From the Decision Support on the **Ground** to the Decision Support in the **Cloud**

Aida Omerovic, SINTEF ICT

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Outline

- Why decision support
- What we have on the ground
- What we need in the cloud
- What we propose
Why model-based decision support on the ground?

- Make informed decisions
- Handle changes
- Handle complexity
- Exchange knowledge
- Reduce risk
- Make requirements, risk, quality and cost explicit
- Foresee implications
- Models as means of specifying, reasoning and communicating
Outline

• Why decision support
• **What we have on the ground**
• What we need in the cloud
• What we propose
We have...

PREDIQT (model-based quality prediction)
- Language
- Process
- Tool

CORAS (model-based risk analysis)
- Language
- Process
- Tool

AND MUCH MORE
We have...

**PREDIQT process**

<table>
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<th>Phase 1: Target modeling</th>
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<td><strong>Sub-phase 1</strong>: Characterization of the target and the objectives</td>
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<td><strong>Sub-phase 2</strong>: Development of Quality Models</td>
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<td><strong>Sub-phase 3</strong>: Mapping of Design Models</td>
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<th>Phase 2: Verification of prediction models</th>
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<td><strong>Sub-phase 3</strong>: Approval of the final prediction models</td>
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<th>Phase 3: Application of prediction models</th>
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<td><strong>Sub-phase 1</strong>: Specification of a change</td>
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<td><strong>Sub-phase 3</strong>: Quality prediction</td>
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**CORAS process**

1. high level analysis
2. risk identification
3. approval
4. risk evaluation
5. risk estimation
6. risk treatment
Model-based quality prediction – the PREDIQT approach
Motivation

• Many design alternatives towards a quality goal

• A design alternative may impact several quality characteristics (e.g. security, performance, scalability, availability...) in the different directions

• Need decision-making support which facilitates the analysis of effects of architectural adaptations, on the overall quality of a system
Focus

Business processes, regulations, standards, technologies, requirements...

System architecture

System quality
Prediction models

- Quality models
- Architecture models
- Dependency views
PREDIQT language and tool

Benefit of the resulting QCF increase by 0.006?

Cost of increasing QCF by 0.025?

OR

Cost of increasing QCF by 0.04?

Illustrative example with fictitious values
Model-Driven Risk Analysis – The CORAS Approach
What is risk?

- Many kinds of risk
  - Contractual risk
  - Economic risk
  - Operational risk
  - Environmental risk
  - Health risk
  - Political risk
  - Legal risk
  - Security risk
Main concepts

- **Vulnerability**
- **Threat**
- **Asset**
- **Unwanted incident**
- **Likelihood**
- **Consequence**
- **Risk**
- **Party**
- **Treatment**
Risk modeling

• The CORAS language consists of five kinds of diagrams
  – Asset diagrams
  – Threat diagrams
  – Risk diagrams
  – Treatment diagrams
  – Treatment overview diagrams

• Each kind supports concrete steps in the risk analysis process

• In addition there are three kinds of diagrams for specific needs
  – High-level CORAS diagrams
  – Dependent CORAS diagrams
  – Legal CORAS diagrams
CORAS language and tool

Benefit of the resulting risk reduction?

Cost of treatment?

Illustrative example with fictitious values
Outline

• Why decision support
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• What we propose
Needs in the cloud

- Cloud technologies as an enabler – business models, quality levels, capabilities...

- Similar services available from several providers – replaceability, redundancy of services
  - Risk of vendor lock-in reduced, quality may improve

- Challenges:
  - Services vary w.r.t. functionality, quality, cost, value
  - Lack of transparency w.r.t. cost and quality
  - Dynamics
  - Dependencies
Needs in the cloud cont.

- How to choose service and provider?
  - Need a systematic, comprehensive support for decision maker
  - Dynamics of multi-clouds require light-weight processes and tools

- A model-based trade-off analysis of enterprise and software architectures
  - Easy-to-understand cost-benefit analysis
  - Merge of the aspects of risk, cost and quality in a consolidated view
A decision support method

• By Decision Support Method (DSM) we mean: process, language and tool for decision support

• The DSM process is undergone while developing, verifying and applying the decision support models

• Four types of actors are involved:
  • Analyst
  • Decision maker
  • Domain expert
  • Cloud management service
Objectives of the DSM stakeholders

• **Analyst**
  • Usefulness of the method, cost-effective method, expressive models

• **Decision maker**
  • Useful method for making informed decisions, cost-effective method

