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An XML Methodology to Model and Use Scenarios in the Software Development Process

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#### **Scenarios**

#### how the users will be using the system

- 1. taking a user's point of view, to describe system external behaviour, promote and advance tight user involvement in the system development
- 2. improve communication between the different group involved in system development
- 3. user-system interactions are an ideal base to design system test cases
- 4. provide guidelines to build prototype
- 5. build a valuable base for project documentation and user manual

#### Motivation

- the lack of a unique modelling process and a unique environment, to support the scenario life cycle and the scenario management
- the lack of transformation techniques to reuse scenarios in other phases of SE, e.g. testing phase, design phase
- the lack of a proper structure and semantics for *scenario model*, conceived as a collection of scenarios integrated in a unique model through the composition operators

## **Thesis Contribution**

- the definition of a modelling process to support the life cycle and scenario management, based on:
  - a scenario model that preserves the potential benefits of scenario written using informal language
  - a set of transformation rules to derive other form of specification, i.e. test cases, without introduce intermediate formalism
- the development of a prototype software environment to support the entire methodology
- the application of the process on a wide variety of case studies in order to refine and validate the methodology

# Scenario Model Development Process (SMDP)



## **SMDP** Characteristics

Lightweight
XML based
Textual and Graphical
Multi viewpoint
Iterative and Incremental

## **SMDP Structures/Languages**

- Scenario Model: is the structure for describing a set of scenarios composed through appropriate composition rules
- <u>Test Wodel</u>: is the structure for describing a set of system test cases, establishing that the implemented system conforms to its requirements
- <u>Behaviour Model</u>: is the structure for describing a set of state diagrams, representing the dynamic behaviour of the system.



#### **SMDP**

#### Structure/Languages/Presentation System



## **SMDP** Phases

- <u>definition</u> (where specifications are described and formalized in the form of scenarios)
- <u>refinement</u> (the elaboration of more detailed scenarios)
- <u>composition</u> (the integration phase, where different scenarios are composed)
- <u>transformation</u> (the derivation phase, where other forms of specifications are derived from scenarios)



# **Basic Terminology**

- <u>Interaction</u>: a triple (subject, action, object).
   Which take place between user and system.
- <u>Goal</u>: the result expected from the execution of the user-system interactions
- <u>Main flow</u>: describes a sequence of interactions that allows to achieve the primary actor's goal.

- <u>Exception Flow</u>: a sequence of interactions that represent obstacles to the primary actor's goal achievement
- <u>Alternative Flow</u>: an alternative sequence of interactions that lead to success of the primary actor's goal.
- <u>Scenario</u>: a collection of possible flow of interactions, showing how the primary actor's goal might be delivered or fail.

#### Scenario Model Structure



# An example of Composition Rule

Let S1 and S2 be scenarios. If precondition(S2)=postcondition(S1) and primaryActor(S1)= primaryActor(S2), then S = Sequence (S1, S2) is a scenario such that: - goal(S)= (goal(S1), goal(S2)) - primaryActor(S)=primaryActor(S1) - trigger(S)=trigger(S1) - precondition(S)=precondition(S1) - postcondition(S)=postcondition(S2)

flows of interactions (S) are obtained combining the flows of interactions(S1) and flows of interactions(S2)

#### Scenario Model Structure

- it provides a complete specification of a system's behaviour, providing great expressiveness and unambiguous interaction semantics
- it helps avoid the explosion of scenarios that occur if we try to simply list all the possibile flow of interaction in undisciplined manner
- it allows to integrate scenarios directly without introduce other formalism, improving the quality of requirements specification and keeping scenarios persistent

