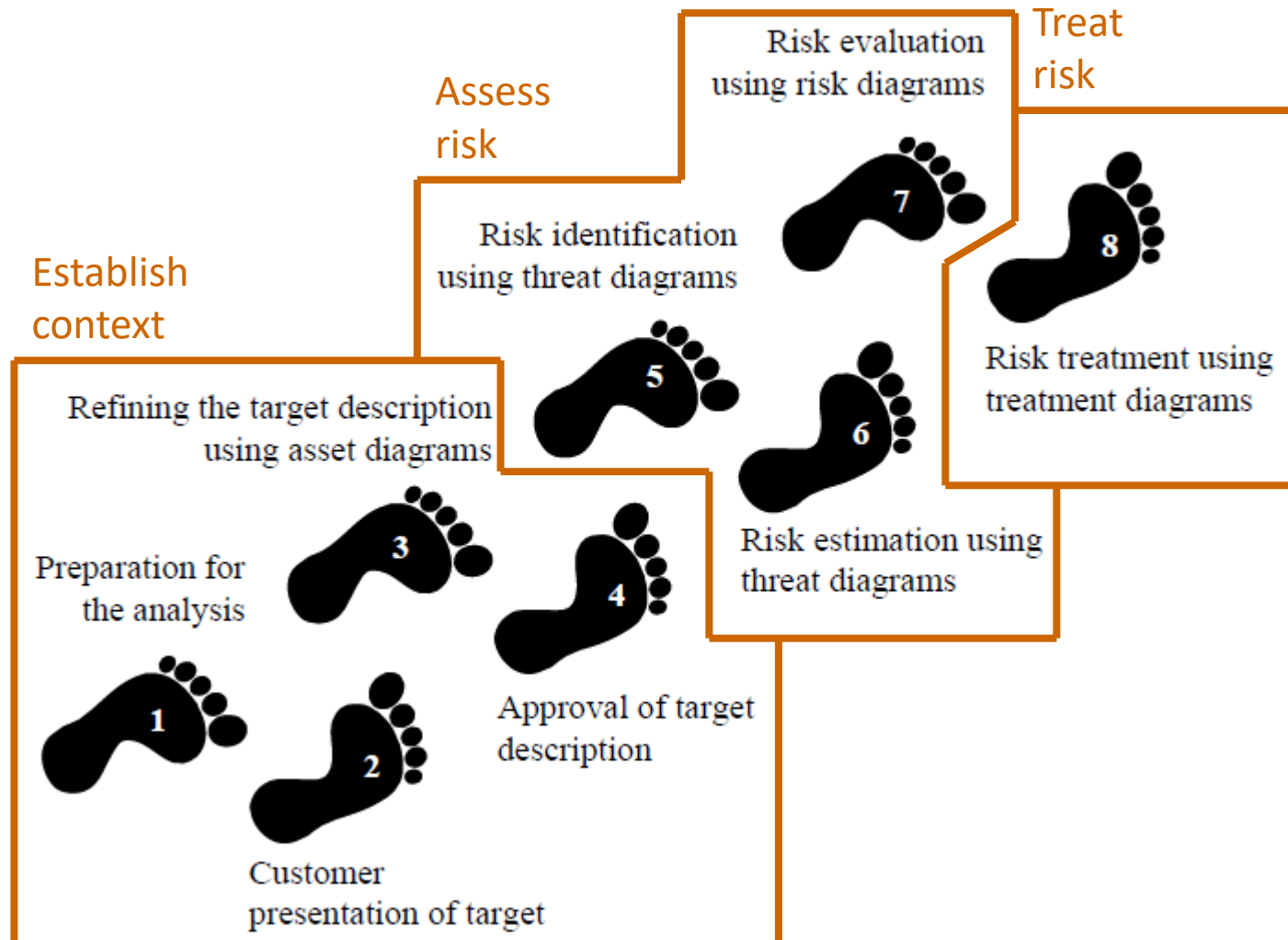




EXAMPLE-DRIVEN INTRODUCTION TO CORAS PART-II

Ketil Stølen

The 8 Steps of the CORAS Method



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

Example Case

- Customer is a national air navigation service provider
- The customer decides on an assessment of 250 person-hours on behalf of the external assessment team
- Focus should be on the role of the Air Traffic Controllers (ATCOs) in the process of arrival management
- Main concerns
 - Information provisioning
 - Compliance



