

The eShop Product Line

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1 Situation

A manufacturer of online store software has provided a specification of his eShop software product line. He asks you – as an expert in the field of software product line testing – to advise him on how to perform system tests for his eShop product line. Especially, he wants two concrete eShop applications to be tested (see Sect. 3).

The commonalities and the variability of the product line have been defined by product management, considering market trends and technical constraints. The variability has been explicitly documented in a variability model (see right hand side of Figure 1).

Further, common and variable requirements of the product line have been elicited and documented by use cases (see use case diagram on the left hand side of Figure 1 and the use case descriptions in Sect. 4). In addition, the manufacturer of the online store provides you with detailed scenario descriptions, including pre- and post-conditions, scenario steps, alternative scenarios, etc.

2 Domain Description

Running an eShop shall allow an online merchant to sell his goods to customers via the internet. An online merchant typically approaches the manufacturer of the eShop product line with specific needs on the functionality of the eShop. Based on the available variability of the product line, the manufacturer will then be able to create an individual application specifically for the merchant.

The variability of the eShop product line is shown on the right hand side of Figure 1. The variability model is documented using the OVM approach (see Pohl, K.; Böckle, G.; van der Linden, F. Software Product Line Engineering – Foundations, Principles, and Techniques, Springer, Berlin, Heidelberg, New York, 2005). Triangles document variation points (“what does vary?”), rectangles document variants (“how does it vary?”), and relations between these elements describe constraints on the possible choice of variants; e.g., for the variation point “bonus” at most one variant may be selected.

The left hand side of Figure 1 shows the use case diagram of the eShop product line. The variable use cases are identified by trace links from the variability model to the use case elements.

2.1 Commonalities of the eShop Product Line

All applications of the eShop product line share the common functionality: **register customer**, **buy product**, and **search product**. For searching a product, the customers can enter the name of the product or an order number.

The **buy product** use case includes the use case **search product** (which can be repeated as often as needed). Each product that a customer wants to buy can be placed in a shopping cart. Once the customer wants to complete his/her purchase, he/she can check out and pay the ordered goods, thereby triggering the dispatch of the goods.

Before customers can buy any goods in the eShop, they must register (use case **register customer**) such that their identity (i.e., name, billing and dispatch address) is known.

2.2 Variability in the eShop Product Line

The eShop product line contains (for simplification reasons only) five variation points (see the variability model in Figure 1). These variation points – together with their variants – allow a total of 72 applications to be derived from the product line.

VP1: Register Type

Customers have to register for the eShop before they are allowed to purchase goods. Therefore, in each application of the eShop product line, at least one of the two different types of registration has to be contained (documented in the variability model by the constraint 1..2).

The two different kinds of registration are described by the use cases **register normally** and **register completely**. During the normal registration process, customers provide their e-mail address and their postal address. During the register completely process, in addition to the address information of the register normally use-case, the bank account (e.g., account number) must be provided and the customers must agree that the online merchant can contact the bank for more information.

