Testing Use Case based product lines with the PLUTO approach

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Testing Use Case based product lines with the PLUTO approach

1. Introduction
2. Product Lines
3. PLUTO
4. Example
5. Conclusion
what do clients want?*

*customised products at reasonable costs [pohl]
common platforms

35% more sales in 3 years
common platforms

✓ better quality
✓ short time-to-market
✓ maintenance
✓ cost estimation
✓ more quality & features for less money

‣ pre investments
‣ testing gets more complicated
software platform*

- set of software subsystems
- common structur
- products easily derivable

* [Meyer & Lehnerd, 1997]
Testing Use Case based product lines with the PLUTO approach

1. Introduction

2. Product Lines

3. PLUTO

4. Example

5. Conclusion
prerequisites
a well defined domain with many communalities
variability

.. an assumption about how members of a family may differ from each other*

* [Weiss, Lay 99]
How does variability occur?

1. client requests (features)
2. business goals
3. legacy systems
Where does variability occur?
Where does variability occur?

- features
Where does variability occur?

- features
- processes / flows
Where does variability occur?

- features
- processes / flows
- data range
Where does variability occur?

- features
- processes / flows
- data range
- data format
Where does variability occur?
Where does variability occur?

- system access
Where does variability occur?

- system access
- user interface
Where does variability occur?

- system access
- user interface
- system interface
Where does variability occur?

- system access
- user interface
- system interface
- quality
variation point

the place where one or more variants are possible
variants

a variant describes a specific forming in respect to one or more variation points
how can we test? *

* for software quality in product lines
Testing Use Case based product lines with the PLUTO approach

1. Introduction
2. Product Lines
3. PLUTO
4. Example
5. Conclusion
general concept

- Product Line Use Cases (PLUCs)
- natural language
- deriving test cases through categorization
Einordnung im V-Modell

PLUC
- Anforderungsanalyse
- System-Architektur
- System-Entwurf
- Software-Architektur

PLUTO
- Abnahme-Test / Nutzung
- System-Integration
- Integrations-Tests
- Unit-Tests
basics
Category Partition* method

- black-box test approach
- derivation of functional tests
  - use of the specification
- natural language

*[Ostrand et al., 1988]*
variability in Product Line

Use Cases: **tags**

- parametric
- alternative
- optional
Testing Use Case based product lines with the PLUTO approach

1. Introduction
2. Product Lines
3. PLUTO
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5. Conclusion
PLUC* example

* Product Line Use Case
Product Line
Use Case

GamePlay

PL USE CASE GamePlay

Goal: Play a game on a [Vo] Mobile Phone and record score
Scope: The [Vo] Mobile Phone
Level: Summary
Precondition: The [Vo] Mobile Phone is on
Trigger: Function GAMES has been selected from the main menu
Primary actor: The Mobile Phone user
Secondary actors: The [Vo] Mobile Phone (the system)
                   The Mobile Phone Company

Main success scenario
1. The system displays the list of the {V1} available games
2. The user selects a game
3. The user selects the difficulty level
4. The user starts the game and plays it until completion
5. The user records the score achieved {V2} and sends the score to Club XXX via WAP

Extensions
1a. No game is available:
   1b1. return to main menu
   3b. The user starts the game and plays it until an incoming call arrives. See CallAnswer.

Variations
V0: Alternative:
   0. Model0
   1. Model1
   2. Model2
V1: Parametric
if V0=0 then display msg "No game available"
else if V0=1 then Snake or Space Impact
else if V0=2 then Snake or Space Impact or Bumper.
V2: Optional
c when V0=2
PL USE CASE GamePlay

Goal: Play a game on a [Vo] Mobile Phone and record score
Scope: The [Vo] Mobile Phone
Level: Summary
Precondition: The [Vo] Mobile Phone is on
Trigger: Function GAMES has been selected from the main menu
Primary actor: The Mobile Phone user
Secondary actors: The [Vo] Mobile Phone (the system)
The Mobile Phone Company

Main success scenario
1. The system displays the list of the [{V1} available] games
2. The user selects a game
3. The user selects the difficulty level
4. The user starts the game and plays it until completion
5. The user records the score achieved [{V2} and sends the score to Club XXX via WAP]

Extensions
1a. No game is available:
   1a1. return to main menu
3a. The user starts the game and plays it until an incoming call arrives. See CallAnswer.

Variations
V0: Alternative:
   0. Model0
   1. Model1
   2. Model2

V1: Parametric
if V0=0 then display the message “No game available”
else if V0=1 then “Snake” or “Space Impact”
else if V0=2 then “Snake” or “Space Impact” or “Bumper”.