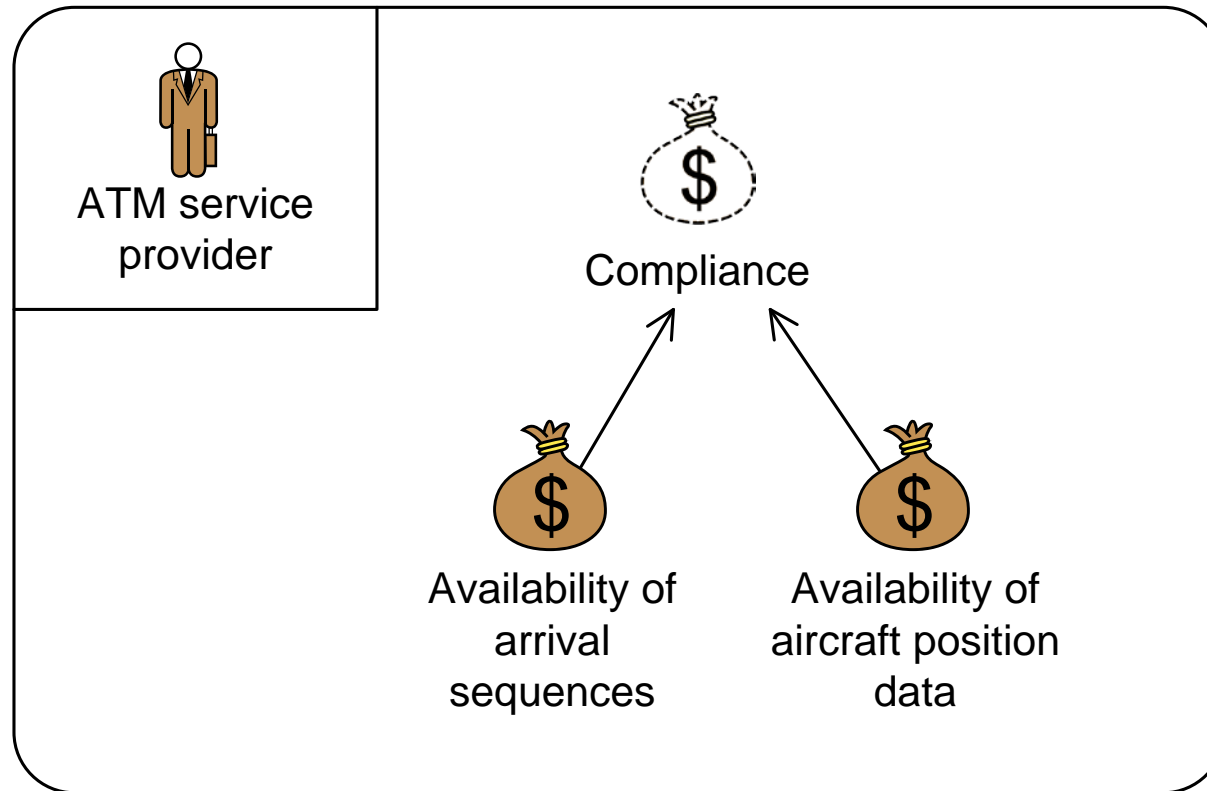
Air Traffic Control (ATC)

- Maintain horizontal and vertical separation among aircrafts and possible obstacles
- Limited interaction with the external world
- Humans at the centre of decisions and work process



Asset Identification Using Asset Diagrams




- Assets are the values the party of the assessment wants to protect



High-level assessment

- Threat, vulnerabilities, threat scenarios and unwanted incidents are identified in a brainstorming session
- Aims to identify biggest worries and increase understanding of focus and scope

Results from High-level Assessment

		
Who/what causes it?	How? What is the scenario or incident? What is harmed	What makes it possible?
Component failure; power loss	Provisioning of information to ATCO fails due to loss of CWP (Controller Working Position)	Insufficient CWP maintenance
Software error	The consolidation of data from several radar sources fails	Lack of redundant aircraft tracking systems
Component failure; radar disturbance	Malfunctioning of radar antenna; loss of aircraft tracking	Insufficient radar maintenance
Software bugs	False or redundant alerts from safety tool	Insufficient software testing

Step 4: Approval of Target Description

Objectives

- Ensure target description is correct and complete
- Ranking of assets
- Scales for risk estimation
- Risk evaluation criteria

Face-to-face meeting

- Structured walk-through of target description
- Plenary discussion on assets, scales and criteria

Consequence Scales

- One consequence scale for each asset is defined
 - Note: Sometimes one scale applies to several assets
- Consequences can be qualitative or quantitative
- Scales can be continuous, discrete or with intervals

Qualitative Consequence Scale

- The same consequence scale applies to the two direct availability assets

Consequence	Description
Catastrophic	Catastrophic accident
Major	Abrupt maneuver required
Moderate	Recovery from large reduction in separation
Minor	Increasing workload of ATCOs or pilots
Insignificant	No hazardous effect on operations

The consequence and likelihood scales are partly based on requirements and advisory material provided by EUROCONTROL

Likelihood Scale

- One likelihood scale is defined
 - The scale is used for all unwanted incidents and threat scenarios
- Likelihoods can be
 - Qualitative or quantitative
 - Probabilities or frequencies
- Scales can be continuous, discrete or with intervals

Qualitative Likelihood Scale

Likelihood	Description
Certain	A very high number of similar occurrences already on record; has occurred a very high number of times at the same location/time
Likely	A significant number of similar occurrences already on record; has occurred a significant number of times at the same location
Possible	Several similar occurrences on record; has occurred more than once at the same location
Unlikely	Only very few similar incidents on record when considering a large traffic volume or no records on a small traffic volume
Rare	Has never occurred yet throughout the total lifetime of the system

Risk Evaluation Criteria

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Rare	Low	Low	Medium	High	Critical
	Unlikely	Low	Low	Medium	High	Critical
	Possible	Low	Low	Medium	High	Critical
	Likely	Low	Medium	High	Critical	Critical
	Certain	Low	Medium	High	Critical	Critical

