

Modellbasierte und modellgetriebene Softwaremodernisierung – MMSM2014

Reverse-Modellierung der Traceability Links zwischen Code, Test und Anforderungen

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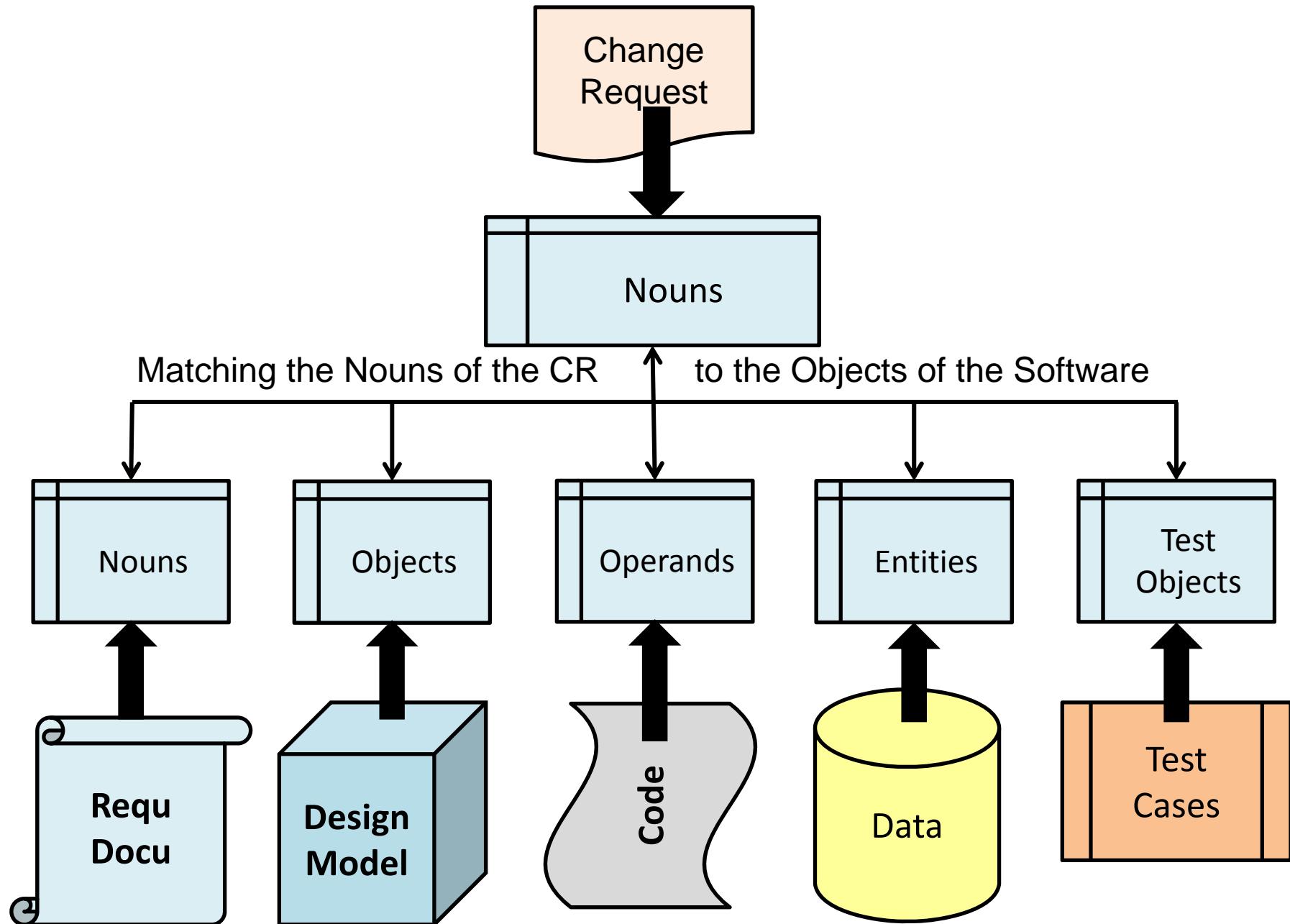
GI Workshop
an der
Universität Wien
19. März 2014

Traceability

zwischen Code, Test und Anforderungen

1. Software = Code + Test + Dokumente
2. Top-Down Verbindungsherstellung
3. Zentrale Rolle der Repository
4. Tracing Change Requests
5. Automatisierte Anforderungsanalyse
6. Automatisierte Testfallanalyse
7. Use Case, Test Case & Code Beziehungstabellen
8. Testfälle als Bindeglied zwischen Code & Anforderungen
9. Beziehungen von Anwendungsfällen zu Daten und Testfällen
10. Aggregierte Beziehungstabellen
11. Konsistenzprüfung
12. Zusammenfassung

Tracing Software Artifacts back to the Requirements



Nouns extracted from Requirement Text, bzw. Change Request

0036 16 NOUN <article_amount>
0037 18 NOUN <article_category>
0038 14 NOUN <article_data>
0039 18 NOUN <article_database>
0040 21 NOUN <article_description>
0041 14 NOUN <article_item>
0042 14 NOUN <article_name>
0043 16 NOUN <article_number>
0044 15 NOUN <article_price>
0045 14 NOUN <article_type>
0046 09 NOUN <article>
0197 07 NOUN <price>
0223 17 NOUN <supplier_number>
0224 17 NOUN <supplier_prices>
0225 10 NOUN <supplier>
0227 15 NOUN <supply_amount>
0228 14 NOUN <supply_clerk>
0229 17 NOUN <supply_deadline>
0230 19 NOUN <supply_order_item>
0231 20 NOUN <supply_order_items>
0232 21 NOUN <supply_order_number>
0233 14 NOUN <supply_order>