# **SDML Scenario Model**



# **SDML Scenario Model**



### **Scenario Model Presentation**

SDML Package "	Library Syste	m "						
Basic Information	ı							
Title	Libra	ary System						
Description	LIbra	ary System scenario model						
Attributes								
Scenario Model (	Components							
Application Domain	Scenario SS1	000 "User logon to the LBB System"						
library_items > Scenario Model	Basic Inform	ation						
+ SC1000 > + SC2000 >	Attributes External References							
- SS1000								
572000 - 353000 >	Main Flow							
- SS4000 >	SS1000.1	Library User - Insert - Card	(1 alternatives)					
- SS5000 > - SS6000 >		Alternative Flow SS1000.1-1: IF Library User - Type - Login parmeters						
- 550000		SS1000.1-1.1 Library User - Type - Login parmeters						
		SS1000.1-1.2 LBB System - Venty - Login parmeters						
		SUCCESS						
	SS1000.2	LBB System - Request - PIN						
	SS1000.3	Library User - Type - PIN						
	SS1000.4	LBB System - Validate - PIN						
	SS1000.5	LBB System - Display - Main_Menu						
	SUCCESS							

## **Scenario Model Presentation**





Ser min SS6000	"horrows a book"
Basic Information	
Goal	User borrows a book
Description	User borrows a book
Primary Actor	Library User
Secondary Actors	LBB System
Trigger	Library User - Select_Borrow - Main_Menu
Preconditions	LBB System - Authenticated - Library User
Postconditions	Library User - Borrowed - Book
Attributes	
External References	
Main Flow	
SS6000.1	Library User - Select_Borrow - Main_Menu
SS6000.2	LBB System - Display - Borrow_Menu
SS6000.3	Library User - Select - Book
SS6000.4	LBB System - Check_avaiability - Book (1 exceptions)
SS6000.5	LBB System - Display - Book_Loan
SS6000.6	Library User - Accept - Book_Loan
SS6000.7	LBB System - Check - Book_Loan (1 exceptions)
SS6000.8	LBB System - Save - Book_Loan
SUCCESS	

## **Scenario Model Presentation**

Scena 'a SS6000 "Siser borrows a book"

Basic Information

#### Attributes

External References

#### Main Flow

1.1.0			
SS6000.1	Library User - Select_Borrow -	Main_Menu	
SS6000.2	LBB System - Display - Borrow	/_Menu	
SS6000.3	Library User - Select - Book		M
SS6000.4	LBB System - Check_avaiability <i>Exception Flow SS6000.4-1:1</i>	7 - Book IF (LBB System - Check_avaiability - Book = false)	(1 exceptions).
	SS6000.4-1.1 SS6000.4-1.2 FAIL	LBB System - Eject - Card LBB System - Display - ErrorMessage	
SS6000.5	LBB System - Display - Book_l	Loan	
SS6000.6	Library User - Accept - Book_I	M	
\$\$6000.7	LBB System - Check - Book_L <i>Exception Flow SS6000.7-1:1</i>	(1 exception)	
SS6000.8	LBB System - Save - Book_Lo	an	
SUCCESS			

## **Construction Phase Activities**



#### **Definition Phase**

- the definition of Vocabulary: list of actors, items, actions
- the identification of the scenario's goals, and the basic list of triggers-condition, pre-condition.
- the description of a mainflow of interaction for each identified goal

Composition Phase

composition of different scenarios through integration rules

#### **Refinement Phase**

- the identification of alternatives flows
- the identification of exceptions flows (goal obstacles)
- the identification of redundant flows (include)
- the identification of extensional flows(extend)

## Validation Phase



#### **Validation** Phase

- Scenario Completeness: the capability of scenarios to represent all the behaviour required.
  - iterative and incremental characteristics of SMDP
  - variant, extend, include, composition rules
  - indicator (i.e. number of: steps of scenarios, variants)
- Scenario Consistency: the capability to avoid contradictions inside the scenario model and respect its derived models
  - vocabulary shared between models
  - cross- referencing obtained through XML
  - variant related to the same goal
- Scenario Correctness: the capability to avoid incorrecteness during flow of interactions composition

#### **Trasformation** Phase

- to derive other forms of specifications :
  - to support validation phase, reducing incompleteness and inconsistency for the scenario model during the construction phase
  - to support other phases of software development, such as testing phase and design phase



#### **Path Generation Algorithm**



A path is defined as an interaction flow included in a scenario, and it corresponds to a flow of actions obtained by analysing all the flows of interaction derived from that scenario (simple or composite).