- **High risk:** Unacceptable and must be treated
- **Medium risk:** Must be evaluated for possible treatment
- **Low risk:** Must be monitored

Step 5: Risk Identification Using Threat Diagrams

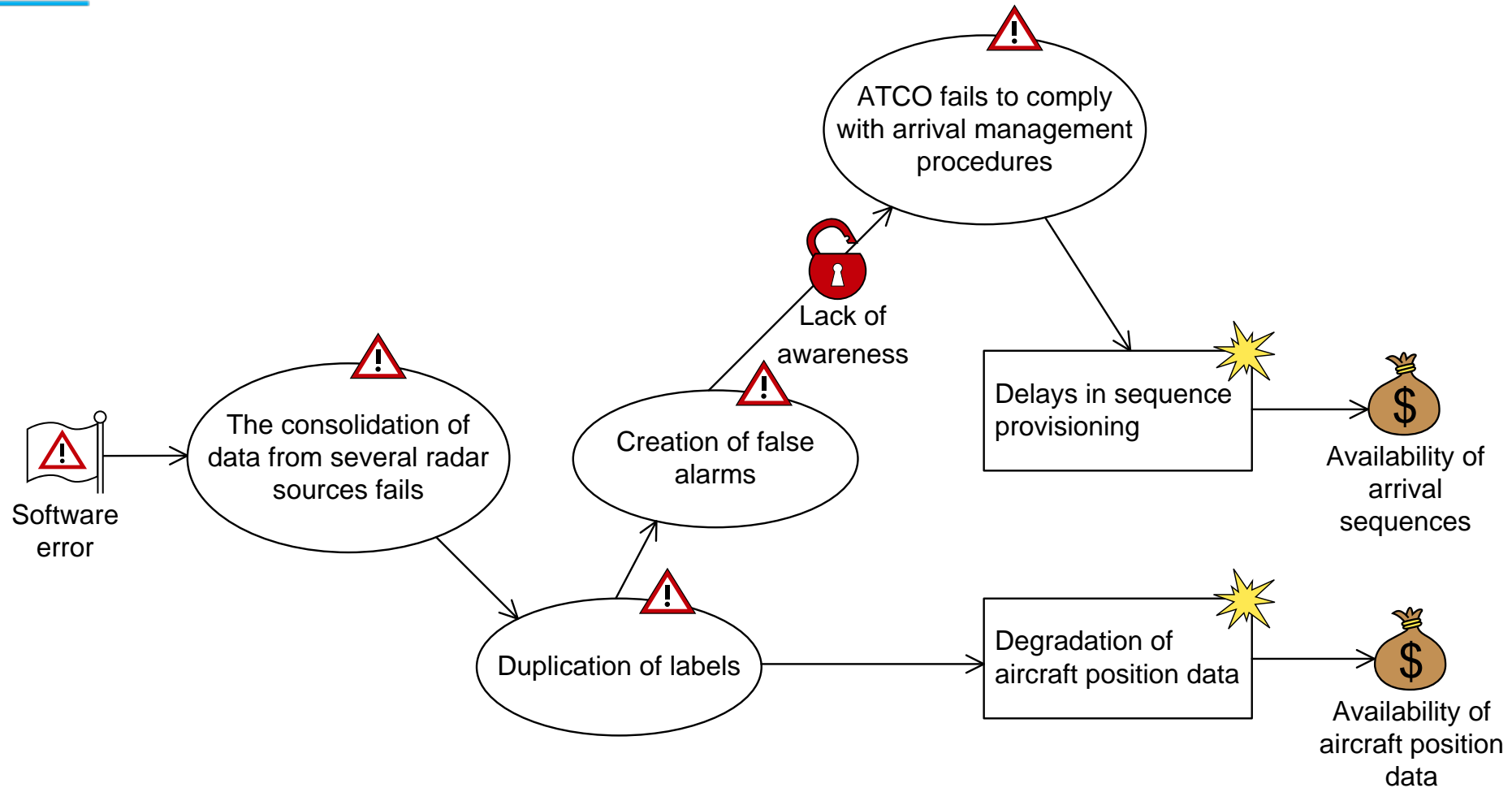
Objectives

- Identify risk: where, when, why and how they may occur

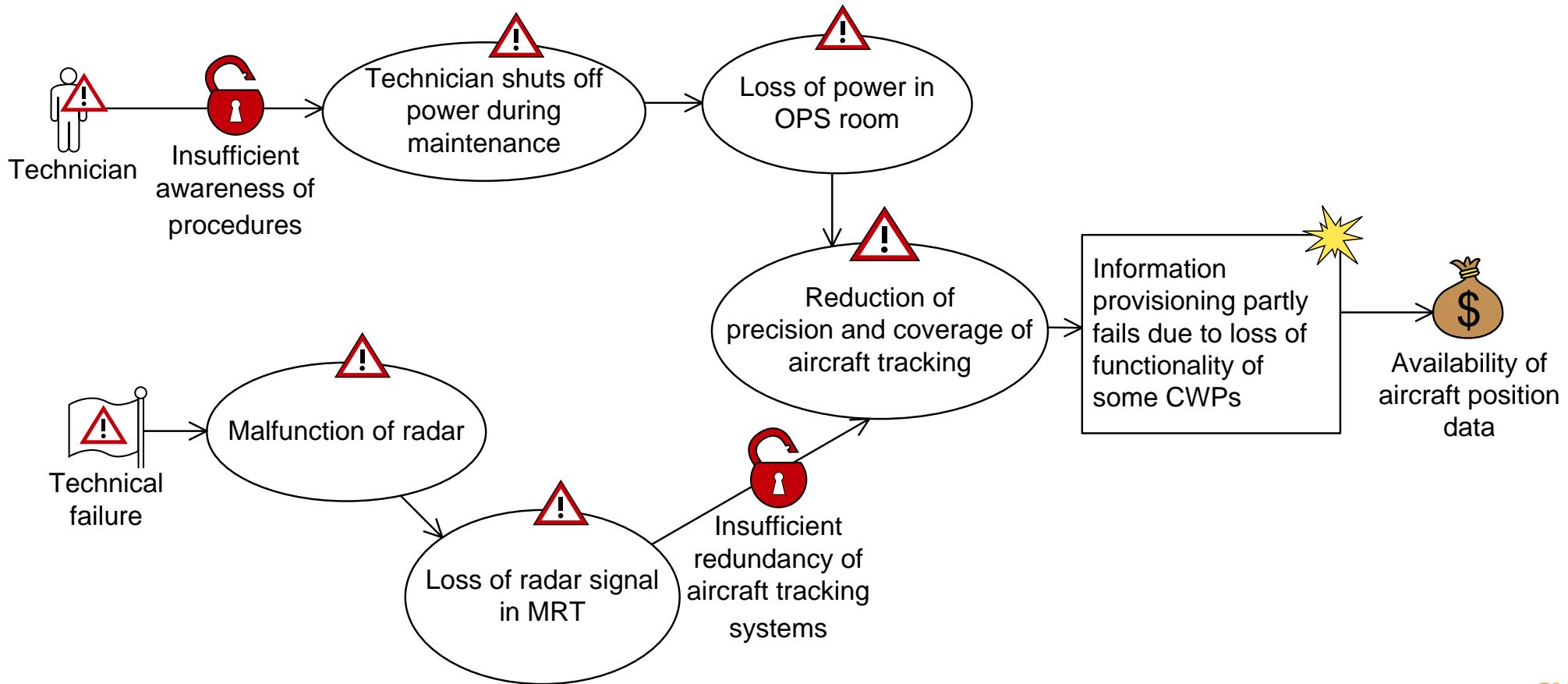
Workshop conducted as a brainstorming session

- Involving people of different background
- Assets and high-level analysis as starting point
- Threats, threat scenarios, vulnerabilities and unwanted incidents documented on-the-fly using threat diagrams

