An OSD Software Systems Stockroom Instance Supporting Autonomous Flight Systems

a briefing at the AFRL Safe & Secure Systems & Software Symposium (S5)

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Software Systems Stockroom (S3)

- New project from the Office of the Secretary of Defense (OSD) Software-Intensive Systems Producibility Initiative

- Collaborative project between the Air Force Research Laboratory Information Directorate (AFRL/RI) in conjunction with the Office of Naval Research (ONR)

- Multiple Stockrooms are being developed to support DOD software producibility
  - The Autonomous Flight Systems S3 is one of these
Software Systems Stockroom Motivation

- Stockroom challenges posed by AFRL and ONR
  - Support “challenges that engineers face in trying to specify, design, build, verify and test software”
  - “improve the capability to produce software for DoD systems by encouraging the capture and reuse of domain knowledge and expertise through an open, community-driven, technically focused shared infrastructure”
  - Work includes “demonstrating and filling capture mechanisms of the infrastructure with knowledge and expertise applicable to one or more domains of interest to DoD”
  - “capture mechanisms may include, but are not limited to, ontologies and metadata, digital libraries, and software / system tools”
  - “support collaboration, encourage community-development, build upon open frameworks, and have a clear path to industrial acceptance”
The Autonomous Flight Systems Domain

- Will be applicable to the domain of autonomous systems flight software targeted at emerging processing systems – with specific focus on multi-core architectures
- UAVs, smart weapons, etc.
  - DoD growth area in all services
  - Meeting military objectives keeping forces out of harm’s way
  - Mix of on-board vehicle management and mission management (including functions that were performed by aircrew on manned platforms) provides significant software producibility challenges
  - Of great interest to the industry component of our Stockroom team (Boeing, Raytheon) and our mil-aero industry competitors
  - Significant interest from other industries (software, tools, etc.), small business, academia
Numerous platforms
- All DOD services
- Many new and future vehicle developments
Benefits to this Domain

- Commodity compute platforms are moving from traditional uniprocessor architectures to parallel computing, and flight platform developers are having to adapt
  - This is a problem for all mil-aero industry members
  - A rich area for pre-competitive collaboration
- Will foster collaboration between producers and consumers of technology that can leverage the **affordability** benefits of reuse and product line support on a grand scale (across mil-aero contractors)
- Provides common meeting place for developing pre-competitive and commodity solutions

( ... and others, large and small)
Benefits to the Autonomous Flight Systems Domain

- Providing coherent guidance to the supply base
  - Like USCAR and AUTOSAR for the very competitive automotive industry
- Frameworks in this domain can be a unifying technology for enabling cost effective integration of components from industry (including small business), government, and academia
- Community in this domain can be a showcase for SBIRs
  - Can post their successes
  - Will get visibility to all the right transition customers – government, larger mil-aero
- Improves value of SBIR research to DoD
Programmatics of Current Effort

• Autonomous Flight Systems S3 team
  • Boeing Research & Technology
    – Boeing’s advanced R&D unit

• Raytheon
  – Multi-contractor, precompetitive effort

• Vanderbilt University
  – Prototype, accessible over Internet, hosted at contractor-neutral university site
  – https://s3.isis.vanderbilt.edu
**Programmatics of Current Effort**

- 6-month prototyping effort
  - Developing infrastructure, policies, procedures
  - Initial content population

**Contents**
- Domain Knowledge
  - Scenarios
  - Processes
  - Requirements
  - Tools
  - CONOPs
  - ...
- Software Components
  - Code
  - Models (Simulink, MATRIXx, etc.)
  - APIs
  - Frameworks
  - ...

**Infrastructure**
- Access Control Engine
- Content Management Engine
- Workflow Engine
- IP Rights Engine
- Metadata Search Engine
- Taxonomy Search Engine
- Natural Language Search Engine
- ...

**Policies, Procedures (IP, ITAR, etc.)**

**Contributor**
- Management, Design Team
- Boeing
- Raytheon
- Vanderbilt University

**Consumer**
Architecture Principles

• Fully access controlled
  • Need to request username and password

• Content and metadata is inseparable
  • Content posting includes submission of metadata

• Authenticity, provenance and integrity of the submissions is monitored and maintained
  • Digital signatures on submissions, secure HTTP interactions

• Reusable software provided with acceptance test information
  • Acceptance tests are repeatable by consumers
• “Open” contributions can be made
  • Open-source, permissive (non-proprietary) licenses
  • Searchable metadata and the content stored in repository
  • Downloadable “payload”
  • As done with VSIPL (Vector Signal Image Processing Library)
  • Reduces constraints on users of Stockroom content

• Plan for proprietary content
  • Non-proprietary auxiliary information and metadata that references proprietary components can be hosted in repository
    – Searchable metadata and “pointers” to proprietary components (points-of-contact, web links, etc.) hosted in repository
    – Data “payload” not hosted on internet-accessible repository, protecting against unauthorized access and downloads of restricted content (Intellectual Property, classified)

• Allows visibility and access to both open and proprietary content for government and platform development contractor stakeholders
Structural Architecture

Contributor Portal

Consumer Portal

Management Interface

Server(s)

Access control engine

Metadata search engine

Content management / workflow engine

Taxonomy search engine

Policy engine

Natural language search engine

Repository Database

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Non-search functions

- **Content management / workflow engine:**
  - Orchestrates the execution of use cases

- **Access control engine:**
  - Provides role-based access control for system functions

- **Policy engine:**
  - Enforces policies for data content access such as IP rights, ITAR
Repository Functional Elements

Search functions

- **Natural language search engine**
  - Searches content via text description

- **Taxonomy search engine**
  - Searches content via the taxonomy that classifies content

- **Metadata search engine**
  - Searches content via category-specific metadata, validates compatibility
Community Members & Stakeholders Envisioned for the Autonomous Flight Systems S3

- Government Labs and Oversight
  - ARL
  - DoD
  - AFRL

- DoD Acquisition Programs
  - Department of Defense
  - Air Force

- Other Government Research Organizations
  - NASA
  - DARPA

- COTS Vendor Community
  - Software Tools
  - Middleware
  - Operating Systems
  - Compute Hardware
  - Other

- Academic Researchers (numerous)
  - Boeing
  - Honeywell
  - Raytheon
  - Northrop Grumman
  - Lockheed Martin
  - ... and others, large and small
Summary and Future Activities

• This Stockroom is currently in development
  • Supports the important growth area of autonomous flight systems

• Will be opening it up for insertion and mining of content
  • Reusable software, algorithms, papers, tools, etc.
  • Content visibility to government program offices, platform development contractors

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