Problem Specification

Definitions

Abstract

URDAD

Quality drivers embedded in URDAD

Internal consistency

Summary

URDAD as Quality-Driven Process [1]

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[1] Accepted as a regular paper at SOMET 2011, the 10 International Conference on Intelligent Software Methodologies, Tools, and Techniques, St Petersburg, 28 - 30 Sept 2011

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- Inferior requirements
    - Core contributor to poor software quality & high cost.

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  - Constrain cost & skills requirements.
  - Degree of formalization of process & inputs/outputs.

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  - Constrain cost & skills requirements.
  - Degree of formalization of process & inputs/outputs.
- Model Driven Engineering (MDE)
  - Fall into class of semi-formal approaches
  - Problems:
    - Often no defined engineering process.
    - Design structures, quality & semantics often vary.

Definitions

Definition

Quality is the degree to which a set of inherent characteristics fulfills requirements. [2]

[2] David Hoyle, *ISO 9000: 2000 Quality Systems Handbook*. 4th ed, 2000.

[3] P. G Petersen, et al., Software quality drivers and indicators. *System Sciences*, p210 –218 vol.2, 1989.

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A *quality driver* is an activity which improves one or more process or model quality criteria. [3]

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  - We identify for each quality criterion
    - Set of quality drivers.

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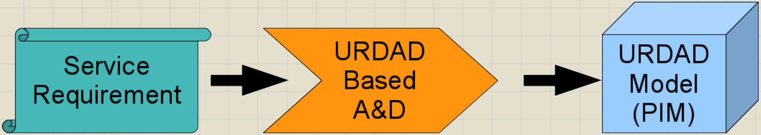
  - Methodology supported by metamodel & DSL.
- Contributions of this paper
  - We identify for each quality criterion
    - Set of quality drivers.
  - Show quality drivers used in URDAD.

URDAD

- Systematic methodology for technology-neutral A&D
  - service-oriented approach
  - generates MDA's PIM



URDAD as recursive analysis & design algorithm

```
class Urdad
{
  provideService(serviceRequirement):Service
  {
    serviceContract = negotiateContract(serviceRequirement)

    try
    {
      return serviceRegistry.getService(serviceContract)
    }
    catch (noRealizingServiceException)
    {
      service = designService(serviceContract)

      for (lowerLevelServiceRequirement : service.requiredServices)
        provideService(lowerLevelServiceRequirement)
    }
  }
}
```

URDAD analysis phase

```
class UrdadAnalysis
{
  negotiateContract(serviceRequirement):ServiceContract
  {
    for (stakeholder:identifyStakeHolders(serviceRequirement))
    {
      functionalRequirements = sourceFunctionalRequirements(
          stakeholder, serviceRequirement)
      qualityRequirements = sourceFunctionalRequirements(stakeholder,
           serviceRequirement)
    }
    negotiateConsistentRequirements()
    groupFunctionalRequirementsIntoServiceRequirements(
        functionalRequirements)
    for (functionalRequirement:functionalRequirements)
      defineCondition(functionalRequirement)
        // includes test & associated exception
    specifyDatastructuresForRequestAndResultClasses()
    assembleServiceContract()
    assignServiceContractToResponsibilityDomain()
    return serviceContract
  }
}
```

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Model quality impacted by quality of modeling language.

- Define semantics via metamodel or ontology.

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Qualities of modeling language:

- *Completeness*
  - Formal lang: power to express statements needed for URDAD.
    - All meaning to be conveyed can be conveyed.
  - Informally verified through
    - Analyze URDAD process & models for required semantics.
    - Empirically tested via example models.

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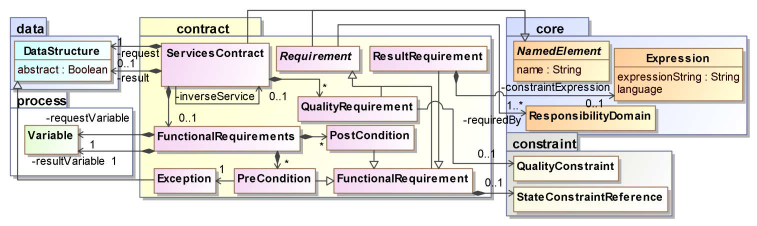
- *Consistency*
  - Metamodel/ontology is instantiable
  - Verified: transform to ontology & assessed consistency using logical reasoner.
- *Complexity*
  - Assessed by counting classes, relationships & constraints.
  - Much lower than for UML (generic language).
    - UML: 16x more classes, 7x more relationships.

Example: Language elements for contract specification



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- Generate validating editor for concrete syntax.
  - Done using MDA tool suite.
- Use model validators
  - Compliance to metamodel structure.
    - Valid if constructed via concrete syntax.
  - Adherance to metamodel constraints.
    - Not all metamodel constraints enforced by concrete syntax.

Example: Service contract specification (1/2)

```
ResponsibilityDomain RequirementsEngineering
{
  ServiceContract specifyService
  {
    FunctionalRequirements receiving Variable specifyServiceRequest
         ofType SpecifyServiceRequest
    {
      PreCondition serviceHasStakeholders requiredBy (Client) raises
           NoStakeholdersException checks Constraint
           ServiceHasStakeholders
      PreCondition stakeholderRequirementsConsistent requiredBy (
           Client Implementation Testing) raises
           InconsistentStakeholderRequirementsException checks
           Constraint RequirementsConsistent
      PostCondition serviceContractSpecified requiredBy (Client
           Implementation Testing) ensures Constraint
           ServiceContractSpecified
      PostCondition processSpecified requiredBy (Client
           Implementation) ensures Constraint ProcessSpecified
    }
    ...
```

Example: Service contract specification (2/2)

```
    ...
    QualityRequirement traceability requiredBy (ProcessDesign
         ProjectManagement Development)
    Request DataStructure SpecifyServiceRequest
    {
      has Component serviceRequirements ofType _ServiceRequirements
    }
    Result DataStructure SpecifyServiceResult
    {
      has Component serviceContract ofType _ServiceContract
      has Component service ofType _Service
    }
  }
  Exception NoStakeholdersException {}
  Exception InconsistentStakeholderRequirementsException {}
}
```

Simplicity quality driver

Inverse measure of complexity.