Example of Threat Diagram



Example of Threat Diagram



Step 6: Risk Estimation Using Threat Diagrams

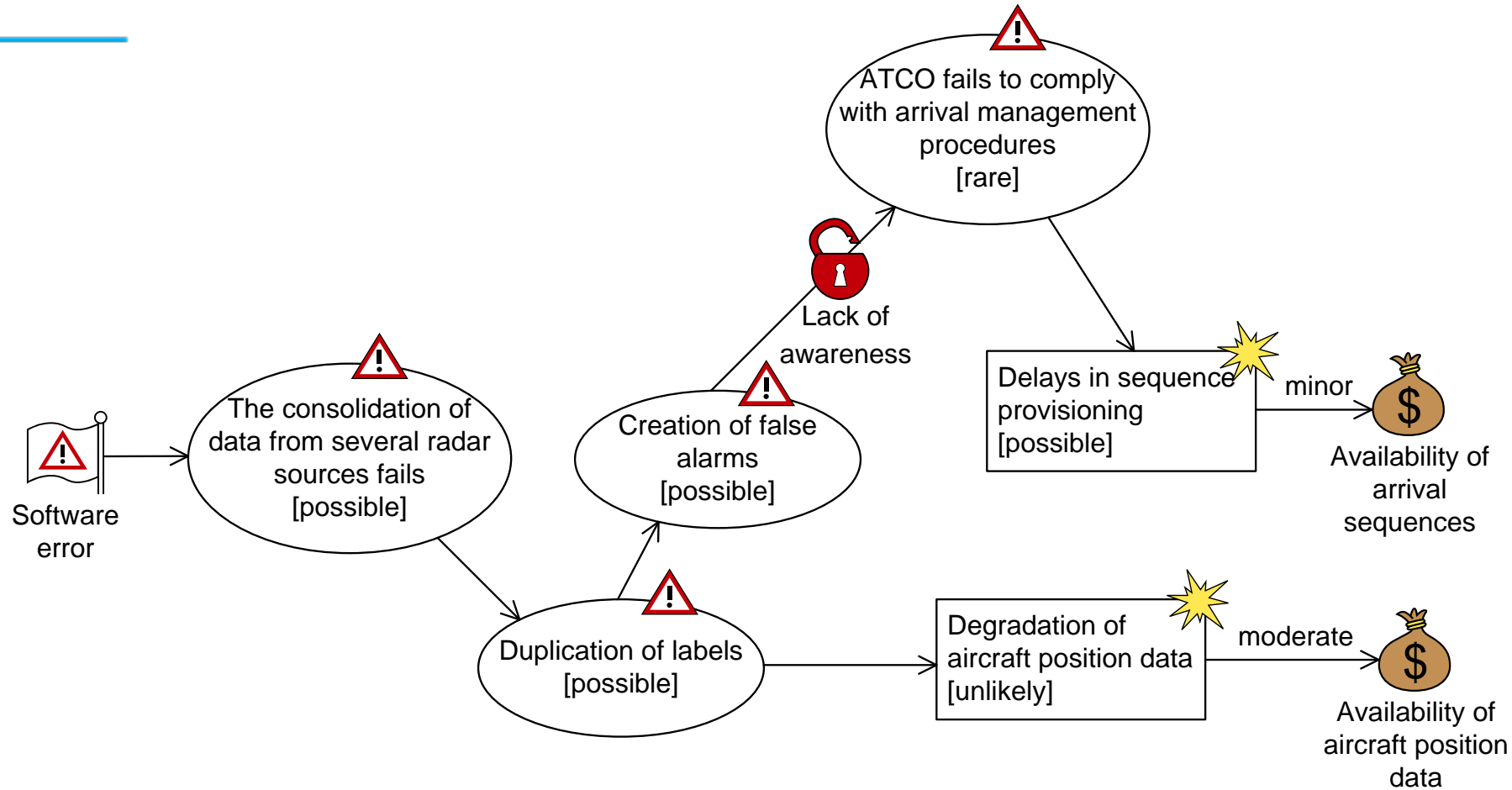
Objectives

- Determine the level of identified risks

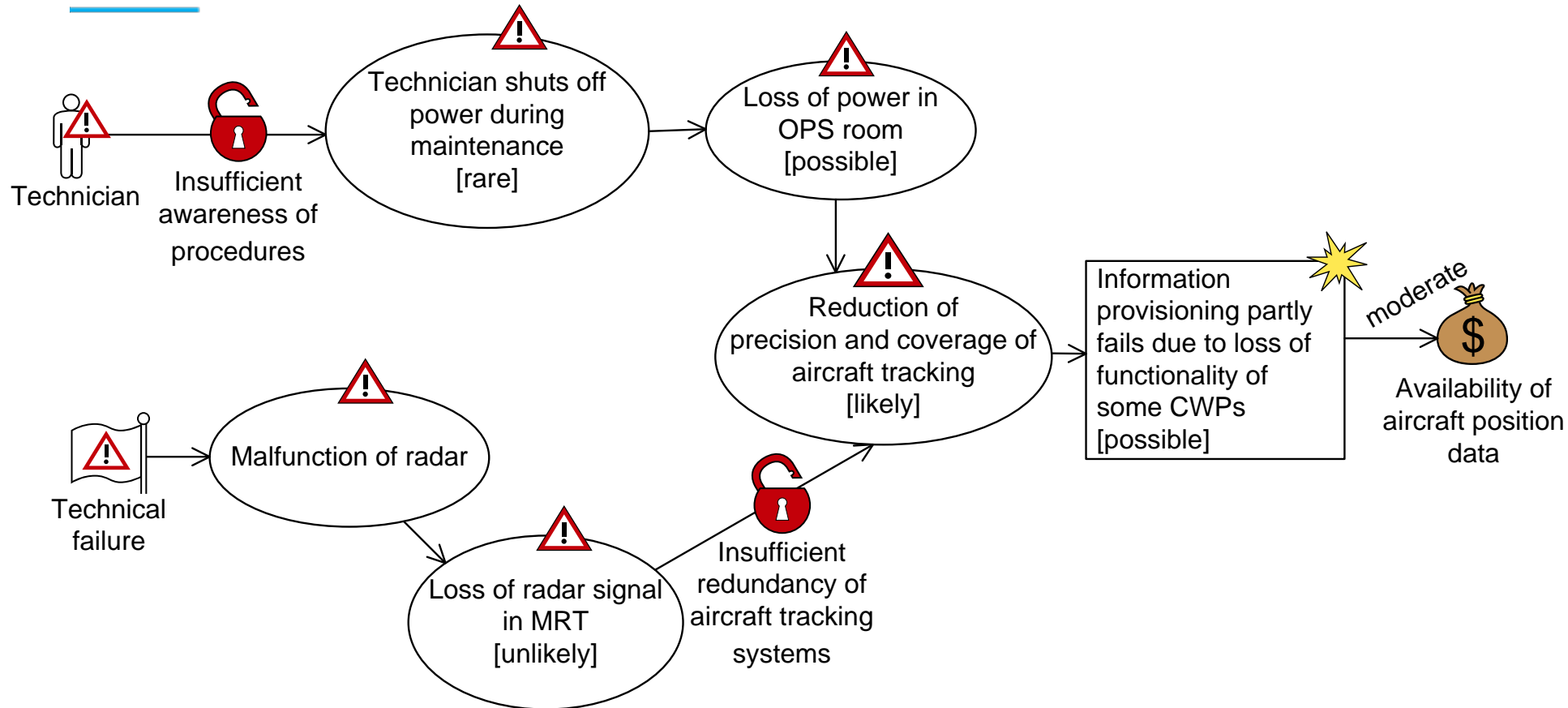
Workshop

- Involving people of different background
- Walk-through of threat diagrams
- Likelihood estimates on threat scenarios, unwanted incidents and relations between them
- Consequence estimates on relation between unwanted incidents and assets

