Three Lectures on Requirements Engineering

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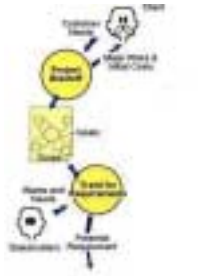
Lecture 2

Where are we now?

Step 1 outlined the business context of the project

Recall: Work context diagram

Recall Step 2: »Trawl for Reqs«



Main Activity:
analyze the business processes that the software must support

Main Output:
+ process descriptions
+ potential requirements for the software

Recall: Scenarios

- describe what is being done by the business use case as a series of steps
  (recall: in response to a business event)
- 3 to 10 steps
- stakeholder-friendly description
- "broad-brush picture"
- stakeholders are invited to participate and revise the scenarios until they represent a consensus view of what the work should be

A Detailed Scenario Example

Example business use case

checking a passenger in for an international flight

Constructing the initial scenario (1)

The check-in agent tells the analyst:

"I call the next customer in line. When he gets to my desk, I ask for a ticket. If the passenger is using an e-ticket, I need the booking record locator. Most of the passengers are not organized enough to have it written down, so I ask them their name and the flight they are on. Most people don't know the flight number, so I usually ask for their destination."

checking a passenger in for an international flight

1. Get the passenger's ticket or record locator.

Constructing the initial scenario (2)

"I make sure I have the right passenger and the right flight. It would be embarrassing to give away someone else's seat or to send a passenger to the wrong destination. Anyway, I locate the passenger's flight record in the computer. If he has not already given it to me, I ask for the passenger's passport. I check that the picture looks like the passenger and that the passport is still valid."

2. Is this the right passenger, flight, and destination?
3. Check the passport is valid and belongs to the passenger.

Constructing the initial scenario (3)

"If there is no frequent-flyer number showing against the booking, I ask the passenger if he belongs to our mileage scheme. Either he hands me the plastic card with the FF number, or I ask him and if he wishes to join I give him the sign-up form. We can put temporary FF numbers against the flight record so the passenger is credited for that trip."

4. Record the frequent-flyer number.

Constructing the initial scenario (4)

"If the computer has not already assigned a seat, I find one. This usually means I ask if the passenger prefers a window or an aisle seat, or, if the plane is already almost full, I tell him what I have available. Of course, if the computer has assigned one, I always ask if it is okay. Somehow we settle on a seat and I confirm it with the computer system. I can print the boarding pass at this stage, but I usually do the bags first."

5. Find a seat.

Constructing the initial scenario (5)

"I ask how many bags the passenger is checking and, at the same time, verify that he is not exceeding the carry-on limit. Some people are unbelievable with what they want to carry into a fairly space-restricted aircraft cabin. I ask the security questions about the bags and get the passenger's responses. I print out the bag tags and securely attach them to the bags, and then I send the bags on their way down the conveyor belt."

6. Ask security questions.
7. Check the baggage onto the flight.

Constructing the initial scenario (6)

"Next I print the boarding pass. This means that I have everything done as far as the computer is concerned. But there is one more thing to do: I have to make sure that everything agrees with the passenger's understanding. I read out from the boarding pass where he is going, what time the flight is, and what time it will board. I also read out how many bags have been checked and confirm that their destination matches the passenger's destination. I hand over the documents, and wish the passenger a good flight."

8. Print and hand over the boarding pass and bag tags.
9. "Have a good flight."

The initial scenario

checking a passenger in for an international flight

1. Get the passenger's ticket or record locator.
2. Is this the right passenger, flight, and destination?
3. Check the passport is valid and belongs to the passenger.
4. Record the frequent-flyer number.
5. Find a seat.
6. Ask security questions.
7. Check the baggage onto the flight.
8. Print and hand over the boarding pass and bag tags.
9. "Have a good flight."