• **Domain expert**
  • Improved knowledge management, comprehensible method

• **Cloud measurement service**
  • Relevant, practically feasible, accurate and precise
The challenge of designing a DSM

Balance between:

• Scalability in a real-life setting
• Expressiveness of the models
• Accuracy and validity of the models

and

• Comprehensibility
• Practical feasibility within limited resources
• Support for dynamics through a light-weight method
Preliminary success criteria for a DSM

1. DSM facilitates the making of informed decisions
   - The method assists in making informed and trustworthy decisions
   - The method is useful in the design time

2. DSM can be applied in real-life setting within limited resources
   - In an industrial setting, an analysis is conducted during a specified number of workshops and with a pre-defined budget
   - The method can cover the scope of a realistic analysis

3. DSM is cost-effective
   - It is well worth using the method
   - The cost of resources needed is not higher than using comparable other approaches
Preliminary success criteria cont.

4. DSM is sufficiently comprehensible to the stakeholders
   • The stakeholders (who are not necessarily experts in the domain or the DSM) can gain a common understanding of the process and the models
   • The models can be approved based on a common interpretation
   • They demonstrate the understanding by actively participating in the analysis and applying the results

5. The models of the DSM are sufficiently expressive, complete and certain
   • The models can express the aspects needed and cover the scope of the analysis
   • Certainty of the contents is acceptable for the intended purpose

6. DSM facilitates knowledge management and documenting of the decision process
   • Consolidation of the knowledge, origination from the different sources
   • Traceability of the decision process and selection criteria
We lack in the cloud...?

- Merge of risk analysis and quality prediction
- Value-based approach: notion of cost and utility
- Run-time dynamics
  - light-weight process, short cycles
  - KPI identification, aggregation and measurement in real-time
- Easy-to-understand method
- Standardized interfaces for negotiations among cloud services w.r.t. risk, quality and cost
- Support for variation of usage profile and quality/risk/cost definitions
- Prediction of quality/risk/cost variation over time
- Process guidance in the tool
Outline

- Why decision support in cloud
- What we have on the ground
- What we need in the cloud
- **What we propose**
What we propose

- As a result of the research within the MODAClouds project we propose a Decision Support Method (DSM)
- Migration is central
- From understanding of the migration process, we deduce the relevant quality attributes and risks
- We propose a DSM process for developing and using models for decision making with respect to quality, risk and cost in multi-clouds
Migration process as a starting point
Quality Aspects in Multi-Clouds

- **Interoperability**
  - Technical
    - Communication compatibility
    - Compatible quality of service
    - Technological compatibility
  - Semantic
    - Data syntax consistency
    - Data quality
  - Organizational
    - Compatibility of working processes (services do the same functionality)
  - Legal
    - Regulatory Compliance

- **Intercloud replaceability**
  - Ease of setup migration
  - Export of setup
  - Import of setup
  - Testability of alternative services
  - Test coverage
  - Performance of migration
  - Performance with high data volumes
  - Performance with high transaction throughput
  - Requirements fulfillment by alternative services

- **Security**
  - Confidentiality
  - Integrity
    - Mechanisms to ensure data integrity
  - Availability
  - Non-repudiation
  - Accountability
    - Forensic requirements
  - Authentication and Authorization
    - Federated/unified access control systems
The process of DSM – overall
The process of DSM – phase 1
The process of DSM – phase 2

1. Create dependency views for quality and cost
2. Identify risks
3. Estimate risk/quality/cost parameters
4. Validate the decision models

Analyst

Domain Expert

Cloud Measurement Service
The process of DSM – phase 3

1. Specify treatment
2. Apply the treatment on the decision models
3. Quality prediction
4. Risk evaluation
5. Cost prediction
6. Analyze a consolidated view of impact of the treatments w.r.t. quality, cost and risk
Conclusions

• A DSM to facilitate the selection of cloud services and providers in a multi-cloud environment

• We argue that risk, quality and cost are among the main factors in such a selection process

• Challenges:
  • The dynamics of multi-clouds require light-weight processes and tools
  • The decision makers depend on easy-to-understand representations
  • The notion of cost less established in the trade-off analysis of architectures
  • Merge of the aspects of risk, cost and quality in a consolidated view

• The state of the art can be leveraged
Future work

• Case studies, evaluation, adaption/refinement of the method
• Development of the modelling languages for a consolidated model-based risk analysis, quality prediction and cost analysis.
• Easy-to-understand visualization
• A prototype tool
Questions/comments?

Thank you!

aida.omerovic@sintef.no