Sample change request

CR-11 Credit Check

UC-03: Customer_Order_Processing

BO-02 Customer

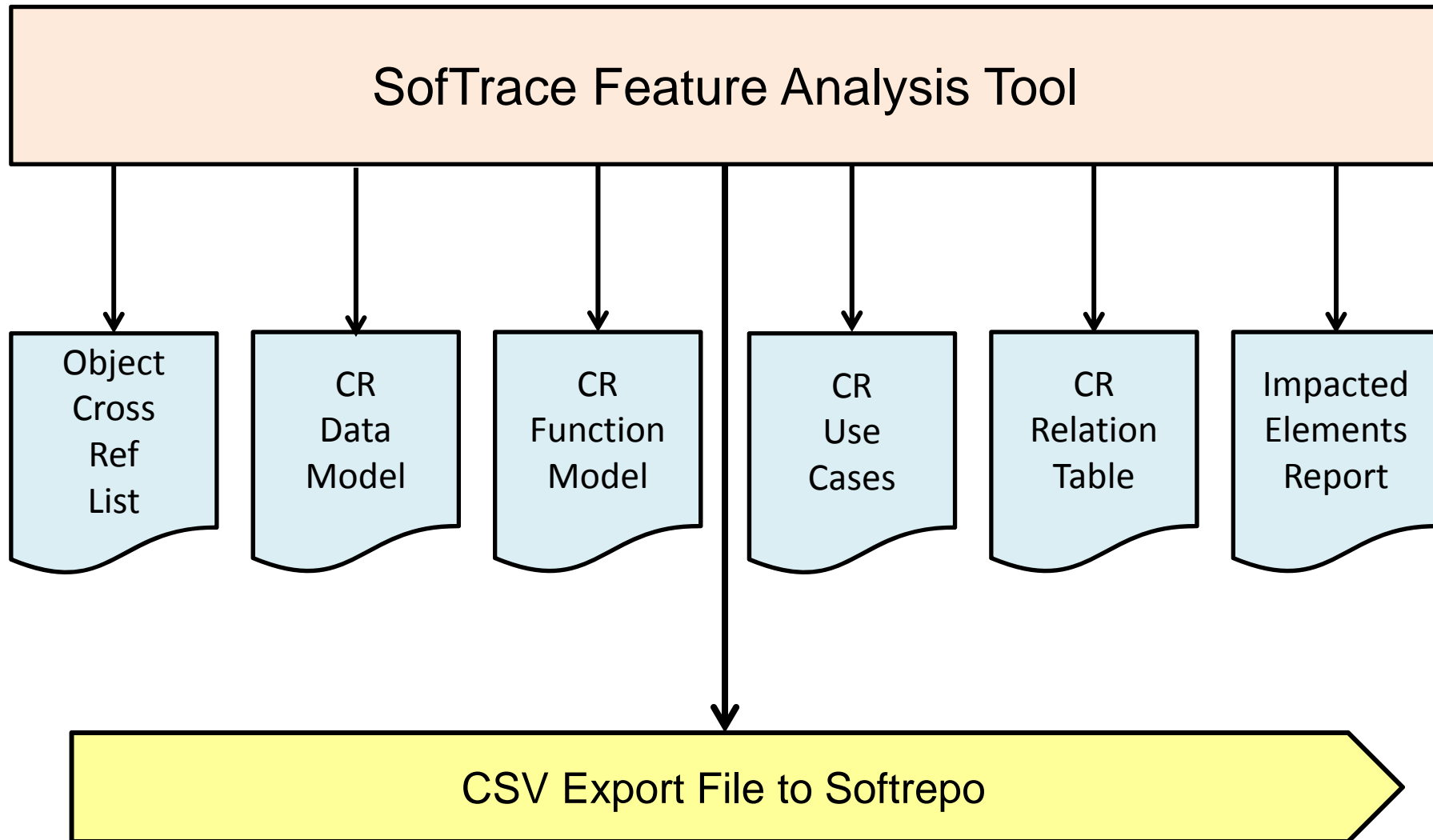
REQ-22: Credibility Checking

The customer credibility should be changed from a numeric to a character data type of the same length. The minimum credit rating should be 4 instead of 3. Customers with credibility less than 4 are not allowed to order articles.