Updated Threat Diagram



Updated Threat Diagram



Step 7: Risk Evaluation Using Risk Diagrams

Objectives

- Determine which risks are unacceptable and must be evaluated for treatment

Off-line activity

- Calculate risk levels from estimates
- Present risks in risk diagrams

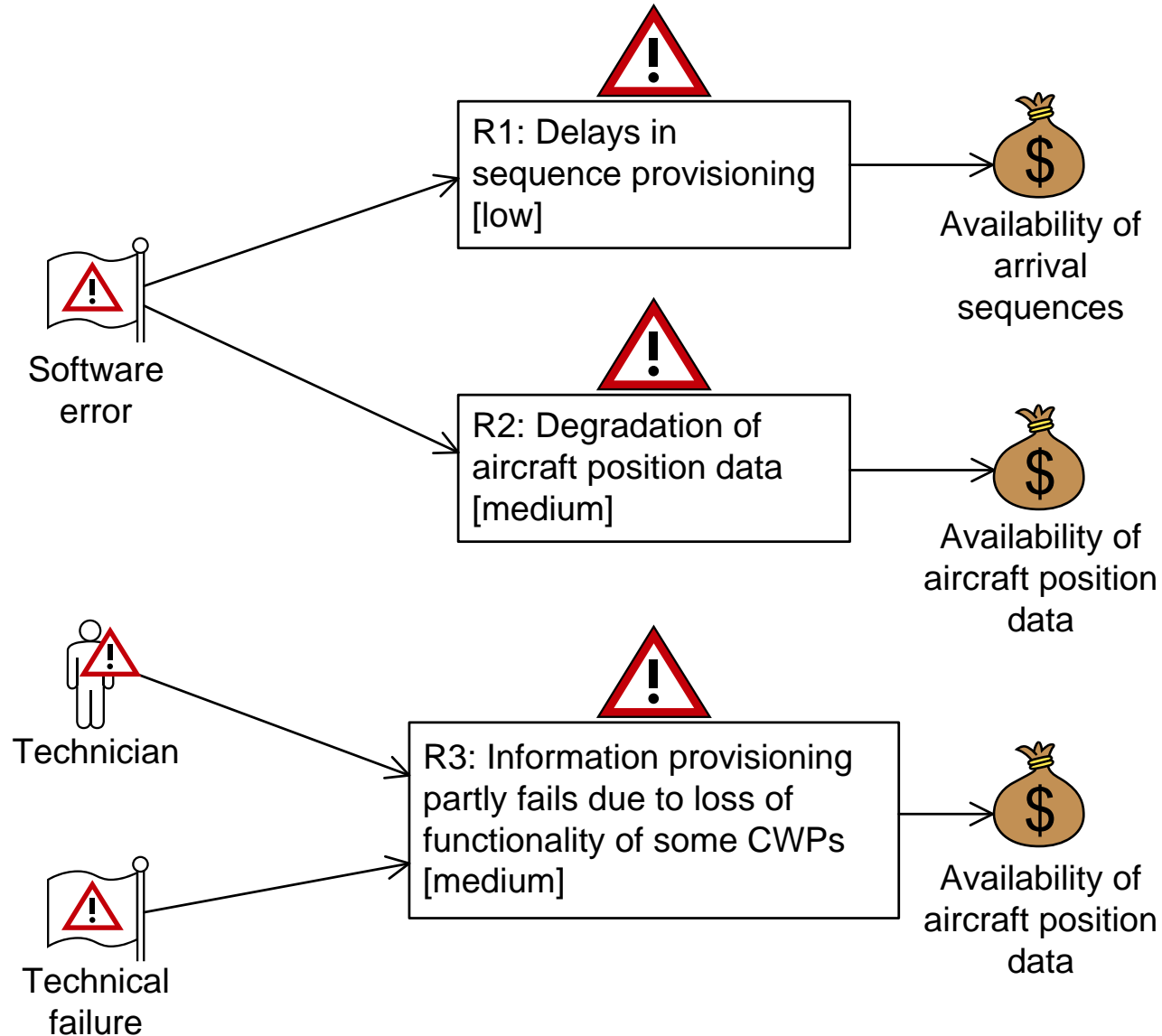
Assess potential impact of identified risk

