustainment.”

Mr. Stephen Welby
United States Deputy Assistant Secretary of Defense for Systems Engineering
(Modeling & Simulation Journal, Spring 2013)
Overall Gap Analysis Process

Team 1
- Systems Engineering
- Technical Reviews

Team 2
- Configuration Management

Team 3
- Logistics Support Analysis
- Reliability & Maintainability Engineering

Team 4
- Manufacturing/Quality

What needs to be done?
What is available?
What are the gaps?
Where should solutions reside?

Policy

Top Level Guidance (i.e., DAG)

Lower Level Guidance

Standards

Processes
OSD formed Gap Analysis Working Groups (summer 2011) to evaluate standardization gaps and potential solutions in several functional areas, including Systems Engineering and Tech Reviews and Audits.

Recommendation for SE and TR&A standards was briefed in November 2011 to Defense Standardization Council (DSC).

- Need based on WG findings.

DSC agreed with recommendations.

- OSD clarified direction in March 2012: All teams are to develop commercial standards.

OSD issued direction to establish a SE and TR&A Working Group (Dec 2012).

In Jun 2013, OSD selected IEEE to develop the SE and TR&A standards (each standard was individually evaluated and selected).

DSC and DSE Direction:

- Concurred with findings and recommendations.
- Non-government standards (NGS) are preferred approach.
- AF will lead multi-service working groups.
- Develop standards that apply to contractors.
IEEE Joint Systems Engineering WG

- DoD-IEEE Standards Working Group established
  - Kickoff meetings 15 & 22 Aug 2013
  - Leadership Team
    - WG Chair, Garry Roedler, Lockheed Martin
    - WG Vice-chair, Dave Davis, USAF SMC
    - WG Secretary, Brian Shaw, The Aerospace Corp.
  - Technical Editors
    - SE Standard, Bill Bearden, Los Alamos National Labs
    - TR&A Standard, Mark Henley, L-3 Com
  - DoD & Industry broadly represented (next chart)
    - Same WG members for SE and TR&A teams

- Two IEEE projects
  - 15288.1 Defense Systems Engineering: DoD addendum to 15288
    - Leverage 15288 process language; specify work products and attributes
  - 15288.2 TR&A Standard: stand-alone document
    - No equivalent industry standard
    - Hook reviews/audits to 15288 process
IEEE Joint Systems Engineering WG

Industry
- BAE Systems
- Ball Aerospace
- Boeing
- General Dynamics
- Harris
- Lockheed Martin
- Northrop Grumman
- Raytheon
- SAIC/Leidos
- United Technologies
- Ingalls Shipbuilding

Associations
- AIA
- IEEE-CS/SA
- INCOSE
- ISO/IEC
- NDIA
- SAE Intl

Defense
- Air Force
- Army
- Navy
- OSD – DASD (SE)
- DAU
- DSPO
- DOD SERC Universities – Systems Engineering Research Center

Leadership Team
Chair, Garry Roedler, Lockheed Martin
Vice-chair, Dave Davis, USAF SMC
Secretary, Brian Shaw, The Aerospace Corp.
Technical Editor, Bill Bearden, Los Alamos Nat. Lab.

* Although any individual was welcome to participate in the working group, individuals from the organizations above were requested to ensure a good cross section of the industry stakeholders. Names and affiliations of individuals rather than organizations will be used for identification of working group membership as individuals sign up for the group.
IEEE Standard for Application of SE on Defense Programs

Summary of Project Authorization Request for Systems Engineering

- Identifier of Standard – IEEE Std 15288.1
- Title: Standard for Application of Systems Engineering on Defense Programs

  - Scope:
    • System life cycle processes, activities, and tasks of ISO/IEC/IEEE 15288 for use on any defense system across the life cycle

  - Purpose:
    • This standard implements ISO/IEC/IEEE 15288 for use by United States Department of Defense (DoD) organizations and other defense agencies in acquiring systems or systems engineering support.

  - Need:
    • Provide the defense specific language and terminology for the standard to ensure the correct application of acquirer-supplier requirements for a defense prgm.

  - Technical Approach:
    • Addendum to ISO/IEC/IEEE 15288 and will:
      - Not repeat processes and information in 15288
      - Include defense specific language and terminology
      - Include necessary tailoring or changes to existing elements
      - Include any additional explanation or guidance
IEEE Standard for Application of Technical Reviews & Audits

Summary of Project Authorization Request for Technical Reviews & Audits

- Identifier of Standard – IEEE Std 15288.2
- Title: Standard for Application of Technical Reviews and Audits on Defense Programs

- Scope:
  - Establishes the requirements for technical reviews and audits to be performed throughout the acquisition lifecycle for the U.S. Department of Defense (DoD) and other defense agencies.