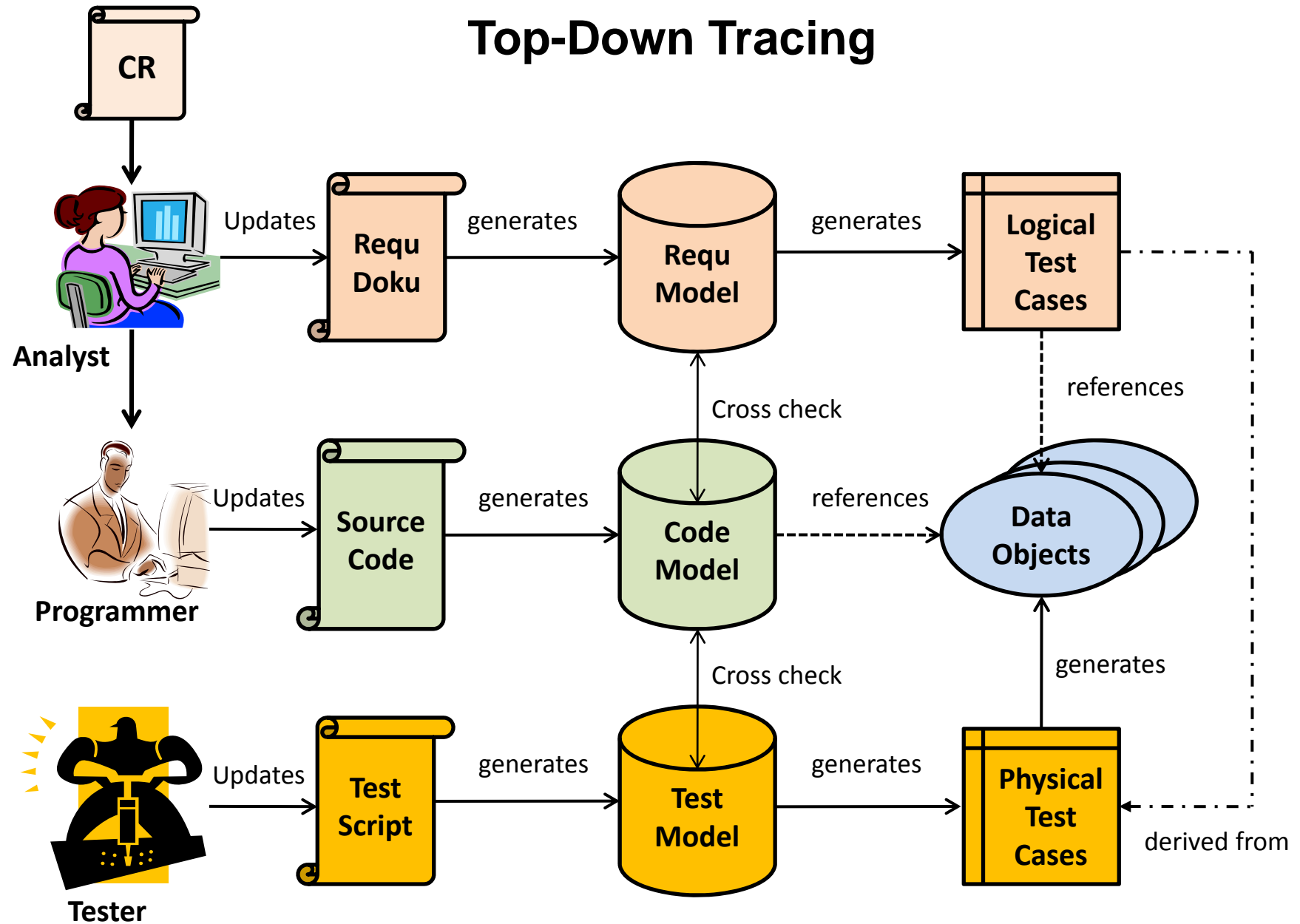
Sample change request CSV-File

<u>Type;Base Entity</u>	<u>;Rel ;Type;Target Entity</u>
PROD;STORE	;OWNS;SYST;ORDERS
SYST;ORDERS	;OWNS;DOCU;CR_11_Credit.txt
DOCU;CR_11_Credit.txt	;ISAT;LIB ;CR_11_Credit.txt
SECT;CR_11_Credit	;USES;DATA;customer_credibility
SECT;CR_11_Credit	;USES;DATA;character_data_type
SECT;CR_11_Credit	;USES;DATA;length
SECT;CR_11_Credit	;EXEC;TEST;ORDERS0001
SECT;CR_11_Credit	;USES;DATA;minimum_credit
SECT;CR_11_Credit	;EXEC;TEST;ORDERS0002
SECT;CR_11_Credit	;USES;DATA;customers
SECT;CR_11_Credit	;USES;DATA;credibility
SECT;CR_11_Credit	;USES;DATA;order
SECT;CR_11_Credit	;USES;DATA;articles

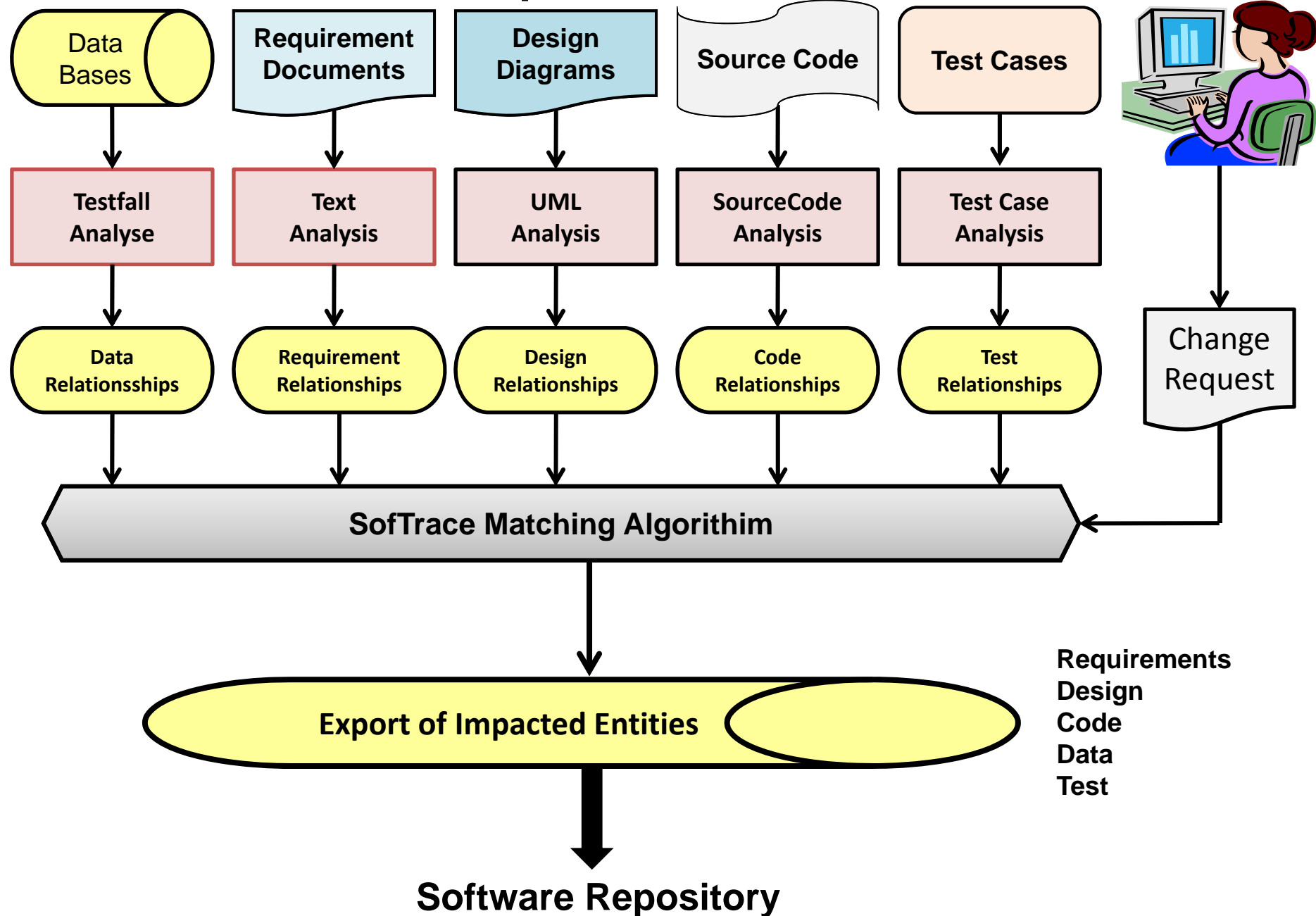
Collecting Information on the Effect of a Change