## Path Generation Algorithm

```
path step st {
/*prolog denotes a set of interactions common to a set of subflows */
prolog Ø;
while (st does not contain variants and st <> success or failure){
 if (st is an interaction) {
  append st to prolog;
    let st' be the step following st in the current interaction flow;
  set st to st':
 } else if (st is a goto) {
    while {st is a goto) {
       set st to the step reached by the goto in the current interaction flow;
     \left| \right| / w hile
   }// else if
}//while
if (st contains variants) {
 let st' be the step following st in the current interaction flow;
 foreach st''in variants(st ) {
   /*subflows(x) is the set of interaction flows starting from the step x */
   set subflows (st'') to path step(st'');
 }/ / foreach
 /*mainsubflows is the set of interaction flows that follow the step st */
 set mainsubflows to path_step(st')
 foreach st''in variants(st) {
   insert prolog at the beginning of each interaction flow contained in subflows [st''];
 }//foreach
 insert prolog then step at the beginning of each interaction flow contained in
    mainsubflows;
 return the union of subflows and mainsubflows;
 } else {
    return prolog;
   \}// else
```

## **Test Model Generation**



- 1. <u>ActionToBePerformed</u>: scenario interactions that have user as primary actor
- 2. <u>ExepectedResult</u>: scenario interactions that have system as primary actor