- Risks that accumulate
- Risks with respect to indirect assets

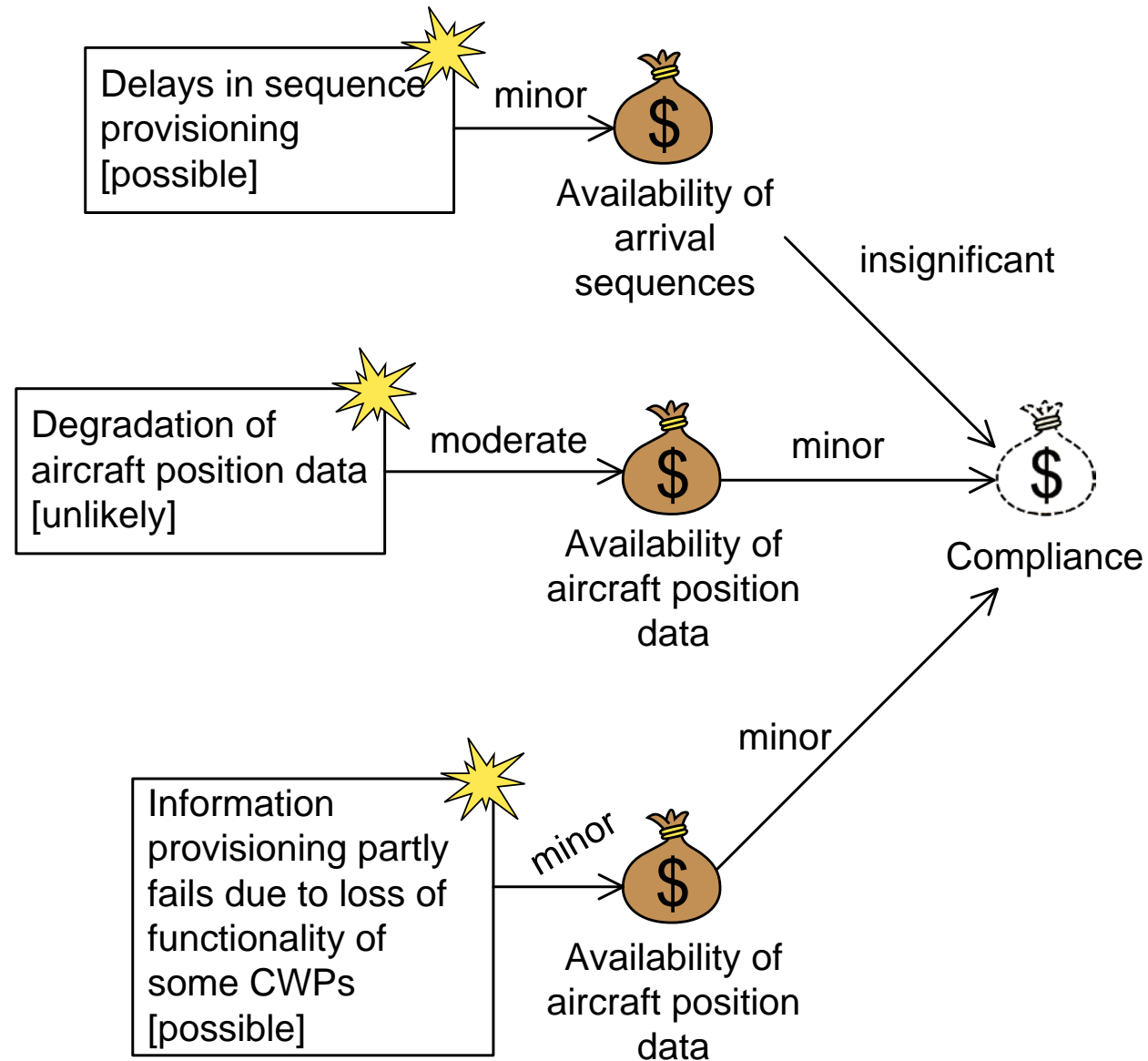
Filled in Risk Evaluation Matrix

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Rare					
	Unlikely		R5	R2		
	Possible	R4	R1, R6	R3		
	Likely					
	Certain					