Top-Down Tracing



Inputs to SofTrace




```

+-----+
|               SOFTTRACE LINKAGE REPORT               |
|  PRODUCT:STORE                                DATE:   31.10.18 |
|  SYSTEM:  ORDERS                             VERSION:1.1   |
+-----+
|  CR:      CR_11_Credit                                PAGE: 1 |
+-----+
| Class      | BackEnd |
| Connecting Change Req't Noun :<ARTICLE_PRICE>
| Connected Source Object Name:PRICE
+-----+
| Class      | getAddress |
| Connecting Change Req't Noun :<ARTICLE>
| Connected Source Object Name:ARTICLE
+-----+
| ArtifactType: System Source Code                                LEVEL:   3 |
+-----+
| Type      | Associated Artifacts and Connecting Nouns |
+-----+
| Function | ARTICLE_PACK_ARTICLE_REC
| Connecting Change Req't Noun :<PRICE>
| Connected Source Object Name:ART_PRICE
+-----+
| Structur | ARTICLE_RECORD
| Connecting Change Req't Noun :<PRICE>
| Connected Source Object Name:ART_PRICE_AUS;9999
+-----+

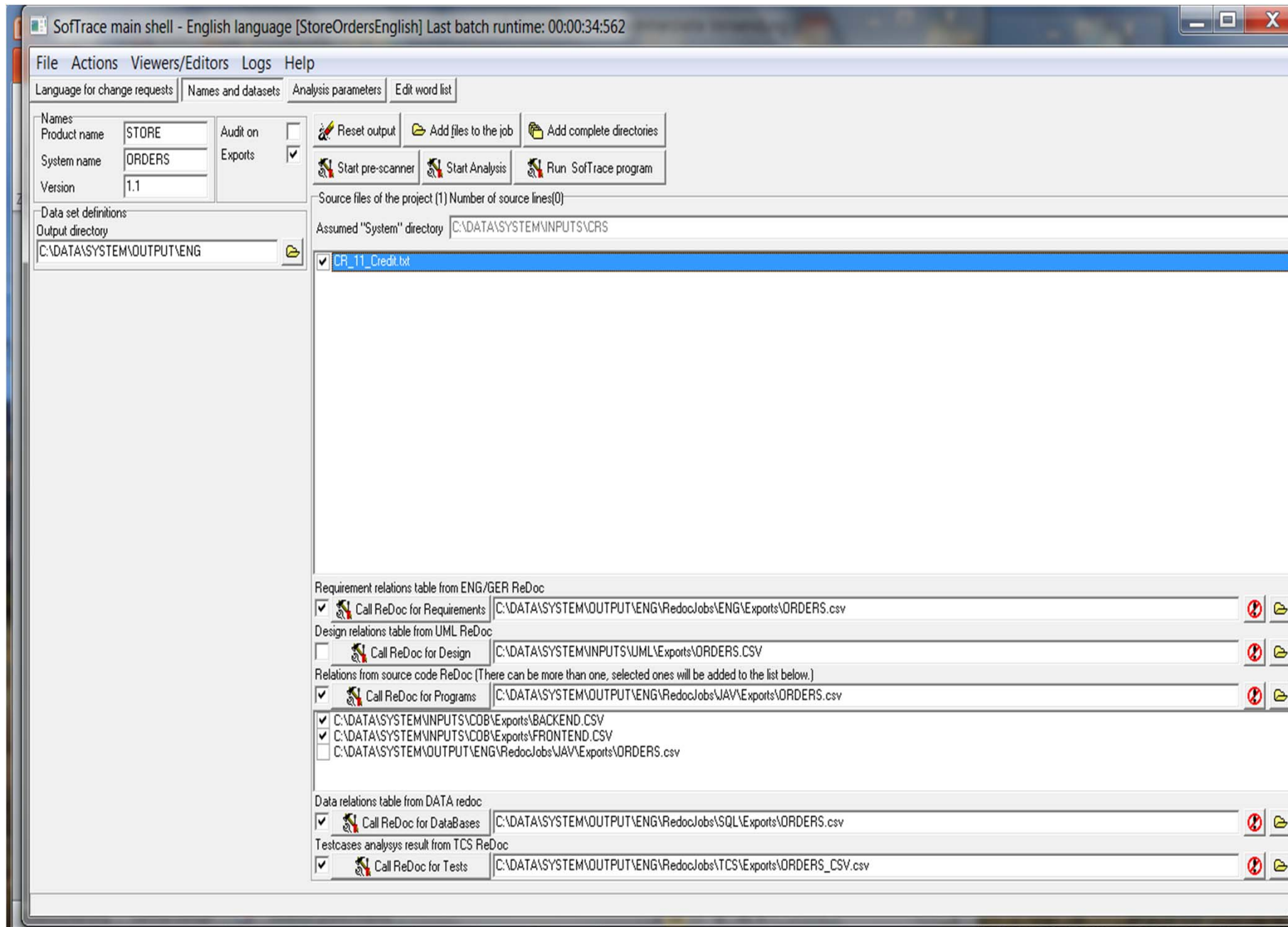
```

Outputs from SofTrace

