Ontology-Based Solutions for Software Reuse

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Goal – Improve Current Software Repository Capabilities

• Types of searches typically supported by repositories
  – Keyword search over metadata – dependent upon semantic assumptions
  – Browsable categories – becomes ineffective as size grows

• The goal of this research is to improve repository utility by expanding capabilities

• Initial research conducted in support of PEO IWS for the SHARE repository
Repository Framework

• Developed enriched metadata and semantic descriptions for improved search and reuse
• Goal of proposed framework is to enable multiple search and discovery options:
  – Semantic Search (e.g., relationships)
  – Model-Based Search (e.g., structures)
  – Maintain traditional search options (e.g., keyword)
• Approach: Repository Framework
  – Component Specification
  – Ontology
Component Specification and Ontology

- Component Specification - a description or model of the items in the repository
  - “Typical” Metadata - information about an asset/artifact
  - Software Behavior Description – a searchable representation of the software asset’s behavior
- Ontology – a contextual model of the repository items describing their relationships to aid in associating artifacts with user needs
Metadata

• “As-is” Schema
  – Reflects current metadata schema in SHARE
  – Align with data entry steps in SHARE’s Asset Information Form wizard

• Recommended “To-be” Schema
  – XML Schema designed using Artifacts as the basis
  – Incorporates software behavior and ontology references

• Evaluated both schema approaches against other metadata schemes
As-is Metadata Schema

- Top Level Elements correspond to steps 2-12 of the SHARE data entry wizard.

All XML Schema developed using Altova XMLSpy.
To-be Metadata Schema

- Two schemas to capture data at appropriate level of granularity
- Artifact Schema describes individual artifacts (smallest useful package of items)
- Asset Schema defines package of artifacts to meet a particular need
- Allows user-defined assets as well as submitter-defined
Software Behavior Representation

• Informal Approach
  – Common System Function List, Web Service Description Language

• Behavioral description elements are included in the metadata for each artifact
Relationships (Ontology)

• Multiple sources of context for repository artifacts
  – Artifact’s place in the Software Engineering Lifecycle
  – Original System Architecture (Aegis, SSDS, etc.)
  – Surface Navy Open Architecture reference architecture
  – Semantic relationships (ReSEARCH work)

• Ontologies represented in OWL-DL (Description Logic)

Fish Eye Graph
(Sarkar and Brown, 1993)
Lifecycle-Artifact Ontology

- Links artifact types to development activities

- LifecyclePhases
  - ConceptDevelopmentActivity
  - DeploymentActivity
  - DesignActivity
  - ImplementationActivity
  - MaintenanceActivity
  - RequirementsActivity
  - TestingActivity

- SoftwareArtifacts
  - ArchitectureArtifacts
  - CodeArtifacts
    - CompiledLibrary
    - ExecutableProgram
    - SourceCode
  - DesignArtifacts
  - InterfaceArtifacts
  - OtherArtifacts
  - RequirementsArtifacts
  - SimulationArtifacts
  - TestArtifacts
  - UserArtifacts
Original System Architecture

• Captures
  – System-subsystem relationships
  – Interfaces
  – Any other desired architectural relationships

• Report includes example to show possibilities

• From Aegis SV-1 available in RDA CHENG Naval Architecture Repository System (NARS)
Surface Combat System Top Level Objective Architecture

• Converted architecture view to OWL
Schema References to Ontologies

Recommended metadata schemas tie artifacts to ontologies
User Scenarios

• Requirements Phase Scenario
  – Start with metadata to select a particular item of interest
  – Use behavior descriptions (CSFL) and ontologies to expand list of useful items

• Design Phase Scenario
  – Start with CSFL to identify group of items of interest
  – Use metadata to identify items that should be retrieved.

• User’s context drives search and discovery process
Current Research Efforts

• Design of software repository tools that allow for guided navigation and insertion of artifacts in repositories
  – These tools will take advantage of the improved repository framework developed during the previous effort.
  – Demonstrate the value of these tools through use case demonstrations, sponsor evaluation, and a focus group study

• Detailed Specification
  – Search and Discovery Tool
  – Asset Submission Tool
Questions?

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