Detailing the initial scenario

- after confirming the initial scenario with the stakeholders, the analyst starts to "formalize" the scenario using a scenario template
- the analyst captures normal case, alternative case, and exception case scenarios
- along the way, the analyst clarifies and rewrites the steps
- all the necessary information comes from the stakeholders

Scenario template

- Business Event Name
- Business Use Case Name and Number
- Trigger
- Preconditions
- Interested Stakeholders
- Active Stakeholders
- Normal Case Steps
- Alternative Steps
- Exception Steps
- Outcome

the data, or request for service, or temporal condition that triggers this case

the conditions that must exist before this case is valid

the people or systems that are doing the work in this case

the desired situation after this case (see the stakeholder's objective)

Robertson p. 148

Template for the example (part 1)

- **BE:** Passenger decides to check in
- **BUC:** Check passenger onto flight
- **Trigger:** Passenger's ticket, record locator, or identity and flight
- **Preconditions:** The passenger must have a reservation
- **Interested Stakeholders:** Check-in agent, baggage handling, reservations, security, immigration
- **Active Stakeholders:** Passenger, check-in agent
- **Scenarios:** ....

Clarifying the main scenario (1)

1. Get the passenger's ticket or record locator.

the ticket and record locator are merely means to an end – namely, to find the passenger's reservation; hence, the step gets rewritten:

1. *Locate the passenger's reservation.*

Clarifying the main scenario (2)

2. Is this the right passenger, flight, and destination?

turn the question into an action – namely, to ensure the condition is met; hence, the step gets rewritten:

2. *Ensure the passenger is correctly identified and connected to the right reservation.*

Clarifying the main scenario (3)

3. Check the passport is valid and belongs to the passenger.

this check is more complex and needs explanation; either add detail* or refer to the corresponding business rules; hence, the step gets augmented:

3. Check the passport is valid and belongs to the passenger.
   see procedure guidelines EU-175

* f.e., the passport must not expire before the end of the trip; visas must be current; and so on

The rewritten main scenario

1. Locate the passenger's reservation.
2. Ensure the passenger is correctly identified and connected to the right reservation.
3. Check the passport is valid and belongs to the passenger. see procedure guidelines EU-175
4. Attach the frequent-flyer number to the reservation.
5. Allocate a seat.
6. Get correct responses to security questions.
7. Check the baggage onto the flight.
8. Print and convey the boarding pass and bag tags.
9. Wish the passenger a pleasant flight.

Alternative steps

4. Attach the frequent-flyer number to the reservation.

the passenger is given choices by the airline to provide better service to him; hence, there are alternative steps:

4.a Allow the FF number to be changed to that of a partner airline.

4.b Allow the FF number to be changed to that of a family member, or the mileage of the flight to be donated to a charity of the passenger's choice.

Exception steps (1)

5. Allocate a seat.

on occasion, the seat chosen by the passenger is not available; this is unwanted, but possible; hence, there are exception steps:

Exception 5.a

Condition: The passenger's choice of seat is not available.

Steps:

i. Record a request for a seat change by the gate agent.

Exception steps (2)

3. Check the passport is valid and belongs to the passenger.

on occasion, there may occur a problem with the passenger's passport; this is unwanted, but possible; hence, there are exception steps:

Exception 3.a
Condition: The passenger produces a passport that is not his.
Steps:
i. Call security.
ii. Freeze the reservation.

Template for the example (part 2)

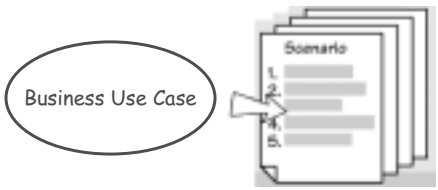
[... Normal Case Steps ...]

[... Alternative Steps ...]

[... Exception Steps ...]

- **Outcome:** The passenger is recorded as checked onto the flight, the bags are assigned to the flight, a seat is allocated, and the passenger possesses a boarding pass and bag claim stubs.

Where are we now?



each business use case is described by several scenarios

Volere Step 2b: Scoping the Software Product

Scoping

- not all steps in the response to a business event can be or shall be done by a software
- some business steps are done by humans (f.e., users, operators), others are done by existing systems (f.e., other software)
- scoping means to decide which part of the work shall be handled by the new software

engl. *scope*: Abgrenzung, Rahmen, Geltungsbereich, Reichweite, Umfang

Scoping and analysis

- the analyst must never *assume* what the responsibilities of the software product are
- instead, the software's scope must be determined step-by-step during requirements analysis from an understanding of the work
- in the end, the client decides – within the project constraints, money, feasibility...

