Analysing Risk in Practice
The CORAS Approach to Model-Driven Risk Analysis

Bjørnar Solhaug
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Contact

- Bjørnar Solhaug
- SINTEF ICT, Norway
- E-mail: Bjornar.Solhaug@sintef.no
- Web: www.sintef.no
Overview

- Part I  Introduction – Risk management and the CORAS approach
- Part II  Example-driven walkthrough of the CORAS method
- Part III  Change management
Part I: Introduction

Risk Management and the CORAS Approach
Overview of Part I

- What is risk?
- What is risk management?
- Central terms
- What is CORAS?
- Main concepts
- The CORAS process
- Risk modeling
- Semantics
- Likelihood reasoning
- The CORAS tool
- Further reading
What is Risk?

- Many kinds of risk
  - Contractual risk
  - Economic risk
  - Operational risk
  - Environmental risk
  - Health risk
  - Political risk
  - Legal risk
  - Security risk
Definition of risk from ISO 31000

- **Risk**: Effect of uncertainty on objectives
  - NOTE 1 An effect is a deviation from the expected — positive and/or negative
  - NOTE 2 Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process)
  - NOTE 3 Risk is often characterized by reference to potential **events** and **consequences**, or a combination of these
  - NOTE 4 Risk is often expressed in terms of a combination of the **consequences** of an event (including changes in circumstances) and the associated **likelihood** of occurrence
  - NOTE 5 Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of an event, its consequence, or likelihood
What is Risk Management?

- **Risk management:** Coordinated activities to direct and control an organization with regard to risk
  [ISO 31000:2009]
Risk Analysis Involves

- Determining what can happen, why and how
- Systematic use of available information to determine the level of risk
- Prioritization by comparing the level of risk against predetermined criteria
- Selection and implementation of appropriate options for dealing with risk
Terms

- Asset
- Vulnerability
- Threat

Risk

Need to introduce risk treatment

Reduced risk
Terms

Computer running Outlook

Vulnerability

Worm

Threat

Infected PC

Unwanted incident

- Infected twice per year
- Infected mail send to all contacts

Internet

Risk

Install virus scanner

Treatment
Risk Analysis Using CORAS
Overview

- What is CORAS?
- Main concepts
- Process of eight steps
- Risk modeling
- Semantics
- Calculus
- Tool support
- Further reading
What is CORAS?

- CORAS consists of
  - Method for risk analysis
  - Language for risk modeling
  - Tool for editing diagrams
- Stepwise, structured and systematic process
  - Directed by assets
  - Concrete tasks with practical guidelines
  - Model-driven
    - Models as basis for analysis
    - Models as documentation of results
- Based on international standards
Main Concepts

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

- **Asset**: Something to which a party assigns value and hence for which the party requires protection
- **Consequence**: The impact of an unwanted incident on an asset in terms of harm or reduced asset value
- **Likelihood**: The frequency or probability of something to occur
- **Party**: An organization, company, person, group or other body on whose behalf a risk analysis is conducted
- **Risk**: The likelihood of an unwanted incident and its consequence for a specific asset
- **Risk level**: The level or value of a risk as derived from its likelihood and consequence
- **Threat**: A potential cause of an unwanted incident
- **Treatment**: An appropriate measure to reduce risk level
- **Unwanted incident**: An event that harms or reduces the value of an asset
- **Vulnerability**: A weakness, flaw or deficiency that opens for, or may be exploited by, a threat to cause harm to or reduce the value of an asset
Process of Eight Steps

1. Preparations for the analysis
2. Customer presentation of the target
3. Refining the target description using asset diagrams
4. Approval of the target description
5. Risk identification using threat diagrams
6. Risk estimation using threat diagrams
7. Risk evaluation using risk diagrams
8. Risk treatment using treatment diagrams

Establish context
Assess risk
Treat risk
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
Example: Threat Diagram

Threat scenario: Server is infected by computer virus [possible]

Vulnerability: Computer virus
Virus protection not up to date

Threat: Hacker

Likelihood: 0.1

Consequence: Hacker gets access to server [unlikely]
Confidentiality of information: high
Integrity of server: high
Availability of server: high

Vulnerability: Server goes down [unlikely]

Likelihood: 0.2

Consequence: Virus creates back door to server [possible]
Confidentiality of information: high
Integrity of server: high
Availability of server: high

Asset: Unwanted incident
Semantics

- How to interpret and understand a CORAS diagram?
- Users need a precise and unambiguous explanation of the meaning of a given diagram

- Natural language semantics
  - CORAS comes with rules for systematic translation of any diagram into sentences in English

- Formal semantics
  - Semantics in terms of a probability space on traces
Example

- **Elements**
  - *Computer virus* is a non-human threat.
  - *Virus protection not up to date* is a vulnerability.
  - **Threat scenario** *Server is infected by computer virus* occurs with likelihood *possible*.
  - *Unwanted incident* *Server goes down* occurs with likelihood *unlikely*.
  - *Availability of server* is an asset.