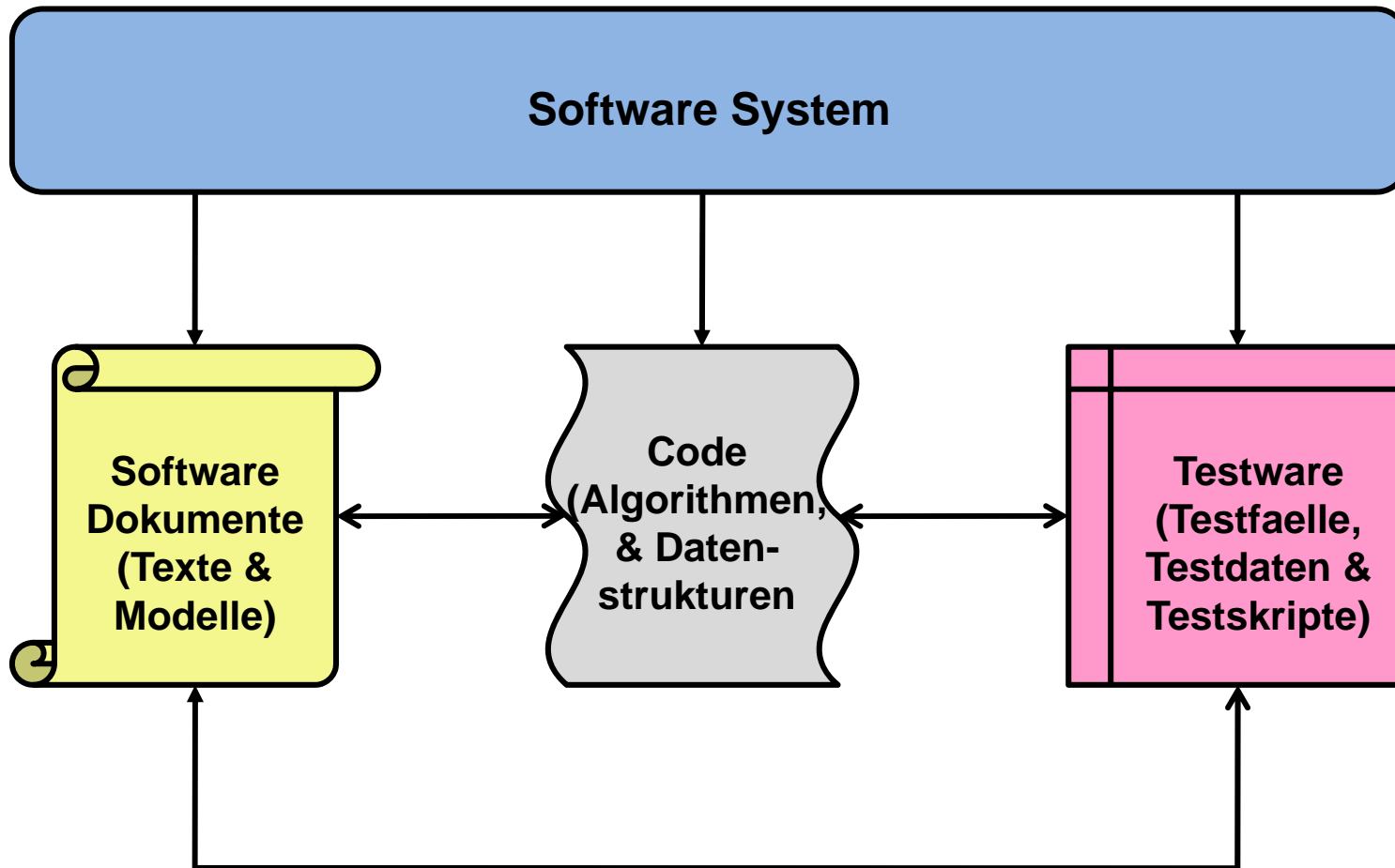
TYPE	BaseEntityName	TargetEntityType	TargetEntityName	CommonEntityNoun	
DSGN	CR_11_Credit	UseCase	Customer_Query	CUSTOMER	
DSGN	CR_11_Credit	UseCase	Dispatching	DISPATCHER	
DSGN	CR_11_Credit	UseCase	Billing	MONTH	
CODE	CR_11_Credit	Interfac	appendRecord	ART_AMOUNT	
CODE	CR_11_Credit	Interfac	AddRec	BACK_ORDER_DATE	
CODE	CR_11_Credit	Interfac	ConnectToDB	DATABASE_NAME	
CODE	CR_11_Credit	Function	main	TEST	
CODE	CR_11_Credit	Function	convertIntToString	SOURCE	
CODE	CR_11_Credit	Interfac	startElement	ATTRIBUTES	
CODE	CR_11_Credit	Class	ALogLine	CURRENT_DATE	
CODE	CR_11_Credit	Function	characters	_ORDER	
DATA	CR_11_Credit	Table	CUSTOMER	CUST_NAME	
DATA	CR_11_Credit	Table	SUPPLIER	NAME	
TEST	CR_11_Credit	TestCase	ORDERS0001	%CUSTOMER	
TEST	CR_11_Credit	TestCase	ORDERS0002	%ARTICLES	
TEST	CR_11_Credit	TestCase	ORDERS0003	%CUSTOMER	
TEST	CR_11_Credit	TestCase	ORDERS0004	%CUSTOMER	
TEST	CR_11_Credit	TestCase	ORDERS0005	%ORDER	
TEST	CR_11_Credit	TestCase	ORDERS0006	%ARTICLE	