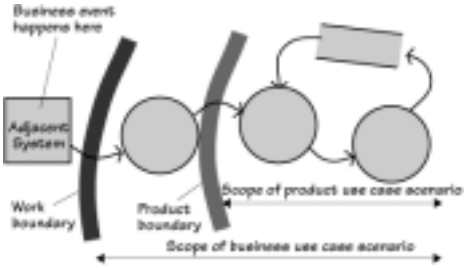
Product use case

- product use case = that part of a business use case that shall be performed by the software product
- for scoping, business use cases / scenarios map onto product use cases / scenarios
- hence,
  business use case ≠ *product* use case

Check-in example: The main product scenario

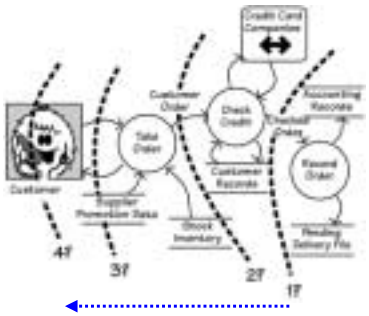
1. Locate the passenger's reservation.
2. ~~Ensure the passenger is correctly identified and connected to the right reservation.~~
3. ~~Check the passport is valid and belongs to the passenger. — see procedure guidelines EU-175~~
4. Attach the frequent-flyer number to the reservation.
5. Allocate a seat.
6. ~~Get correct responses to security questions.~~
7. Check the baggage onto the flight.
8. Print and convey the boarding pass and bag tags.
9. ~~Wish the passenger a pleasant flight.~~

Work scope vs. product scope



thinking in terms if process diagrams, scoping means drawing the product boundary

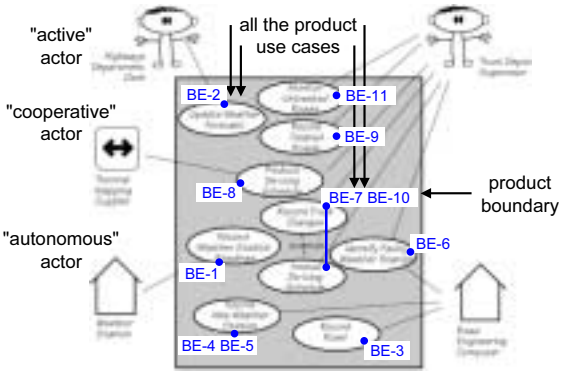
Choosing the product scope



different product scopes for a telephone ordering system

software functionality increases – manual work decreases

Ex: Product use case diagram



Recall Ex: Business Events

Event	Information (I/O)
1 Weather Station transmits reading	Weather Station Readings
2 Weather Bureau forecasts weather	District Weather Forecasts
3 Road engineers advise changed roads	Changed Road
4 Road Eng. installs new weather station	New Weather Station
5 Road Eng. changes weather station	Changed Weather Station
6 Time to test weather stations	Failed Weather Station Alert
7 Truck Depot changes a truck	Truck Change
8 Time to detect icy roads	Road de-icing Schedule
9 Truck treats a road	Treated Road
10 Truck Depot reports problem with truck	Truck Breakdown Amended de-icing Schedule
11 Time to monitor road de-icing	Untreated Road Reminder

Cross-checking... (1)

- most business events just map to a product use case (BE-1, BE-2, BE-3, BE-6, BE-8, BE-9)
- BE-4 *RoadEngInstallsNewWeatherStation* and BE-5 *RoadEngChangesWeatherStation* map to the same product use case: *RecordNewWeatherStation*
- BE-7 *TruckDepotChangesTruck* and BE-10 *TruckDepotReportsProblemWithTruck* map to the same product use case: *RecordTruckChanges*
- BE-11 *TimeToMonitorRoadDeicing* turns into product use case: *MonitorUntreatedRoads*

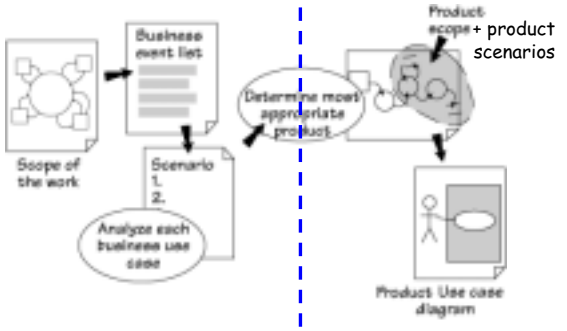
Cross-checking... (2)