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    - Reduce model size & improves understandability.

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- Enforce single responsibility principle
    - Assignment of services to responsibility domains.
- No duplication of statements
    - Only one way to specify things.

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  - Service provider need not be designed - could be plugged in.
- Process assistance for completeness via process steps with
  - defined inputs & outputs, and
  - defined process tasks.

Model Consistency Drivers

Consistency often problematic in UML models

- Different UML models structurally and even semantically very different.
- Consistency issues across diagrams (e.g. sequence, activity diagrams & state charts).

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Model consistency drivers

- Repeatable process with defined inputs, outputs & tasks for each process step.
- Enforced model structure & semantics through metamodel.
  - Does not allow duplicate specifications

Model Cohesion Drivers

- Responsibility localization
    - Contracts contain only services from same responsibility domain.
    - “Encouraged” by process.

Model Cohesion Drivers

- Responsibility localization
  - Contracts contain only services from same responsibility domain.
  - “Encouraged” by process.
- Services as cohesive, self-contained units
  - Statelessness enforced by metamodel.
  - Each service must address complete functional requirement at some level of granularity.

Modifiability Drivers

- Decoupling via services contracts
    - Modifiability through decoupling.
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- Simplicity and hence its quality drivers also improve modifiability.

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- All services realize services contracts
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- Enforced adapter layer.

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Traceability important for validation & estimation

- Validation for both, sufficiency and necessity.

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Quality drivers

- Process requires service identification for each functional requirement.
- Metamodel provides
  - Traceability of services across levels of granularity.
  - Traceability from service to functional requirement realized.
  - Traceability from functional requirement to stakeholder who requires it.

Example: Service specification

```
Service specifyServiceImpl realizes specifyService receiving
     Variable specifyServiceRequest ofType SpecifyServiceRequest
{
  use identifyStakeholders toAddress (serviceHasStakeholders)
  use performAnalysis toAddress (serviceContractSpecified)
  use designProcess toAddress (processSpecified)

  Process doSequential
  {
    create Variable identifyStakeholdersRequest ofType
         IdentifyStakeholdersRequest
    set Query OCL:"identifyStakeHoldersRequest.serviceRequirements"
         equalTo Query OCL:"specifyServiceRequest.serviceRequirements
         "
    requestService identifyStakeholders with
         identifyStakeholdersRequest yielding Variable
         identifyStakeholdersResult ofType IdentifyStakeholdersResult
          on NoStakeholdersException raiseException
         NoStakeholdersException

    create Variable specifyServiceContractRequest ofType
         SpecifyServiceContractRequest
    ...
```

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Testability Drivers

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  - In service-oriented paradigm, services can only be tested by
    - Extracting information about environment using other services.
    - Assessing constraints on obtained information.
- Metamodel
  - Contract has constraint as either pre- or post-condition.
  - Same state constraint can be pre- and post- condition for different services.

Example: State constraint specification

```
StateConstraint ServiceContractSpecified receiving Variable
     serviceRequirements ofType _ServiceRequirements
{
    StateAssessmentProcess doSequential
    {
create Variable serviceContractAvailable ofType Boolean
set Query OCL:"serviceContractAvailable" equalTo Constant "true"

create Variable provideServiceContractRequest ofType
     ProvideServiceContractRequest
set Query OCL:"provideServiceContractRequest.serviceRequirements"
     equalTo
Query OCL:"serviceRequirements"
requestService provideServiceContract with
     provideServiceContractRequest
yielding Variable provideServiceContractResult ofType
     ProvideServiceContractResult
on NoServiceContractAvailableException
set Query OCL:"serviceContractAvailable" equalTo Constant "false"
    }
    Constraint OCL:"serviceContractAvailable = true"
}
```

Summary of quality drivers in URDAD

Quality-driver	Model qualities									
			Pragmatic model qualities							
	Semantic	Syntactic	Simplicity	Completeness	Modifiability	Consistency	Decoupling	Cohesion	Reusability	Traceability
Define metamodel or ontology	✓	✓	✓	✓	✓	✓	✓			✓
Define concrete DSL grammars		✓	✓		✓					
Define levels of granularity			✓		✓				✓	✓
Decouple services via contracts			✓		✓		✓		✓	✓
Single reponsibility principle			✓		✓			✓	✓	✓
Testable pre- & post-conditions				✓	✓	✓				
Localize controll logic			✓		✓		✓	✓	✓	✓
Include traceability links			✓	✓	✓	✓				✓

Internal consistency of methodology

- URDAD = analysis & design methodology used to design services
  - Apply process to design service of performing analysis & design for service
    - must regenerate itself
    - if it doesn't, then not internally consistent
    - if it does, it does show that URDAD is a good methodology, but only that it is consistent

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    - if it does, it does show that URDAD is a good methodology, but only that it is consistent
- Applying URDAD to design service-oriented A&D methodology regenerates
  - process, and
  - metamodel.

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- Demonstrated how quality drivers used in URDAD process.

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- Linked quality drivers to quality criteria.
- Demonstrated how quality drivers used in URDAD process.
- When using URDAD to design A&D process, one can regenerate URDAD with its metamodel.