Artifacts are linked to Requirements by Common Names

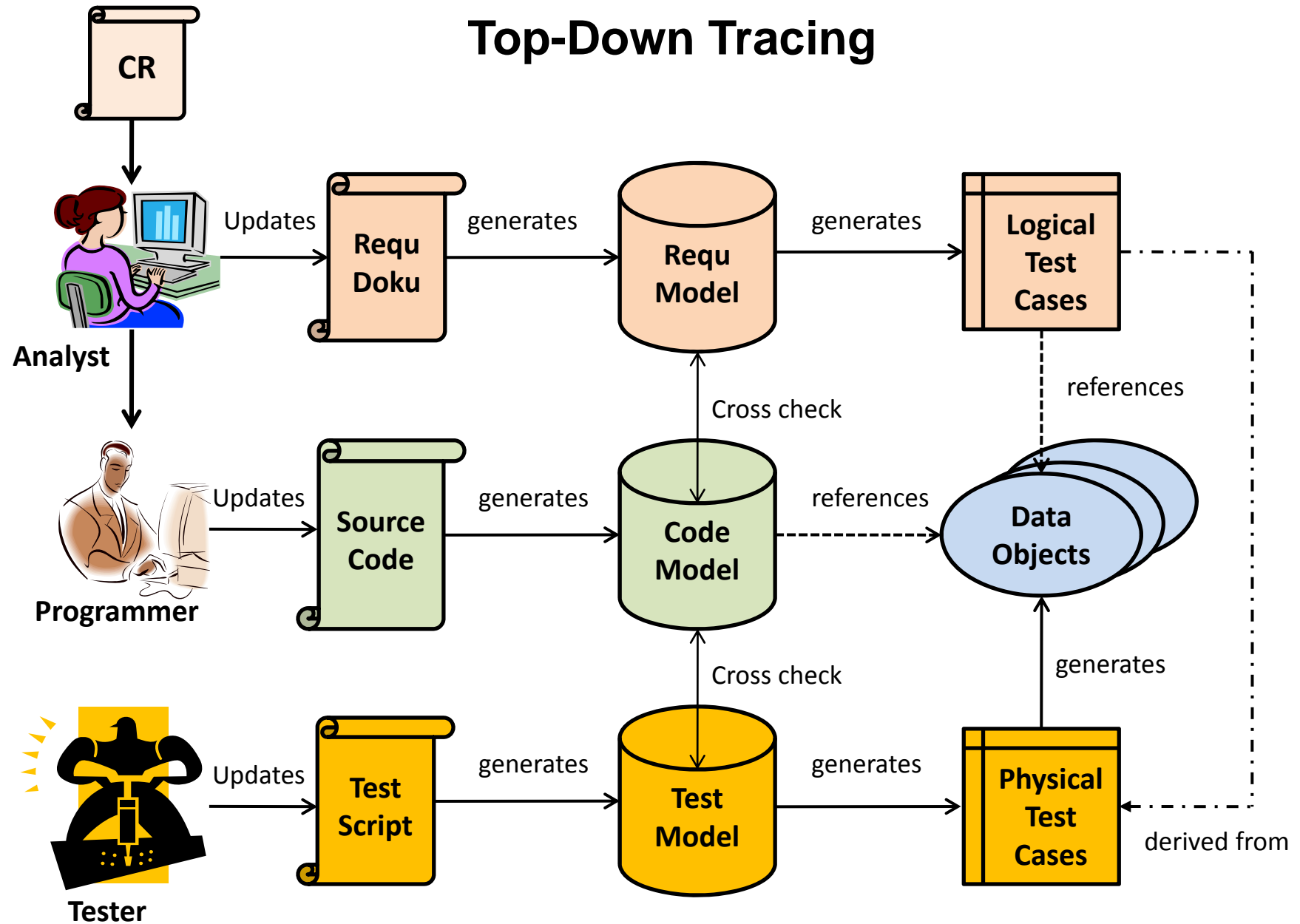
SofTrace User Interface



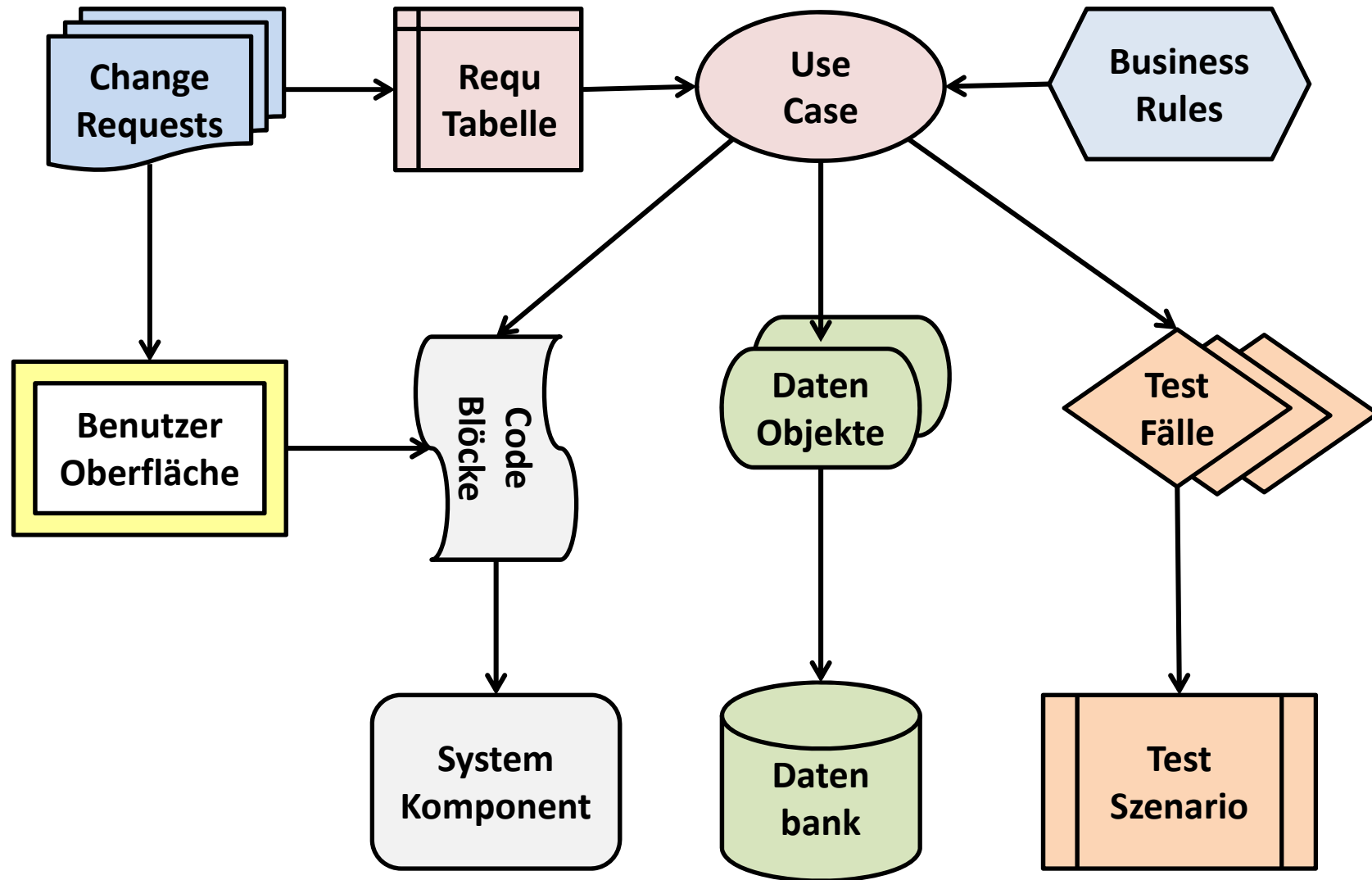
Software = Dokumentation + Code + Test



Top-Down Tracing



Tracing Change Requests



Use Case Relations

Type	Base Entity	Rel	Type	Target Entity
DOCU	ReportBhBelegAction	OWNS	CASE	ReportBhBelegAction
CASE	ReportBhBelegAction	USES	DATA	Zahlungstransaktionen
CASE	ReportBhBelegAction	USES	DATA	Mitglied
CASE	ReportBhBelegAction	EXEC	TEST	TC043
CASE	ReportBhBelegAction	USES	DATA	Mitglied
CASE	ReportBhBelegAction	USES	DATA	Mahnungskosten
CASE	ReportBhBelegAction	USES	DATA	Gerichtskosten
CASE	ReportBhBelegAction	USES	DATA	Exekutionskosten
CASE	ReportBhBelegAction	USES	DATA	Mitglied
CASE	ReportBhBelegAction	EXEC	TEST	TC044
CASE	ReportBhBelegAction	USES	DATA	Fehler
CASE	ReportBhBelegAction	EXEC	TEST	AUSSEND0045
CASE	ReportBhBelegAction	USES	DATA	Liste
CASE	ReportBhBelegAction	USES	DATA	Mitglied
CASE	ReportBhBelegAction	EXEC	TEST	TC046
CASE	ReportBhBelegAction	USES	DATA	Reihe
CASE	ReportBhBelegAction	EXEC	TEST	TC047
CASE	ReportBhBelegAction	USES	DATA	Bewegung
CASE	ReportBhBelegAction	USES	DATA	Zahlungstransaktion
CASE	ReportBhBelegAction	USES	DATA	Bewegungstyp
CASE	ReportBhBelegAction	USES	DATA	Forderungstyp
CASE	ReportBhBelegAction	USES	DATA	Beschlusstyp
CASE	ReportBhBelegAction	EXEC	TEST	TC048
CASE	ReportBhBelegAction	USES	DATA	Bewegungstyp
CASE	ReportBhBelegAction	USES	DATA	Mahnung
CASE	ReportBhBelegAction	USES	DATA	Exekution
CASE	ReportBhBelegAction	USES	DATA	Forderungstyp
CASE	ReportBhBelegAction	EXEC	TEST	TC049
CASE	ReportBhBelegAction	USES	DATA	Forderungstyp
CASE	ReportBhBelegAction	USES	DATA	Vorschreibung
CASE	ReportBhBelegAction	USES	DATA	Gerichtskosten