- use case *RecordTruckChanges* extends use case *AmendDeicingSchedule* – after a truck change or truck breakdown, the schedule must be adapted
- actor *ThermalMappingSupplier* participates in use case *ProduceDeicingSchedule*
- actor *RoadEngComputer* participates in use case *IdentifyFaultyWeatherStation*

Refining product use cases

- during analysis, product use cases can be subdivided, merged, augmented...
- this often happens when analysis reveals common sub-processes in the product use cases
- leads to «extends» or «uses» relationships between use cases

Where are we now?



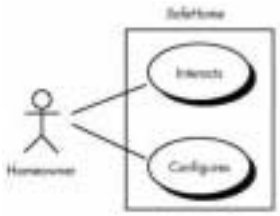
business description | product description

Cross-check against Pressman's Book

SafeHome – comments

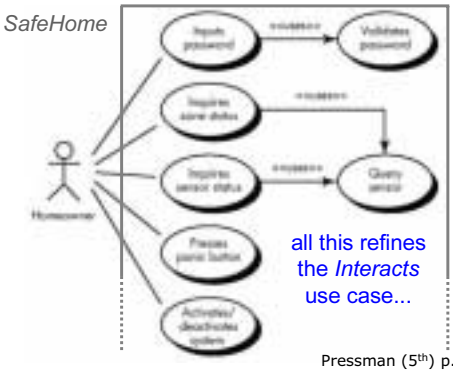
- Pressman (5th edition) fails to distinguish between *business* and *product* use cases
- that is, scoping is not presented well
- Pressman's use case template (6th edition) is similar to the Volere template

SafeHome: Use case diagram (1)



Pressman (5th) p. 582

SafeHome: Use case diagram (2)



Pressman (5th) p. 281+582

SafeHome – comments (cont.)

- let's cross-check the use case diagrams against the context diagram

- the actor *Homeowner* is merged from the adjacent systems *ControlPanel* and *ControlPanelDisplay* – that's okay
- there are missing actors: *Sensors*, *Alarm*, and *TelephoneLine* – that's not okay

A word on Pressman 6th edition

- matters are better in the 6th edition
- several diagrams have been improved, and more diagrams have been added
- for the sake of the Web Engineering chapter, the *SafeHome* example has been extended
- yet, the 5th edition helps illustrate that certain steps in the analysis are not *that* easy to get straight...

Volere Step 2c: Identifying the Requirements

Functional requirements

Functional requirements describe what the product must do to carry out the work for which it is intended. They are independent of any technology used by the product.

we'll cover other types of requirement later...

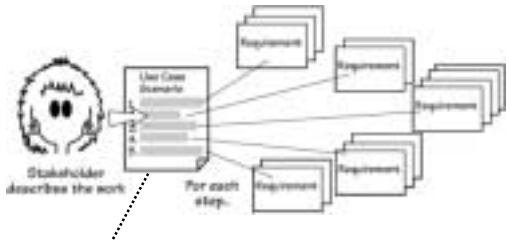
Writing a functional requirement

⇨ The product shall record the new weather stations.

- the product must do something...
- ...an action that contributes to the project goal
- ...stated in one, plain sentence
- ...taking a product's viewpoint

keep it short, simple, and self-explanatory

From scenario to requirements



means:
product scenario

Ex: Product scenario to requirements

Ex: Studying the scenario (1)

Produce road de-icing schedule

1. Engineer provides a scheduling date and district identifier.
2. Product selects the relevant thermal maps.
3. Product uses the thermal maps, district temperature readings, and weather forecasts to predict temperatures for each road section for the district.
4. Product predicts which roads will freeze and when they will freeze.
5. Product schedules available trucks from the relevant depots.
6. Product advises the engineer of the schedule.

Ex: Studying the scenario (2)

Produce road de-icing schedule

1. Engineer provides a scheduling date and district identifier.

⇨ The product shall accept a scheduling date.