n Flow						
	asert - Card					
Alt manye mo	w 201000.1-1: IF	Librarv User - Tvpe - I	ogin parmeters			
SS1000.1-1.1		Library User - Type - Lo	gin parmeters			
SS1000.1-1.2	i	LBB System - Verify - Lo	ogin parmeters			
SS1000.1-1.3	1	LBB System - Display - (	Query Menu			
SUCCESS						
00.2 LBB System - R	equest - PIN					
00.3 Library User T	ype Till					
1 <b>00.4</b> LBB System - V	alidate - PIN					
100.5 LBB System - D	isplay - Main_Me	enu				
CESS						
		TEST CASES				
		TEST CRSES				
·						
D_TESTCASE	TC1000	PRIORITY	mandatory	TYPE	FT	
D_TESTCASE DESCRIPTION	TC1000 User Logon on	the LBB System	mandatory	ТҮРЕ	FT	
D_TESTCASE DESCRIPTION TRIGGER	TC1000 User Logon on Library User - In	the LBB System nsert - Card	mandatory	ТУРЕ	FT	
D_TESTCASE DESCRIPTION TRIGGER PRE-REQUIREMENTS	TC1000 User Logon on Library User - In Library User - C	the LBB System nsert - Card Iwn - Card	mandatory	ТҮРЕ	FT	
D_TESTCASE DESCRIPTION TRIGGER PRE-REQUIREMENTS DATA INPUT	TC1000 User Logon on Library User - In Library User - C Login paramete:	the LBB System <u>nsert</u> - <u>Card</u> <u>lwn</u> - <u>Card</u> rs	mandatory	Түре		
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D_TESTCASE DESCRIPTION TRIGGE PRE-REQUIREMENTS DATA INPUT NOTE STEP Step 1 Step 2	TC1000 User Logon on Library User - Ir Library User - C Login paramete	PRIORITY the LBB System <u>nsert - Card</u> Dwn - <u>Card</u> Ts nsert - <u>Card</u> <u>ype - PIN</u>	LBB System - Va	TYPE  Type-indResult  quest - PIN  Idate - PIN  Idate - PIN		
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ID_TESTCASE	TC9000	PRIORITY	mandatory	ТҮРЕ	FT			
DESCRIPTION	User retrive and show document							
TRIGGER	<u>User</u> - <u>Open</u> - <u>B</u>	rowser IE6.0						
PRE-REQUIREMENTS	<u>User - know - U</u>	IRL						
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NOTE								
STEP		Action	ExpectedRes	ult				
Step 1	<u>User</u> - <u>Open</u> - <u>B</u>	rowser IE6.0	<u>System - Load - Browser I</u>	<u>E6.0</u>				
Step 2	<u>User</u> - <u>insert</u> - <u>L</u>	IRL	System - Display - Home H	Page				
Step 3	<u>User</u> - <u>Select</u> - <u>A</u>	Archive	System - Request - Login	parameters				
Step 4	<u>User</u> - <u>Type</u> - <u>L</u>	ogin parameters	System - Verify - Login pa System - Show Login corr System - Show - Archive	<u>rameters</u> ect - <u>Messa</u>	ge			
Step 5	<u>User</u> - <u>Insert</u> - O	Query	System - Update - Query A	Area				
Step 6	<u>User</u> - <u>Consult</u>	- <u>Lemma Network</u>	<u>System - Display - Keywo</u>	rd				
Step 7	<u>User</u> - <u>Choice</u> -	<u>Keyword</u>	System - Update - Query					
Step 8	<u>User</u> - <u>Execute</u> -	- <u>Query</u>	<u>System - Check - Query</u> <u>System - Execute - Query</u> <u>System - Update - Researc</u>	c <u>h Tree</u>				
Step 9	<u>User</u> - <u>Save</u> - <u>Q</u>	<u>uery</u>	System - Ask_Name - Que	ay				
Step 10	<u>User</u> - <u>Insert_N</u>	ame - Query.	<u>System</u> - <u>Save</u> - <u>Query</u>					
Step 11	<u>User</u> - <u>Active</u> -	Push Service	<u>System</u> - <u>Enable</u> - <u>Push Se</u>	rvice				
Step 12	<u>User</u> - <u>Consult</u>	- <u>Set of Document</u>	System - Show Titles - Set	t of Docume	nt			
Step 13	<u>User</u> - <u>Select</u> - <u>I</u>	Document	System - Show - Documer	<u>nt</u>				

### **Behaviour Model Generation**



- 1. <u>system action:</u> scenario interactions that have system as primary actor
- 2. <u>transition:</u> scenario interactions that have user as primary actor



#### Main Flow

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330000.1	Liorary Oser - Select_Borrow - Mani_Meric
SS6000.2	LBB System - Display - Borrow_Menu
SS6000.3	Library User - Select - Book
SS6000.4	LBB System - Check_avaiability - Book (1 exceptions)
	Exception Flow SS6000.4-1: IF (LBB System -
	Check_avaiability - Book = false)
	SS6000.4-1.1 LBB System - Eject - Card SS6000.4-1.2 LBB System - Display - ErrorMessage FAIL
882000 F	IPP Gratery Display Deals Leave
2200002	LBB System - Display - Book_Loan
SS6000.6	Library User - Accept - Book_Loan
SS6000.7	LBB System - Check - Book_Loan (1 exceptions)
SS6000.8	LBB System - Save - Book_Loan
SUCCESS	

#### Main Flow

1.1.1.1.1.1.0	
SS6000.1	Library User - Select_Borrow - Main_Menu
SS6000.2	LBB System - Display - Borrow_Menu
SS6000.3	Library User - Select - Book
SS6000.4	LBB System - Check_avaiability - Book (1 exceptions) Exception Flow SS6000.4-1: IF (LBB System - Check_avaiability - Book = false)
	SS6000.4-1.1       LBB System - Display - Message         SS6000.4-1.2       Library User - Accept - ErrorMessage         SS6000.4-1.3       LBB System - Eject - Card         FAIL       Example 1
SS6000.5	LBB System - Display - Message
SS6000.6	Library User - Accept - Message
SS6000.7	LBB System - Display - Book_Loan
SS6000.8	Library User - Accept - Book_Loan
SS6000.9	LBB System - Check - Book_Loan (1 exceptions)
SS6000.10	LBB System - Save - Book_Loan
SUCCESS	