- Purpose:
  - Amplify ISO/IEC/IEEE 15288 Clause 6.3.2.3.a for selection, negotiation, agreement, and performance of the necessary technical reviews and audits, while allowing tailoring flexibility for the variety of acquisition situations/environments when the technical reviews or audits are conducted.

- Need:
  - Provide the defense specific language and terminology for the standard to ensure the correct application of acquirer-supplier requirements for a defense program.

- Technical Approach:
  - Standard will be in the form of a full standard that has links to ISO/IEC/IEEE 15288 and will:
    - Elaborate on the activities and tasks related to TR&A
    - Include defense specific language and terminology needed for the standard
    - Include the criteria for reviews & audits
    - Include the expected/required outcomes/products of reviews & audits
    - Include any additional explanation or guidance
Example SE Addendum (15288.1)


Tailoring Needed for Defense Programs

<table>
<thead>
<tr>
<th>6.3.1 Project planning process</th>
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<tr>
<td><strong>6.3.1.1 Purpose</strong></td>
<td><strong>6.3.1.1 Purpose</strong></td>
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<td>The purpose of the Project Planning Process is to produce and coordinate effective and workable plans. This process determines the scope of the project management and technical activities, identifies project outputs, tasks and deliverables, establishes schedules for task conduct, including achievement criteria and required resources to accomplish tasks. This is an ongoing process that continues throughout a project, with regular revisions to plans.</td>
<td>ISO/IEC/IEEE 15288:2014 6.3.1.1 &quot;Purpose&quot; applies as stated.</td>
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<td><strong>6.3.1.2 Outcomes</strong></td>
<td><strong>6.3.1.2 Outcomes</strong></td>
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<td>An implementation of the Project Planning Process shall achieve the following outcomes:</td>
<td>ISO/IEC/IEEE 15288:2014 6.3.1.2 &quot;Outcomes&quot; shall apply in accordance with the acquirer-supplier agreement:</td>
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<td>a) Objectives and plans are defined and recorded.</td>
<td>a) Systems Engineering Management Plan (SEMP) with the following attributes:</td>
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<td>b) Roles, responsibilities, accountabilities, authorities are defined.</td>
<td>1) Identifies the technical assessment and control of the project, including required technical reviews and audits and their completion criteria, technical measurement, quality assurance, baseline management, and change control.</td>
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<td>c) Resources and services necessary to achieve the objectives are formally requested and committed.</td>
<td>2) Provides a description, or reference to, the life cycle model and systems engineering processes or process model description for the technical effort, including an overview of the methods, tools and techniques which are applicable across the project.</td>
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<td>d) Plans for the execution of the project are activated and maintained.</td>
<td>3) Identifies any specific infrastructure needs to support the technical effort.</td>
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<td><strong>6.3.1.3 Activities and tasks</strong></td>
<td><strong>6.3.1.3 Activities and Tasks</strong></td>
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<td>The project shall implement the following activities and tasks in accordance with applicable organization policies and procedures with support to the Project Planning Process.</td>
<td>ISO/IEC/IEEE 15288:2014 6.3.1.3 &quot;Activities and Tasks&quot; shall apply:</td>
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<td>a) Define the project. This activity consists of the following tasks:</td>
<td>Add: The supplier shall plan, execute, and control the engineering efforts. In addition, the supplier shall ensure appropriate flowdown of requirements and technical management of subcontractors and vendors.</td>
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<td>1) Identify the project objectives and constraints.</td>
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<td>2) Define the project scope as established in the agreement.</td>
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<td>3) Define and maintain a life cycle model that is comprised of phases. Establish a work breakdown structure based on the evolving system architecture.</td>
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<td>4) Define and maintain the processes that will be applied on the project.</td>
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- Purpose
- Outcomes
- Activities and Tasks
- Identifies applicable parts of 15288
- Defines any deltas
- Outputs (added)

Resulting IEEE Standard - DoD Addendum: IEEE 15288.1 - Standard for Application of SE on Defense Programs

Document structure is aligned with ISO/IEC/IEEE 15288 and INCOSE SE Handbook
5 Requirements

.1 Purpose
.2 Description
.3 Timing
.4 Entry Criteria
.5 Content
.5.1 Product
.5.2 Conduct
.5.3 Outputs
.6 Exit Criteria

6 Detailed Criteria

.1 Products Acceptability Criteria
.2 Preparation
.3 Conduct
.4 Closure

7. Application Guidance

Tailorable

Normative Reviews/Audits (10): ASR; SRR; SFR; PDR; CDR; TRR; FCA; SVR; PRR; PCA

Example domain-specific reviews in annexes that “may find useful” (4): SAR; SSR; IRR; FRR
IEEE 15288.1 and 15288.2 Schedule