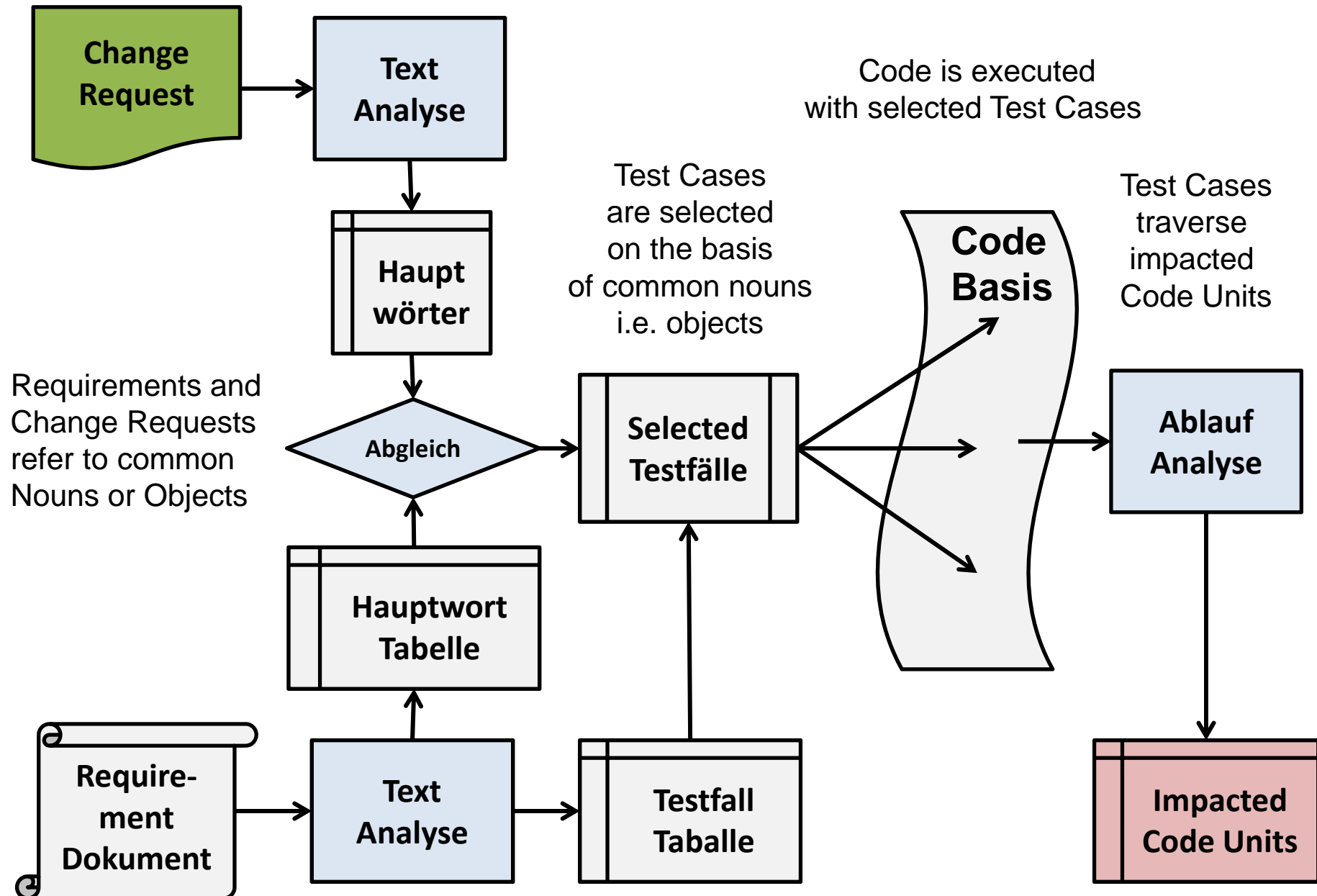
C# Code Relations

Type;Base Entity	;Rel	Type;Target Entity
SRC ;WKOResult.cs	;OWNS;	CLAS; ReportBhBelegAction
CLAS;ReportBhBelegAction	;USES;	CLAS; Action
CLAS;ReportBhBelegAction	;OWNS;	FUNC; ReportBhBelegAction
CLAS;ReportBhBelegAction	;OWNS;	FUNC; base
CLAS;ReportBhBelegAction	;OWNS;	FUNC; performAction
CLAS;ReportBhBelegAction	;OWNS;	FUNC; performActionRequest
FUNC;performActionRequest	;LINK;	PARM; request
DATA;request	;ISOF;	TYPE; request
CLAS;ReportBhBelegAction	;OWNS;	FUNC; getReportBewegung
FUNC;getReportBewegung	;LINK;	PARM; forderungTyp
DATA;forderungTyp	;USES;	TYPE; forderungTyp
CLAS;ReportBhBelegAction	;OWNS;	FUNC; getReportBewegung
FUNC;getReportBewegung	;LINK;	PARM; bewegungTyp
DATA;bewegungTyp	;ISOF;	TYPE; bewegungTyp
FUNC;getReportBewegung	;ASKS;	DATA; forderungTyp
CLAS;ReportBhBelegAction	;OWNS;	FUNC; getGuthabenTyp
CLAS;ReportBhBelegAction	;OWNS;	FUNC; getGuthabenTyp
FUNC;getGuthabenTyp	;LINK;	PARM; bewegungskategorie
DATA;bewegungskategorie	;ISOF;	TYPE; bewegungskategorie
CLAS;ReportBhBelegAction	;OWNS;	FUNC; getMahnExekutionskosten
CLAS;ReportBhBelegAction	;OWNS;	FUNC; getMahnExekution

Test Case Relations

TCNr	Type	Name	TC-Type	PreCondition
"TC082";	"UC";	"ReportBeleg";	"action";	"1)System holt die Gerichtskosten.";
"TC083";	"UC";	"ReportBeleg";	"action";	"2)System holt den Guthabentyp.";
"TC084";	"UC";	"ReportBeleg";	"action";	"3)System sammelt die Mahnkosten.";
"TC085";	"UC";	"ReportBeleg";	"action";	"4)SystemermitteltderBewegungstyp."
"TC089";	"UC";	"ReportBeleg";	"action";	"System findet Mitglied nicht.";
"TC090";	"UC";	"ReportBeleg";	"action";	"System merkt sich das Bundesland";
"TC091";	"UC";	"ReportBeleg";	"rule";	"Hat das Mitglied nicht gezahlt";
"TC092";	"UC";	"ReportBeleg";	"rule";	"Sonst wird einen Fehler gemeldet.";
"TC093";	"UC";	"ReportBeleg";	"rule";	"Wenn die Nachricht ok ist, wird ...";
"TC094";	"UC";	"ReportBeleg";	"rule";	"Falls der Typ eine Mahnung ist";
"TC094";	"UC";	"ReportBeleg";	"rule";	"Falls der Typ eine Exekution ist";
"TC095";	"UC";	"ReportBeleg";	"rule";	"Wenn der Typ eine Verschreibung ist";
"TC096";	"UC";	"ReportBeleg";	"rule";	"Nur berechnigte Bearbeiter duerfen";
"TC097";	"UC";	"ReportBeleg";	"rule";	"Wenn kein RequestMessage vorliegt";
"TC098";	"UC";	"ReportBeleg";	"rule";	"Wenn die Nachricht ok ist";
"TC099";	"UC";	"ReportBeleg";	"state";	"Sachbearbeiter muss berechnigt sein.";
"TC100";	"UC";	"ReportBeleg";	"state";	"Mitglied muss vorhanden sein.";