LBB System

Library User-Logoff-LBB System

Failure 0

6

# Outline

#### Scenario Model Development Process

- ✓ Overview
- Scenario Model Structure
- Scenario Description Markup Language
- Scenario Model Presentation System
- Phases and Activities
- Test Model and Behaviour Model
- Scenario Model Environment
- Case Study: ItalgiureWeb System
- Conclusion and Future works

# Scenario Model Environment



The use of SME



### SME -> Architectural Overview



- <u>Scenario Model Manager (SMM):</u> supports the creation,maintenance, validation and visualisation of the SDML documents corresponding to the scenarios that compose the scenario model.
- <u>Test Model Manager (TMM):</u> allows to automatically derive a set of test cases from the entire scenario model.The test model is visualised in a tree –structured fashion,where each test case has an hypertextual format.
- <u>Behavior Model Manager (BMM):</u> allows to encode the entire scenario model into a set of state diagrams.The behaviour model can be visualised through an external viewer.

# Scenario Model Manager

#### **Design View**

#### **Presentation View**

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scenarioRodel     Generation Domain     Contextum Domain     Contextum Domain     Contextum Domain     Contextum Domain     Contextum Domain     Contextum Domain		Basic, arro, ion	rtup Application ItalginreWeb"	
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- 0 55000 - 0 55000 H- 0 55000	-	Postconditions Datainput	Systen - Display - Home Page	
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00 00 000000 00 000 00000 00 000 00000		Priority Revision	mandatory 0	
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		SUCCESS		

#### **Scenario Model Manager**

#### **Test Cases View**

#### **State Diagram View**

Application SDML v. 1.0 - Microsoft Internet Exp	lorer				🔀 🛛 😤 S	tatechart Edit
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- <u>558000</u> - 559000	STEP	Action	ExpectedResult			<ul> <li>User-Exect</li> <li>User-Cons</li> </ul>
₽ <u>□ sc1000</u>	Step 1	<u>User</u> - <u>Open</u> - <u>Browser IE6.0</u>	System - Load - Browser IE6.0			<ul> <li>User-Choic</li> </ul>
B- SC1200 B- SC1500	Step 2	<u>User</u> - <u>insert</u> - <u>URL</u>	System - Display - Home Page			<ul> <li>User-Cons</li> <li>User-Acce</li> </ul>
E <u>5C2000</u>	Step 3	User - Select - Archive	System - Request - Login parameters			<ul> <li>User-Exec</li> </ul>
B-1         SC5000           B-1         SC5000           B-1         SC7000           B-1         SC7000	Step 4	<u>User</u> - <u>Type</u> - <u>Login parameters</u>	<u>System</u> - Verify - <u>Login parameters</u> System - Show Login correct - <u>Mess</u> System - Show - <u>Archive</u>	age	100	<ul> <li>User-Select</li> <li>User-Accel</li> </ul>
E- · · · · · · · · · · · · · · · · · · ·	Step 5	<u>User</u> - <u>Insert</u> - <u>Query</u>	System - Update - Query Area			
	Step 6	<u>User</u> - <u>Consult</u> - <u>Lemma Network</u>	System - Display - Keyword			
	Step 7	<u>User</u> - <u>Choice</u> - <u>Keyword</u>	System - Update - Query			
	Step 8	<u>User</u> - <u>Execute</u> - <u>Query</u>	<u>System</u> - <u>Check</u> - <u>Query</u> <u>System</u> - <u>Execute</u> - <u>Query</u> System - Update - <u>Research Tree</u>			
	Step 9	User - Save - Query	System - Ask Name - Query			
	Step 10	<u>User</u> - <u>Insert Name</u> - <u>Query</u> .	System - Save - Query			
Author: AnnaRita Laurenzi	Step 11	User - Active - Push Service	System - Enable - Push Service			
Description: ItalgiureWeb scenario m	Step 12	User - Consult - Set of Document	System - Show Titles - Set of Docum	ent		
Title: ItalgiureWeb	Step 13	<u>User</u> - <u>Select</u> - <u>Document</u>	System - Show - Document			
Creation Date: 2004-02-10 🔍 🗸					~	