- **Relations**
  - *Computer virus* exploits vulnerability *Virus protection not up to date* to initiate *Server is infected by computer virus* with undefined likelihood.
  - *Server is infected by computer virus* leads to *Server goes down* with conditional likelihood 0.2.
  - *Server goes down* impacts *Availability of server* with consequence high.
Calculus for Likelihood Reasoning

- **Relation**
  \[
  \frac{v_1(P_1) \cdot v_2}{(v_1 \sqcap v_2)(P_1 \cdot P_2)}
  \]

- **Mutually exclusive vertices**
  \[
  \frac{v_1(P_1) \cdot v_2(P_2)}{(v_1 \sqcup v_2)(P_1 + P_2)}
  \]

- **Statistically independent vertices**
  \[
  \frac{v_1(P_1) \cdot v_2(P_2)}{(v_1 \sqcup v_2)(P_1 + P_2 - P_1 \cdot P_2)}
  \]
# Guidelines for Consistency Checking

<table>
<thead>
<tr>
<th>How to check consistency of likelihoods in CORAS diagrams</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exact values in complete diagrams</strong></td>
</tr>
<tr>
<td>Assigned value: $v(p)$</td>
</tr>
<tr>
<td>Calculated value: $v(p')$</td>
</tr>
<tr>
<td>Consistency check: $p = p'$</td>
</tr>
<tr>
<td><strong>Exact values in incomplete diagrams</strong></td>
</tr>
<tr>
<td>Assigned value: $v(p)$</td>
</tr>
<tr>
<td>Calculated value: $v(p')$</td>
</tr>
<tr>
<td>Consistency check: $p \geq p'$</td>
</tr>
<tr>
<td><strong>Intervals in complete diagrams</strong></td>
</tr>
<tr>
<td>Assigned interval: $v([p_i, p_j])$</td>
</tr>
<tr>
<td>Calculated interval: $v([p'_i, p'_j])$</td>
</tr>
<tr>
<td>Consistency check: $[p'_i, p'_j] \subseteq [p_i, p_j]$ or, equivalently, $p_i \leq p'_i$ and $p_j \geq p'_j$</td>
</tr>
<tr>
<td><strong>Intervals in incomplete diagrams</strong></td>
</tr>
<tr>
<td>Assigned interval: $v([p_i, p_j])$</td>
</tr>
<tr>
<td>Calculated interval: $v([p'_i, p'_j])$</td>
</tr>
<tr>
<td>Consistency check: $p_j \geq p'_j$</td>
</tr>
</tbody>
</table>
Tool Support

- The CORAS tool is a diagram editor
- Supports all kinds of CORAS diagrams
- Suited for on-the-fly modeling during workshops
- Ensures syntactic correctness
- May be used during all the steps of a risk analysis
  - Documents input to the various tasks
  - Selection and structuring of information during tasks
  - Documentation of analysis results
- Download: http://coras.sourceforge.net/
Screenshot

- Pull-down menu
- Tool bar
- Palette
- Canvas
- Outline
- Properties window

Diagram showing threat scenario:
- Hacker
- Server is infected by computer virus [possible]
- Virus creates back door to server [possible]
- Hacker gets access to server [unlikely]
- Server goes down [unlikely]
- Low integrity
- High confidentiality
- Low relevance
- Properties:
  - Identifier: Server is infected by computer virus
  - Likelihood: [possible]
Further Reading

- **Book:**
  - [www.springer.com/computer/swe/book/978-3-642-12322-1](http://www.springer.com/computer/swe/book/978-3-642-12322-1)
  - Some chapters may be downloaded for free, including Chapter 3 which gives a Guided Tour of CORAS

- **Tool:**
  - Open source

- **Formal semantics:**