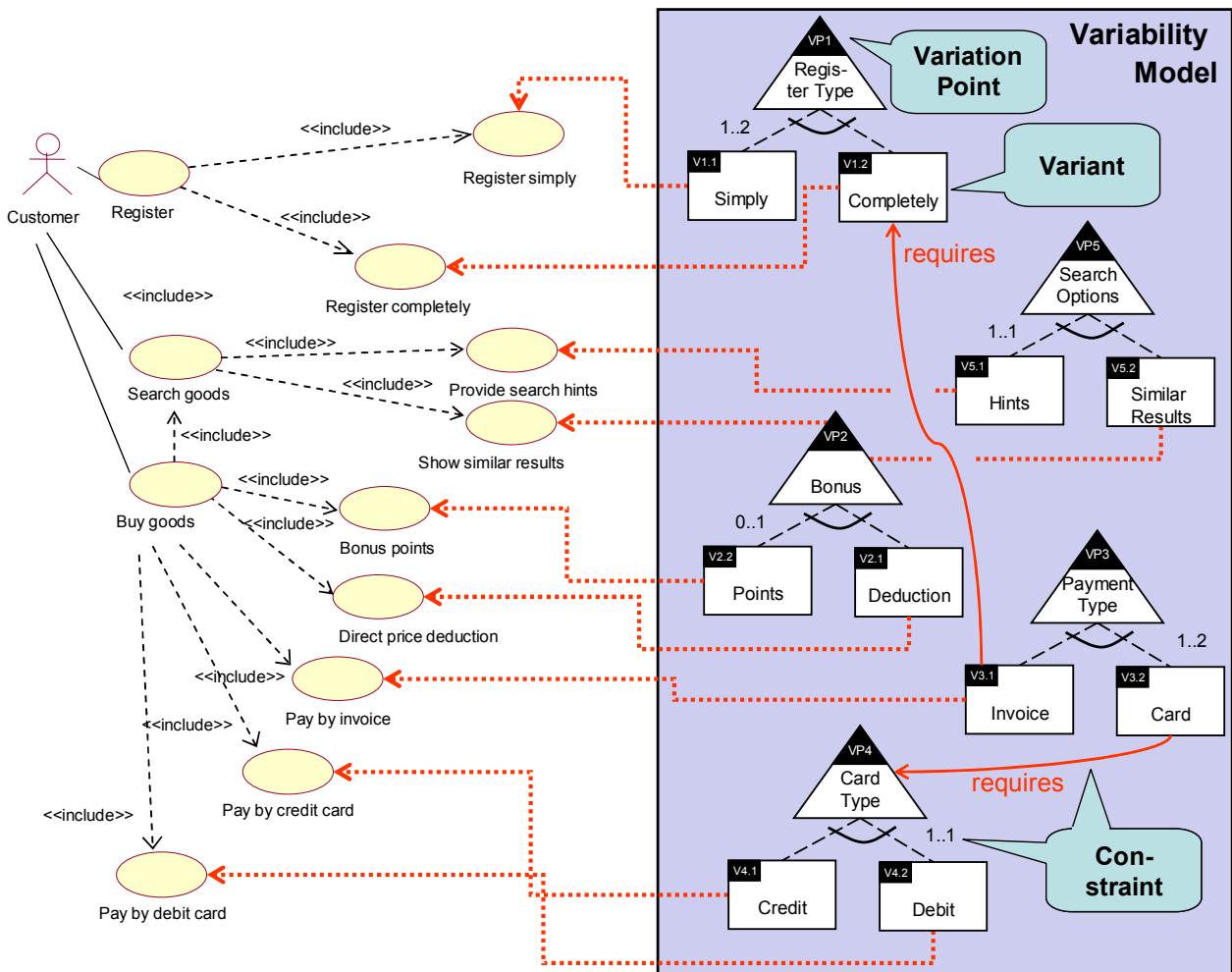


Figure 1: Variability Model and Use Case Diagram of eShop Product Line

VP2: Bonus

The merchant can optionally choose to offer his customers a bonus program. If he decides to do so, he has to decide on whether **bonus points** can be collected or whether a **direct price deduction** will be offered once the value of the order exceeds a certain amount.

The bonus points are calculated based on the goods that have been previously ordered and paid. When offering a direct price deduction, this deduction will be directly reduced from the invoiced amount.

The product line offers only one of the two types of bonus programs to be included in an eShop application (documented by the constraint 0..1 in the variability model).

VP3: Payment Type

The eShop product line offers two major kinds of payments. First, an eShop can allow the customers to **pay by invoice**. Second, the eShop application can offer a **payment by card**. An eShop application can offer both types of payments at once.

If an eShop application shall offer **pay by invoice**, the variant **register completely** is required such that the bank information of a customer is available as a security (or guarantee).

VP4: Card Type

Once the merchant has decided to offer **payment by card**, he further has to refine his selection. Product management of the eShop manufacturer has decided to allow a choice between the (mutually exclusive) alternatives **pay by credit card** and **pay by debit card**. This is expressed by the 1..1 constraint.

VP5: Search Options

The customer can search for a product by entering the product name or the order number of the product using the **search product** use case. If the customers provide an incorrect product name or order number, the **search product** use case might deliver no hits. By using the variant **provide search hints**, the eShop customer is offered a help text on how to modify his search request for better results.

In contrast, the **show similar results** variant will automatically modify the search request of the customer and display all similar results.

Only one of the two variants (show similar results and provide search hints) can be chosen, expressed by 1..1 constraint.

3 Description of the Applications

Two applications have been derived from the product line so far and shall be tested by you. The applications are defined by the variants that have been bound.

Application 1:

- VP1: Register Type = Completely (V1.2)
- VP2: Bonus = Points (V2.2)
- VP3: Payment Type = Invoice (V3.1) + Card (V3.2)
- VP4: Card Type = Debit (V4.1)
- VP5: Search Options = Hints (V5.1)

Application 2:

- VP1: Register Type = Simply (V1.1) + Completely (V1.2)
- VP2: Bonus = -none- (not desired by merchant)
- VP3: Payment Type = Invoice (V3.1)
- VP4: Card Type = -none- (VP has not to be bound)
- VP5: Search Options = Similar results (V5.2)

4 Use Cases

The following tables present the use case descriptions of the eShop product line.