Example of Risk Diagram



ATM Example: Indirect Assets



Step 8: Risk Treatment Using Treatment Diagrams

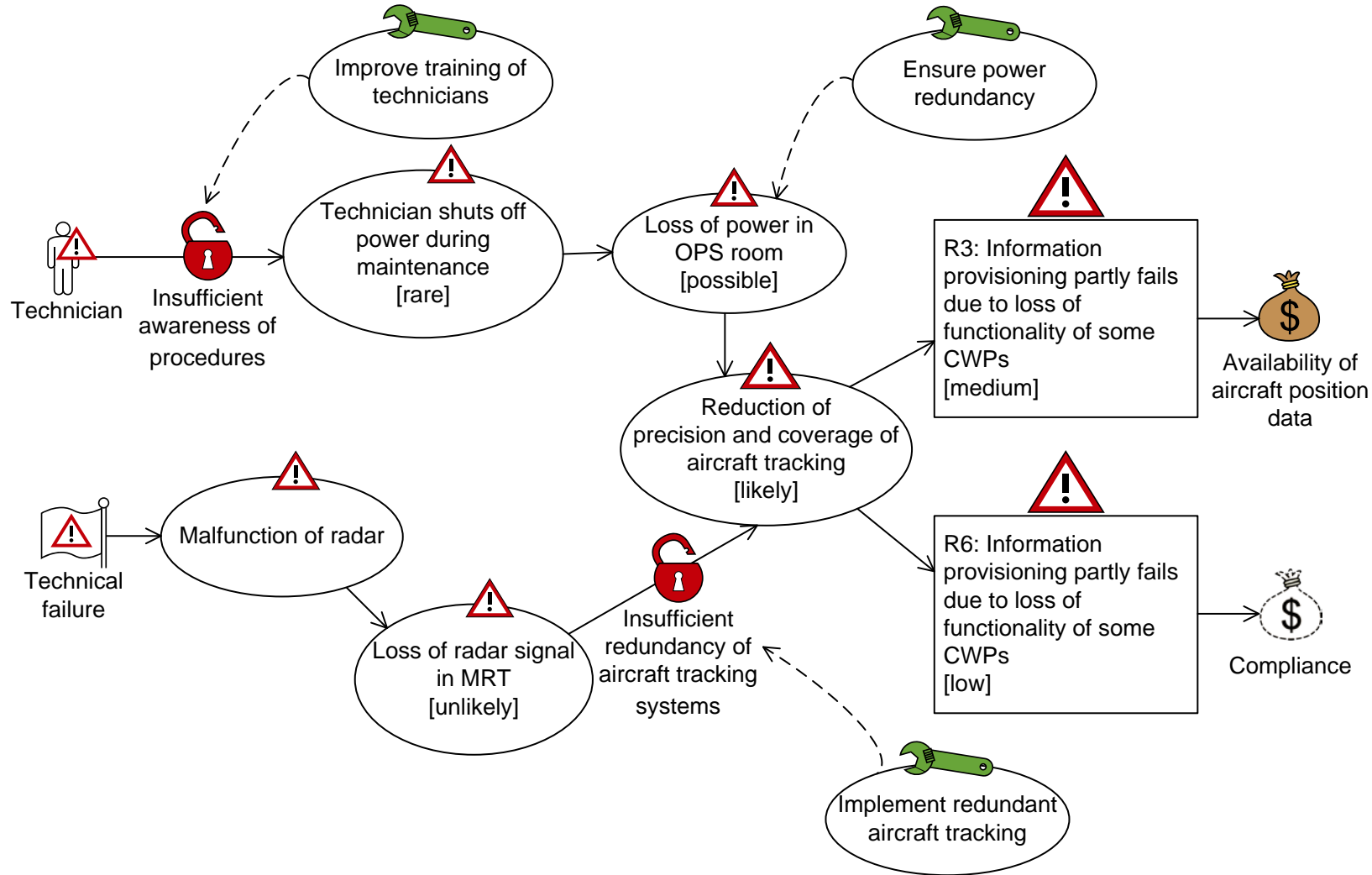
Objectives

- Identify cost effective treatments for unacceptable risks

Workshop with brainstorming session

- Involving people of different background
- Walk-through of threat diagrams
- Identify treatments to unacceptable risks

Example of Treatment Diagram



Tool

<https://stverdal.github.io/>

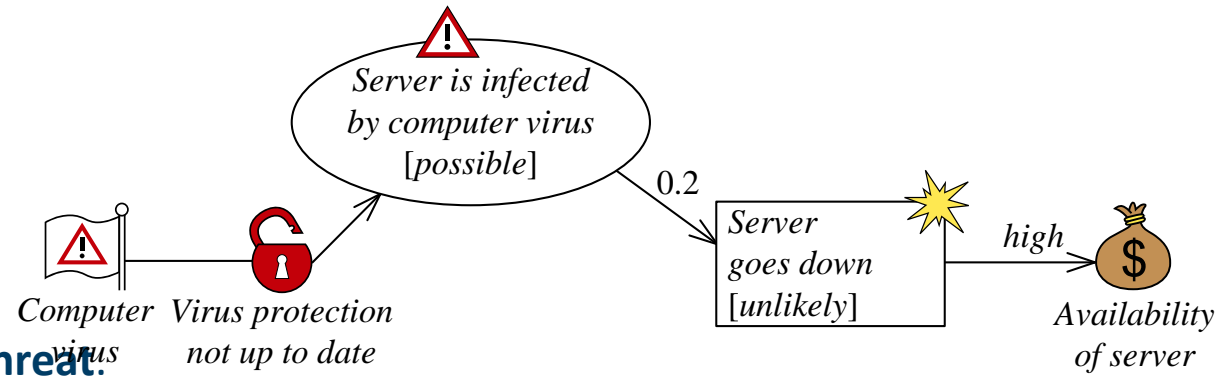
See tutorial made by Simeon Tverdal on the Course Pages:

<https://www.uio.no/studier/emner/matnat/ifi/IN5130/h20/forelesning/svideoer/20201019-CORASToolTutorial.mp4>

Semantics of CORAS language

- 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

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.**

Criticism from System Developers

Some say

- The CORAS language is too simplistic
- It is too cumbersome to use graphical icons

My defence

- In a risk assessment we interact with with all kinds of people
- We need a notion that can be easily understood and function as a basis for discussions without prior training

Criticism from Risk Analysts

Some say

- What is new with the CORAS language?
- We have been using something similar for years, namely Visio, Paint, etc.

My defence

- Any CORAS diagram has a precise semantics expressed in natural language
- The CORAS language is supported by rules and methodology for likelihood calculation and analysis



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