# Test Model Manager

Application SI	DML v. 1.0 - Microsof	t Int	ernet Explorer					
				<u>Scenario Model <mark>Test Mo</mark></u>	del Behavior Model			< >
			Presentation					< >
				TEST CASES				
E TCS1300			ID TESTCASE	TCS4000.3.1 PRIORITY	mandatory	TYPE	FT	
			DESCRIPTION	Set Query on ItalgiureWeb Syste	m			
	10		TRIGGER	<u>User</u> - <u>Insert</u> - <u>Query</u>				
	00.3.1 10.3.2	Ш	PRE- REQUIREMENTS	<u>User</u> - <u>Open</u> - <u>Archive</u>				
			DATA INPUT	Archivie Name=[Civile] Researc	h Keyword=[testo=mino	re]		
E <u>TCS7000</u>			NOTE					
			STEP	Action	ExpectedRe	esult		
E TCC1000			Step 1	<u>User</u> - <u>Insert</u> - <u>Query</u>	<u>System</u> - <u>Update</u> - <u>Que</u>	ry Area		
$\begin{array}{c} \blacksquare \\ \blacksquare $			Step 2	<u>User</u> - <u>Consult</u> - <u>Semantic</u> <u>Network</u>	<u>System</u> - <u>Display defaul</u>	<u>t</u> - <u>Conce</u>	ept	
<u> </u>			Step 3	<u>User</u> - <u>Accept default</u> - <u>Concept</u>	System - Display Cifred	l - Query		
		~						
Author:	AnnaRita Laurenzi	^						
Description:	ItalgiureWeb Test model							
Title:	ItalgiureWeb							

Creation Date: 2004-02-10

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## **Behaviour Model Manager**



## **Classification** Framework



## **Application of SMDP-SME**

#### **ItalgiureWeb**

#### **Further Research**

- to refine and validate SMDP and SME prototype version in order to obtain a real industrial product
- to integrate SME with features of natural language
- to apply our approach in order to document the behaviour of the existent projects before to migrate them using the new technologies
- to support the development of the new project, in particular in the analysis and testing phase
- to document the projects already developed in ordert to create a knowledge repository





## **Thesis Contribution**

• the definition of a modelling process to support the life cycle and scenario management:

- the definition of scenario model that includes the composition operators to compose scenarios, without introducing intermediate formalism
- the definition of a set of transformation rules to derive other form of specification, i.e. test cases
- the definition of a set of activities
- the development of a software environment to support the methodology
- the application of the process on a wide variety of case studies in order to refine and validate the methodology

# Basic Terminology ..continue

- <u>Scenario</u>: is an ordered set of interactions that occurs under certain conditions (precondition), to achieve the primary actor's goal.
- <u>Goal</u> : is defined as the result expected from the execution of the user system interactions
- <u>Actors</u>: they can be a person or another computer system or organization structures that have a role in the scenario
- <u>Item</u>: is a relevant physical element or information that must be available in the scenario

- <u>**Trigger</u>**: is an event that causes the execution of the user-system interaction</u>
- <u>**Precondition**</u>: characterises the condition under which the goal may be achieved.
- <u>Postcondition</u>: indicates what will be the result after the execution of the sequence of interactions.
- <u>Step</u>: corresponds to the interactions between actors (user and system) to achieve the goal of the scenario.