The use case descriptions are based on a suggestion for documenting variable use cases by Bertolino et al. (see Bertolino, A.; Fantechi, A.; Gnesi, S.; Lami, G.; Maccari, A.; „Use Case Description of Requirements for Product Lines”; Proceedings of the International Workshop

on Requirements Engineering for Product Lines 2002 (REPL'02), Technical Report: ALR-2002-033, AVAYA Labs, 2002).

The dependencies between the use cases are expressed by pre- and post-conditions or are shown in Figure 1 by means of the <<includes>> relationships.

Use Case Name	Register	
Brief Description	A customer must register before purchasing goods	
Actors	Customer	
Goal	Register to be able to purchase goods	
Trigger	A customer wants to buy goods online	
Pre-condition	-	
Result	The customer is registered	
Post-condition	The customer is registered	
	Step	Action Description
Main Scenario	1 2 3 4 5	Customer activates registration System shows the form to be filled in {VP1} System shows the data of the customer Customer confirms his data System shows the main page of the eShop.
Scenario Extensions	4a	The customer has found an error in his data and wants to correct it; Scenario continues at Step 2.
Variation Points		Variants
	VP1	V1.1: UC Register simply V1.2: UC Register completely

Use Case Name	Buy goods	
Brief Description	A customer searches, orders and pays goods that he has selected	
Actors	Customer	
Goal	Buy goods	
Trigger	Customers begins his purchase	
Pre-condition	Customer has been registered	
Result	Goods are ordered, payment information is known	
Post-condition	-	
	Step	Action Description
Main Scenario	1 2 3 4 5 6 7 8 9 10	Customer searches goods (refined by UC Search goods) Customer selects goods System adds goods to the shopping cart Customer checks out System calculates and shows amount to be paid System requests payment information {VP3} Customer confirms order System executes order System triggers dispatch of the goods Customer leaves the eShop
Scenario Extensions	5a & 10a	Customer likes to shop for additional goods; Scenario continues at step 1 {VP2}
Variation Points		Variations

VP2	V2.1: UC Direct price deduction V2.2: UC Bonus points
VP3	V3.1: UC Pay by invoice V3.2: requires {VP4}
VP4	V4.1: UC Pay by credit card V4.2: UC Pay by debit card

Use Case Name		
Brief Description		
Customer searches goods in the eShop		
Actors		
Customer		
Goal		
Find goods		
Trigger		
Customer clicks on “search goods” button		
Pre-condition		
-		
Result		
Search results are presented to customer		
Post-condition		
-		
	Step	Action Description
Main Scenario	1	Customer enters a search term
	2	Customer initiates search
	3	System presents search results
	4	Customer chooses desired results
	5	Systems shows details on the selected goods
Scenario Extensions	1a1	Customer chooses detailed search
	1a2	System presents “detailed search” form
	1a3	Customer enters details for searching the goods
	3a1	System shows that no results have been found; Scenario continues at step 1
4a	Customer starts a new search, because he did not find what he searched for; Scenario continues at step 1	
Variation Points		Variations
VP5	3b1	V5.1 (UC Provide search hints): System gives search hints; Scenario continues at step 1
	3b2	V5.2 (UC Show similar results): System shows similar results; Scenario continues at step 3

Use Case Name		
Register simply		
Brief Description		
The customer registers with the eShop in a simple way		
Actors		
Customer		
Goal		
see UC Register		
Trigger		
Alternative 1: The customer has chosen to register simply Alternative 2: The eShop only offers UC Register simply		
Pre-condition		
-		
Result		
Customer has filled in the form for simple registration		
Post-condition		
see UC Register		
	Step	Action Description
Main Scenario	1	The system presents a registration form
	2	The customer fills the fields e-mail address and postal address
	3	System checks the plausibility of the input (e.g., correctness of e-mail address)
Scenario Extensions	3a	System detects an error in the input data; Scenario continues at step 1

Use Case Name	Register completely	
Brief Description	The customer registers completely with the eShop	
Actors	Customer	
Goal	see UC Register	
Trigger	Alternative 1: The customer has chosen to register completely Alternative 2: The eShop only offers UC Register completely	
Pre-condition	-	
Result	Customer has filled in the form for complete registration	
Post-condition	see UC Register	
	Step	Action Description
Main Scenario	1	The system presents a registration form (part 1)
	2	The customer fills the fields e-mail address and postal address
	3	System checks the plausibility of the input (e.g., correctness of e-mail address)
	4	The system presents a registration form (part 2)
	5	The customer (additionally) fills in his bank account information (e.g., IBAN, ...)
	6	System checks the plausibility of the input (e.g., validity of the IBAN)
Scenario Extensions	3a	System detects an error in the input data; Scenario continues at step 1
	5a	System detects invalid bank account information; Scenario continues at step 4