Is there anything special about the scheduling date?
"Scheduling is never done more than two days in advance"

⇨ The product shall warn if the scheduling date is neither today nor the next day.

Ex: Studying the scenario (3)

Produce road de-icing schedule

1. Engineer provides a scheduling date and district identifier.

⇨ The product shall accept a valid district identifier.

What do you mean by a valid identifier? "....."

⇨ The product shall verify that the district is within the de-icing responsibility of the area covered.

⇨ The product shall verify that the district is the one wanted by the engineer.

Ex: Studying the scenario (4)

Produce road de-icing schedule

4. Product predicts which roads will freeze and when they will freeze.

⇨ The product shall determine which areas in the district are predicted to freeze.

⇨ The product shall determine which road sections pass through areas that are predicted to freeze.

⇨ The product shall determine when the road sections will freeze.

Ex: Studying exceptions

Produce road de-icing schedule

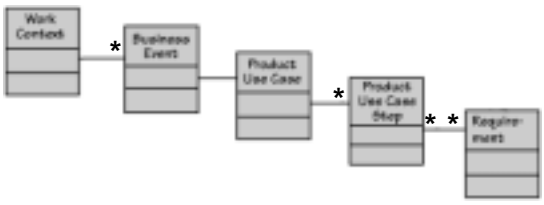
5. Product schedules available trucks from the relevant depots.

What happens if no trucks are available? "....."

⇨ If there are no trucks available, the product shall generate an emergency request to truck depots in adjacent counties.

explicitly state the exceptional condition

From work context to requirements



information gathered during the requirements process

Volere Step 2x: Diagramming the Scenarios

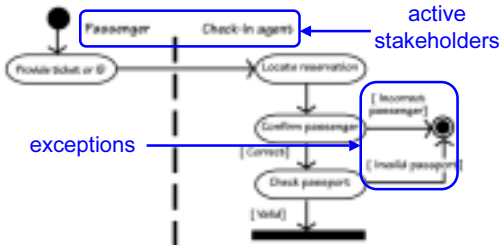
Diagrams and scenarios

- some customers and analysts prefer process diagrams over textual scenarios
- diagrams can also be used for documenting and merging textual scenarios
- important: model the dynamics, whether as a textual scenario or as a diagram
- requirements can be identified from the diagrams *the same way* as from the textual scenarios

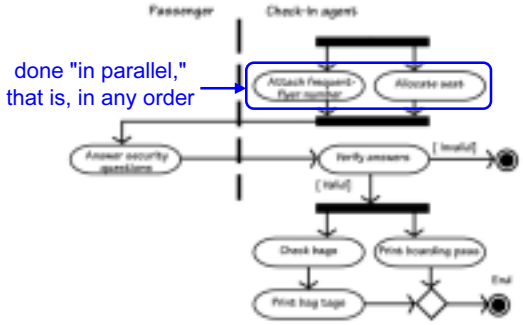
Variety of process diagrams

- long-standing:
  - data-flow diagram (DFD)
  - control-flow diagram (CFD)
  - flow chart
  - message sequence chart
  - Petri net
- with UML:
  - activity diagram
  - sequence diagram

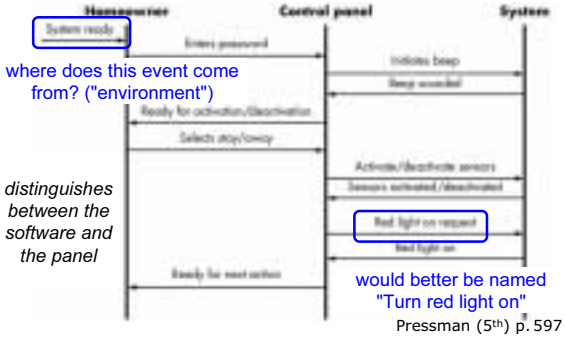
Check-in example as an activity diagram (part 1)



Check-in example as an activity diagram (part 2)