- Bi-weekly meetings and document development is on-schedule
  - Working draft review by organizations: May 10, 2014
  - Formal ballot period: June 12 to July 17, 2014; recirculation as required
  - Completed with 100% approval by ballot committee
  - Publication: January 2015

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Note: 2014 RevCom Meetings
- Aug 19-21
- Dec 8-10
How DoD will implement

- **These standards:**
  - Will be adopted by DoD as soon as published
  - Will start to be listed as requirements on RFPs
  - Should influence the SOW

- **Application to contracts**
  - Expect to see on new contracts
  - Possibly on follow-on contracts
  - No change expected at this time for existing contracts

- **Impact to current processes**
  - Many industry organizations use 15288 as a source for their process documentation
Transition Initiative

- Initiated by NDIA/AIA Workshop
  - Workshop conducted in SEP 2015
  - Consensus reached on what is needed
- NDIA SE Division to establish transition assets, including
  - Tailoring Guidance
    - Both Acquisition perspective and Supplier perspective
  - RFP Language
    - To be published as an NDIA Report
    - Results to be considered for DoD publication
  - Compliance Mapping
    - Several methods possible
    - Level of mapping to be determined
SAE G-23 Manufacturing Management Committee

AS6500 Manufacturing Management Standard
• OSD formed Gap Analysis Working Groups (summer 2011) to evaluate standardization gaps and potential solutions in several functional areas, including Manufacturing

• Recommendation for a manufacturing standard was briefed in November 2011 to Defense Standardization Council (DSC)
  • Need based on Mfg/QA root causes of problems in weapon system acquisition
  • Quality area was deemed to have sufficient coverage by commercial standards

• DSC agreed with recommendations
  • OSD clarified direction in March 2012: All teams are to develop commercial standards

• OSD issued direction to establish a Manufacturing Standard Working Group (Dec 2012)

• In Sep 2013, OSD selected SAE International to develop the manufacturing management standard
Purpose

• The goal of the standard is to encourage the use of best manufacturing management practices aimed at promoting the timely development, production, modification, fielding, and sustainment of affordable products.

• The standard is primarily intended for use in the defense industry, but may be applicable to other commercial industries.

• The standard is intended for use as a contractual requirement, to be included in Requests for Proposals and Statements of Work.

• The requirements of the standard are readily tailorable to each program’s unique situation.
SAE G-23 Manufacturing Management Committee Membership

Chair: David Karr (US Air Force)

Vice-Chair: Mark Gordon (NCAT)

Secretary: Hamid Akhbari (US Air Force)

SAE Technical Project Specialist: Becky DeGutis

Organizations represented:

**DoD Members**
- Army
- Navy
- Air Force
- OSD
- DCMA
- DAU

**Industry Members**
- Boeing
- Lockheed Martin
- BAE
- Raytheon
- Northrop Grumman
- GE Aviation
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SAE AS6500 Overview of Content

Manufacturing Management System:
Program, Policies, Objectives

Manufacturing planning
- Manufacturing Plan
- Supply chain, materiel management
- Manufacturing technology
- Cost
- M&S
- System Verification
- Workforce
- Facilities/tooling

Design analysis for manufacturing
- Producibility analysis
- Key Characteristics
- Process FMECAs

Manufacturing operations management
- Scheduling & control
- Surveillance
- Continuous improvement
- Process control plans
- Process capabilities
- First article inspections
- Supplier management
- Supplier quality

Manufacturing Risk Identification and Resolution:
- Feasibility assessments, MRLs, PRRs
AS6500 Integration with Other SAE Standards

Variation Management of Key Characteristics

AS9100 Quality Management Systems – Aerospace Requirements

AS9103

AS6500 Manufacturing Management Program

Counterfeit Parts Prevention

AS5553

First Article Inspections

AS9102

FMECAs

J1739
AS6500 Manufacturing Standard Status

• Committee ballot resulted in nearly unanimous approval
  • 93% approval
  • Dissenting vote related to implementation of the standard as opposed to the content of the standard

• Draft AS6500 standard forwarded to SAE's Aerospace Council
  • SAE's tech editor “clean-up” process

• Aerospace Council voting expected to commence NLT end of October for a 28 day ballot process

• Committee intent to develop guidance and training on implementation of the standard
Summary

• Teaming with industry essential!
  • For both technical and political reasons
  • Selection of industry partners critical
    • Willingness to publish standard consistent with government needs
    • Basis for military standard if no cooperative agreement with industry org established

• Experience – *Industry collaboration can be done provided ground rules and working relationships are forged*
  • SE, TR&A, Manufacturing Standards examples of excellent participation and support from industry

• Common recognition that awareness, training targeted at appropriate implementation critical
  • Objective of standards is to apply proven management and technical practices that will result in improved cost, schedule, and quality performance and more robust and reliable products for our customers