Use Case Name	Bonus points	
Brief Description	Customer orders goods and receives bonus points	
Actors	Customer	
Goal	Buy goods	
Trigger	Customer proceeds to checkout in UC Buy goods	
Pre-condition	-	
Result	Order of goods, update of bonus points	
Post-condition	-	
	Step	Action Description
Main Scenario	1	System calculates bonus points and adds them to the bonus points of the customer

Use Case Name	Direct price deduction	
Brief Description	Customer orders goods and receives a price deduction	
Actors	Customer	
Goal	Buy goods	
Trigger	Customer proceeds to checkout in UC Buy goods	
Pre-condition	-	
Result	Order of goods, update of bonus points	
Post-condition	-	
	Step	Action Description
Main Scenario	1	System calculates price deduction and reduces the invoiced amount

Use Case Name	Pay by invoice	
Brief Description	Customer pays his goods by invoice	
Actors	Customer	
Goal	Buy goods and pay	

Trigger	Customer proceeds to checkout	
Pre-condition	Alternative 1: Customer has chosen to pay by invoice Alternative 2: System only offers UC Pay by invoice	
Result	Goods have been ordered; payment has been authorized; invoice information has been stored, and bill has been printed	
Post-condition	-	
	Step	Action Description
Main Scenario	1 2 3 4 5 6	System requests billing address Customer enters billing address Customer authorizes transaction System checks validity of billing address System requests confirmation of billing address and form of payment Customer confirms
Scenario Extensions	5a1 5a2 5a3	Billing address is faulty; System shows errors in billing address System requests modification/correction of address Customer corrects address; Scenario continues at step 3

Use Case Name	Pay by debit card	
Brief Description	Customer pays his goods by debit card	
Actors	Customer	
Goal	Buy goods and pay	
Trigger	Customer proceeds to checkout	
Pre-condition	Alternative 1: Customer has chosen to pay by debit card Alternative 2: System only offers UC Pay by debit card	
Result	Goods have been ordered; payment information is available; payment has been processed by the customer's bank	
Post-condition	-	
	Step	Action Description
Main Scenario	1 2 3 4 5 6	System requests debit card details Customer enters debit card details Customer authorizes transaction System checks validity of debit card System requests confirmation of debit card details and form of payment Customer confirms
Scenario Extensions	4a1 4a2 4a3 1a1 1a2 1a3	Debit card details are faulty; System shows errors in debit card details System requests modification/correction of debit card details Customer corrects debit card details; Scenario continues at step 3 System identifies the customer as having registered completely and therefore presents the account information (i.e., the debit card details) System requests a confirmation of the data Customer confirms

Use Case Name	Pay by credit card	
Brief Description	Customer pays his goods by credit card	
Actors	Customer	
Goal	Buy goods and pay	
Trigger	Customer proceeds to checkout	
Pre-condition	Alternative 1: Customer has chosen to pay by credit card Alternative 2: System only offers UC Pay by credit card	
Result	Goods have been ordered; payment information is available; payment has been processed by the credit card company	
Post-condition	-	

	Step	Action Description
Main Scenario	1	System requests credit card details
	2	Customer enters credit card details
	3	Customer authorizes transaction
	4	System checks validity of credit card
	5	System requests confirmation of credit card details and form of payment
	6	Customer confirms
Scenario Extensions	4a1	Credit card is not valid; System shows error and requests correction of card information (or to provide an alternative credit card)
	4a2	Customer corrects credit card details; Scenario continues at step 3

Use Case Name	Provide search hints	
Brief Description	The system provided no matches for the query; Therefore, hints for searching are provided	
Actors	Customer	
Goal	The customer shall find results for his query	
Trigger	No search results	
Pre-condition	-	
Result	Search hints are given	
Post-condition	-	
	Step	Action Description
Main Scenario	1	The system notifies the customer that no results have been found
	2	The system provides search hints

Use Case Name	Show similar results	
Brief Description	The system provided no matches for the query; Therefore, similar results are automatically retrieved	
Actors	Customer	
Goal	The customer shall find similar results to his query	
Trigger	No search results	
Pre-condition	-	
Result	Similar results are shown	
Post-condition	-	
	Step	Action Description
Main Scenario	1	The system computes and shows similar results