V2: Optional
when V0=2

3 steps
**Title:** PL USE CASE GamePlay

**Goal:** Play a game on a [Vo] Mobile Phone and record score

**Scope:** The [Vo] Mobile Phone

**Level:** Summary

**Precondition:** The [Vo] Mobile Phone is on

**Trigger:** Function GAME1 has been selected from the main menu

**Primary actor:** The [Vo] Mobile Phone user

**Secondary actors:**
- The [Vo] Mobile Phone (the system)
- The Mobile Phone Company

**Main success scenario**
1. The system displays the list of the [V1] available games
2. The user selects a game
3. The user selects the difficulty level
4. The user starts the game and plays it until completion
5. The user records the score achieved [V2] and sends the score to Club XXX via WAP

**Extensions**
1a. No game is available:
   1a.1. Return to main menu
3a. The user starts the game and plays it until an incoming call arrives. See CallAnswer.

**Variations**

**V0:** Alternative:
- 0. Model0
- 1. Model1
- 2. Model2

**V1:** Parametric
- if V0=0 then display msg "no game available" else if V0=1 then Snakell or Space Impact else if V0=2 then Snakell or Space Impact or Bumper.

**V2:** Optional
- when V0=2
**Goal**

**PL USE CASE Gameplay**

**Goal:** Play a game on a [V0] Mobile Phone and record score

**Scope:** The [V0] Mobile Phone

**Level:** Summary

**Precondition:** The [V0] Mobile Phone is on

**Trigger:** Function Games has been selected from the main menu

**Primary Actor:** The Mobile Phone user

**Secondary actors:** The [V0] Mobile Phone (the system)

**The Mobile Phone Company**

**Main success scenario**

1. The system displays the list of the [V1] available games
2. The user selects a game
3. The user selects the difficulty level
4. The user starts the game and plays it until completion
5. The user records the score achieved (V2) and sends the score to Club XXX via WAP

**Extensions**

1a. No game is available:
   1a.1. Return to main menu
1a.2. The user starts the game and plays it until an incoming call arrives. See CallAnswer.

**Variations**

**V0:** Alternative:

1. Model1
2. Model2

**V1:** Parametric

if V0=0 then display msg “no game available”
else if V0=1 then Snail or Space Impact
else if V0=2 then Snail or Space Impact or Bumper.

**V2:** Optional
when V0=2
Goal

Scope
**Goal**

**Scope**

**Level**

---

**PL USE CASE GamePlay**

**Goal:** Play a game on a [V0] Mobile Phone and record score

**Scope:** The [V0] Mobile Phone

**Level:** Summary

**Precondition:** The [V0] Mobile Phone is on

**Trigger:** Function: Games has been selected from the main menu

**Primary actor:** The Mobile Phone user

**Secondary actors:** The [V0] Mobile Phone (the system)

The Mobile Phone Company

**Main success scenario**

1. The system displays the list of the [V1] available games
2. The user selects a game
3. The user selects the difficulty level
4. The user starts the game and plays it until completion
5. The user records the score achieved ([V2]) and sends the score to Club XXX via WAP

**Extensions**

1a. No game is available:
   1a1. Return to main menu
   1a2. The user starts the game and plays it until an incoming call arrives. See CallAnswer.

**Variations**

**V0:** Alternative:
1. Model0
2. Model1
3. Model2

**V1:** Parametric
- If V0=0 then display msg "no game available"
- Else if V0=1 then Snakell or Space Impact
- Else if V0=2 then Snakell or Space Impact or Bumper.

**V2:** Optional
- When V0=2
## Description

- **Goal**
- **Scope**
- **Level**
- **Precondition**

### PL USE CASE GamePlay

**Goal:** Play a game on a [Vo] Mobile Phone and record score

**Scope:** The [Vo] Mobile Phone

**Level:** Summary

**Precondition:** The [Vo] Mobile Phone's options is on

**Trigger:** Function GAMES has been selected from the main menu

**Primary actor:** The Mobile Phone user

**Secondary actors:** The [Wii] Mobile Phone (the system)

The Mobile Phone Company

### Main success scenario

1. The system displays the list of the [V1] available games
2. The user selects a game
3. The user selects the difficulty level
4. The user starts the game and plays it until completion
5. The user records the score achieved ([V2]) and sends the score to Club XXX via WAP

### Extensions

1a. No game is available:
   1a.1. Return to main menu
3a. The user starts the game and plays it until an incoming call arrives. See CallAnswer.