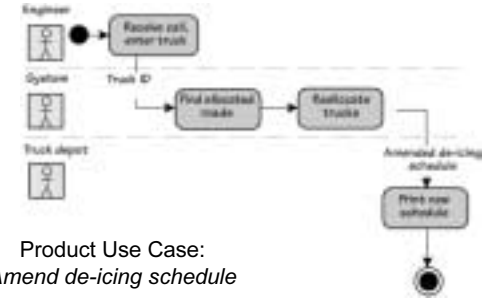


SafeHome: Sample sequence diagram



Pressman (5th) p. 597

Ex: Product use case as an activity diagram



Product Use Case:
Amend de-icing schedule

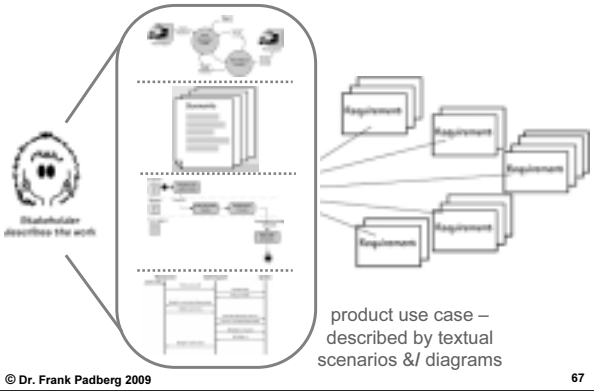
Ex: Product use case as a data-flow diagram

Product Use Case:
Amend de-icing schedule

Ex: Another product use case as a data-flow diagram

Product Use Case:
Record weather station readings

From scenario to reqs – extended

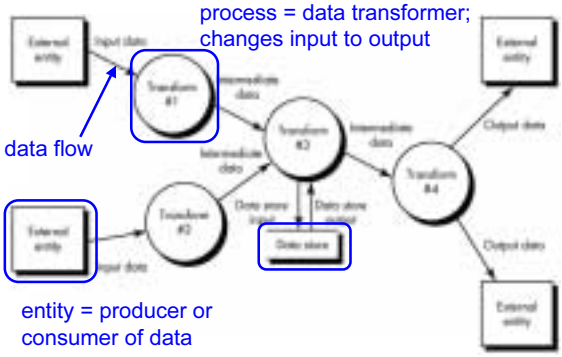


product use case – described by textual scenarios &/ diagrams

Data-Flow Diagrams

Data-flow diagram (DFD)

process = data transformer; changes input to output



data flow

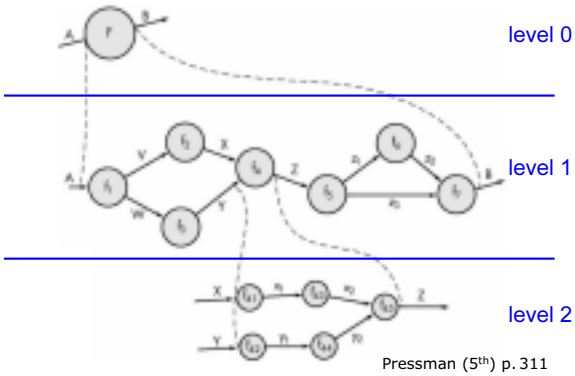
entity = producer or consumer of data

Pressman (5th) p. 310

DFD – comments

- DFD's are ubiquitous in modeling
- during analysis, a DFD often evolves through several levels of detail – refinement of models is easy with DFD's
- the context diagram is a DFD
  [level-0; Pressman (5th ed) p. 311]
- the Volere process diagram is a DFD

Refining data-flow diagrams



Pressman (5th) p. 311

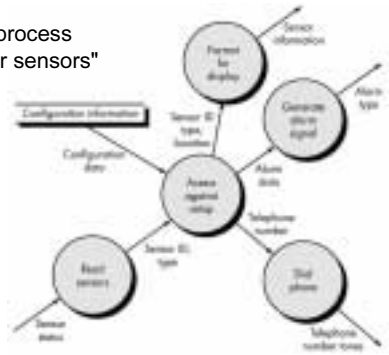
SafeHome: Level-1 DFD

for the process
"SafeHome software"

Pressman (5th) p. 323

SafeHome: Level-2 DFD

for the process
"Monitor sensors"



Pressman (5th) p. 325

Outlook

Next lecture's topics

- more requirements
- writing the specification
- business data modeling
- requirements quality

End of Lecture 2