### Variations

**V0:** Alternative:
- 0. Model0
- 1. Model1
- 2. Model2

**V1:** Parametric
- If V0=0 then display msg “no game available”
- Else if V0=1 then Snakek or Space Impact
- Else if V0=2 then Snakek or Space Impact or Bumper.

**V2:** Optional
- When V0=2
description

- Goal
- Scope
- Level
- Precondition
- Trigger
<table>
<thead>
<tr>
<th>PL USE CASE: GamePlay</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal:</strong> Play a game on a [Yo] Mobile Phone and record score</td>
</tr>
<tr>
<td><strong>Scope:</strong> The [Yo] Mobile Phone</td>
</tr>
<tr>
<td><strong>Level:</strong> Summary</td>
</tr>
<tr>
<td><strong>Precondition:</strong> The [Yo] Mobile Phone is on</td>
</tr>
<tr>
<td><strong>Trigger:</strong> Function GAMES has been selected from the main menu</td>
</tr>
<tr>
<td><strong>Primary actor:</strong> The Mobile Phone user</td>
</tr>
<tr>
<td><strong>Secondary actors:</strong> The [Yo] Mobile Phone (the system) The Mobile Phone Company</td>
</tr>
</tbody>
</table>

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<td>1. The system displays the list of the [V1] available games</td>
</tr>
<tr>
<td>2. The user selects a game</td>
</tr>
<tr>
<td>3. The user selects the difficulty level</td>
</tr>
<tr>
<td>4. The user starts the game and plays it until completion</td>
</tr>
<tr>
<td>5. The user records the score achieved [V2] and sends the score to Club XXX via WAP</td>
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</tbody>
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<td>1. Model1</td>
</tr>
<tr>
<td>2. Model2</td>
</tr>
<tr>
<td>V1: Parametric</td>
</tr>
<tr>
<td>if V0=0 then display msg &quot;no game available&quot; else if V0=1 then Snake or Space Impact else if V0=2 then Snake or Space Impact or Bumper.</td>
</tr>
<tr>
<td>V2: Optional when V0=2</td>
</tr>
</tbody>
</table>

- **Goal**
- **Scope**
- **Level**
- **Precondition**
- **Trigger**
- **Primary Actor**
## Goal

- Play a game on a [Vo] Mobile Phone and record score

## Scope

- The [Vo] Mobile Phone

## Level

- Summary

## Precondition

- The [Vo] Mobile Phone is on

## Trigger

- Function: GAMES has been selected from the main menu

## Primary actor

- The Mobile Phone user

## Secondary actors

- The [Vo] Mobile Phone (the system)
  - The Mobile Phone Company

### Main success scenario

1. The system displays the list of the [V1] available games
2. The user selects a game
3. The user selects the difficulty level
4. The user starts the game and plays it until completion
5. The user records the score achieved [V2] and sends the score to Club XXX via WAP

### Extensions

1a. No game is available:
   - 1a.1 return to main menu
3a. The user starts the game and plays it until an incoming call arrives. See CallAnswer.

### Variations

#### V0: Alternative

- 0. Model0
- 1. Model1
- 2. Model2

#### V1: Parametric

- if V0=0 then display msg “no game available” else if V0=1 then Snake or Space Impact else if V0=2 then Snake or Space Impact or Bumper.

#### V2: Optional

- when V0=2
description

- **Goal**
- **Scope**
- **Level**
- **Precondition**
- **Trigger**
- **Primary Actor**
- **Secondary Actor**
**Main Success Scenario**

**Spielablauf**

**Extensions**

**Behandlung eingehender Anrufe**

---

**PL USE CASE GamePlay**

**Goal:** Play a game on a [V0] Mobile Phone and record score

**Scope:** [V0] Mobile Phone

**Level:** Summary

**Precondition:** The [V0] Mobile Phone is on

**Trigger:** Function GAMES has been selected from the main menu

**Primary actor:** The Mobile Phone user

**Secondary actors:** The [V0] Mobile Phone (the system)

The Mobile Phone Company

**Main success scenario**

1. The system displays the list of the [[V1] available] games
2. The user selects a game
3. The user selects the difficulty level
4. The user starts the game and plays it until completion
5. The user records the score achieved [V2] and sends the score to Club XXX [markup]

**Extensions**

1a. No game is available
   1a1. return to main menu
3a. The user starts the game and plays it until an incoming call arrives. See CallAnswer.

**Variations**

**V0:** Alternative:

1. Model0
2. Model1
3. Model02

**V1:** Parametric

if V0=0 then display msg “no game available”
else if V0=1 then Snake or Space Impact or Bumper
else if V0=2 then Snake or Space Impact or Bumper.

**V2:** Optional when V0=2
variations

PL USE CASE GamePlay

Goal: Play a game on a [Vo] Mobile Phone and record score
Scope: The [Vo] Mobile Phone
Level: Summary
Precondition: The [Vo] Mobile Phone is on
Trigger: Function GAMES has been selected from the main menu
Primary actor: The Mobile Phone user
Secondary actors: The [[V1] Mobile Phone] (the system)
                     The Mobile Phone Company

Main success scenario
1. The system displays the list of the [[V1] available] games
2. The user selects a game
3. The user selects the difficulty level
4. The user starts the game and plays it until completion
5. The user records the score achieved [[V2]] and sends the score to Club XXX via WAP

Extensions
1a. No game is available
1b.1, return to main menu
3a. The user starts the game and plays it until an incoming call arrives. See CalAnswer.

Variations
V6: Alternative:
   0. Mode 0
   1. Mode1
   2. Mode 2

V1: Parametric
if V6=0 then display “no game available”
else if V6=1 then select Maker of Space Impact
else if V6=2 then select Demon or Space Impact or Bumper.

V2: Optional
when V6=2
variations

- V0: Alternative
  - 0. Model 0
  - 1. Model 1
  - 2. Model 2
variations

- **V0: Alternative**
  - 0. Model 0
  - 1. Model 1
  - 2. Model 2

- **V1: Parametric**
  - if V0=0 ..
V1: Parametric

if V=0 then
display msg “no game available”
else if V=1 then
Snakell or Space Impact
else if V0=2 then
Snakell or Space Impact or Bumper
variations

- **V0: Alternative**
  - 0. Model 0
  - 1. Model 1
  - 2. Model 2

- **V1: Parametric**
  - if V0=0 ..

PL USE CASE GamePlay

Goa1: Play a game on a [V0] Mobile Phone and record score
Scope: The [V0] Mobile Phone
Level: Summary
Precondition: The [V0] Mobile Phone is on
Trigger: Function GAMES has been selected from the main menu
Primary actor: The Mobile Phone user
Secondary actors: The [V0] Mobile Phone (the system)
The Mobile Phone Company

Main success scenario:
1. The system displays the list of the [V1] available games
2. The user selects a game
3. The user selects the difficulty level
4. The user starts the game and plays it until completion
5. The user records the score achieved [V2] and sends the score to Club XXX via WAP

Extensions:
1a. No game is available:
   1a1. return to main menu
3a. The user starts the game and plays it until an incoming call arrives. See CallAnswer.

Variations
V0: Alternative:
- 0. Model 0
- 1. Model 1
- 2. Model 2
V1: Parametric
if V0=0 then display "No game available"
else if V0=1 then Space Impact
else if V0=2 then Breakout or Space Impact or Bumper.
V2: Optional when V0=2
variations

- **V0: Alternative**
  - 0. Model 0
  - 1. Model 1
  - 2. Model 2

- **V1: Parametric**
  - if V0=0 ..

- **V2: Optional**
  - when V0=2
3 steps towards usable test cases
1. finding categories

- Mobile Phone Model
- Games
- Scenarios
- Club
2. partitioning

- [V0]: Mobile Phone Model
  - 0. Model0 [Property P0]
  - 1. Model1
  - 2. Model2 [Property P2]

Pluc Gameplay Test Specification
2. partitioning

- Games:
  - none [if P0]
  - Snake II [if NOT P0]
  - Space Impact [if NOT P0]
  - Bumper [IF NOT P0] [if P2]

Pluc Gameplay Test Specification
2. partitioning

- **Scenarios:**
  - Main [if NOT P0]
  - ext: no games available [if P0]
  - ext: a call arrives see CallAnswer [single]

Pluc Gameplay Test Specification
2. partitioning

- [V2]: Club:
  - internet connection on [if P2]
  - internet connection off [if P2]

Pluc Gameplay Test Specification
3. combine

- combination of all possibilities
- instanciating the tags
- e.g. P2 = true
result \left( \frac{1}{n} \right)

Tag $V_0 = 0$

$T_i$: Mobile Phone Model: Model 0

Games: None

Scenarios: ext. no game available
result ( 3 / n )

Tag V0=2

Ti: Mobile Phone Model: Model 2

Games: Snake II, Space Impact, Bumper

Scenarios: main

Club: internet connection on
possible improvements of PLUTO

- taking variability within test data into account
- less complexity in test cases and test conditions
- tool support
Challenges ( for product lines )

- variability across product lines
- support of software maturity models (like CMM)
- ROI (Return On Investment) models for new products within a product line
Literature


any questions?