Test Cases as a Link between Requirements and Code



Requirement to Test Case Relations

TESTPROC: ORDERTEST-TEST		DATE: 29.12.13
SYSTEM: ORDERS		PAGE: 1
Requirement Name	in Document Section	TestCase Name
FUNC-REQ-01 ArticleDisplay	OrderEntry	ORDERS0001
FUNC-REQ-01 ArticleDisplay	OrderEntry	ORDERS0002
FUNC-REQ-02 OrderProcessing	OrderEntry	ORDERS0003
FUNC-REQ-02 OrderProcessing	OrderEntry	ORDERS0004
FUNC-REQ-02 OrderProcessing	OrderEntry	ORDERS0005
FUNC-REQ-02 OrderProcessing	OrderEntry	ORDERS0006
FUNC-REQ-02 OrderProcessing	OrderEntry	ORDERS0007
FUNC-REQ-02 OrderProcessing	OrderEntry	ORDERS0008
FUNC-REQ-02 OrderProcessing	OrderEntry	ORDERS0009
FUNC-REQ-03 Dispatching	OrderEntry	ORDERS0010
FUNC-REQ-03 Dispatching	OrderEntry	ORDERS0011
FUNC-REQ-04 Billing	OrderEntry	ORDERS0012
FUNC-REQ-04 Billing	OrderEntry	ORDERS0013
FUNC-REQ-04 Billing	OrderEntry	ORDERS0014
FUNC-REQ-04 Billing	OrderEntry	ORDERS0015
FUNC-REQ-05 Resupplying	OrderEntry	ORDERS0016
FUNC-REQ-05 Resupplying	OrderEntry	ORDERS0017
FUNC-REQ-05 Resupplying	OrderEntry	ORDERS0018
FUNC-REQ-06 BackOrderProcessing	OrderEntry	ORDERS0021
FUNC-REQ-06 BackOrderProcessing	OrderEntry	ORDERS0022
NF-REQ-01 ReponseTime	OrderEntry	Testcase is missing!
NF-REQ-02 TransactionCapacity	OrderEntry	ORDERS0027
NF-REQ-04 security	OrderEntry	ORDERS0029
NF-REQ-04 security	OrderEntry	ORDERS0030
NF-REQ-04 security	OrderEntry	ORDERS0031

Use Case to Test Case Relations

TESTPROC: ORDERTEST-TEST		DATE: 29.12.13
SYSTEM: ORDERS		PAGE: 1
Use Case Name	in Document Section	TestCase Name
Customer_Query	OrderEntry	ORDERS0065
Customer_Query	OrderEntry	ORDERS0066
Customer_Query	OrderEntry	ORDERS0067
Customer_Query	OrderEntry	ORDERS0068
Customer_Query	OrderEntry	ORDERS0069
Customer_Query	OrderEntry	ORDERS0070
Customer_Order_Processing	OrderEntry	ORDERS0071
Customer_Order_Processing	OrderEntry	ORDERS0072
Customer_Order_Processing	OrderEntry	ORDERS0073
Customer_Order_Processing	OrderEntry	ORDERS0074
Customer_Order_Processing	OrderEntry	ORDERS0075
Customer_Order_Processing	OrderEntry	ORDERS0076
Customer_Order_Processing	OrderEntry	ORDERS0077
Customer_Order_Processing	OrderEntry	ORDERS0078
Customer_Order_Processing	OrderEntry	ORDERS0079
Customer_Order_Processing	OrderEntry	ORDERS0080
Customer_Order_Processing	OrderEntry	ORDERS0081
Customer_Order_Processing	OrderEntry	ORDERS0082
Customer_Order_Processing	OrderEntry	ORDERS0083
Customer_Order_Processing	OrderEntry	ORDERS0084
Customer_Order_Processing	OrderEntry	ORDERS0085
Customer_Order_Processing	OrderEntry	ORDERS0086
Customer_Order_Processing	OrderEntry	ORDERS0087
Customer_Order_Processing	OrderEntry	ORDERS0088
Dispatching	OrderEntry	ORDERS0113
Dispatching	OrderEntry	ORDERS0114
Dispatching	OrderEntry	ORDERS0115
Dispatching	OrderEntry	ORDERS0116
Dispatching	OrderEntry	ORDERS0117
Dispatching	OrderEntry	ORDERS0118
Dispatching	OrderEntry	ORDERS0119

Test Case to Requirement Relations

TESTPROC: ORDERTEST-TEST		DATE: 29.12.13	
SYSTEM: ORDERS		PAGE: 1	
Test Case	tests	Requirement/UseCase	Logical Object
ORDERS0001		FUNC-REQ-01_ARTICLEDISPLAY	%PRICES
ORDERS0002			%ARTICLES
ORDERS0002			%CATEGORY
ORDERS0002		FUNC-REQ-01_ARTICLEDISPLAY	%CATEGORY
ORDERS0003			%CUSTOMER
ORDERS0003			NUMBER
ORDERS0003		FUNC-REQ-02_ORDERPROCESSING	NUMBER
ORDERS0004			%CUSTOMER
ORDERS0004			%ARTICLES
ORDERS0004		FUNC-REQ-02_ORDERPROCESSING	%ARTICLES
ORDERS0005			%ORDER
ORDERS0005			%ITEMS
ORDERS0005			%TIME
ORDERS0005		FUNC-REQ-02_ORDERPROCESSING	%TIME
ORDERS0006			%ARTICLE
ORDERS0006			%STOCK
ORDERS0006			%ORDER
ORDERS0006		FUNC-REQ-02_ORDERPROCESSING	%ORDER
ORDERS0007			%ARTICLE
ORDERS0007			%STOCK
ORDERS0007			%ORDER
ORDERS0007		FUNC-REQ-02_ORDERPROCESSING	%ORDER
ORDERS0008			%STOCK
ORDERS0008			%ORDER
ORDERS0010		FUNC-REQ-03_DISPACHING	OFFICE
ORDERS0011			%ITEM
ORDERS0011			%CUSTOMER
ORDERS0011			%DAY
ORDERS0011		FUNC-REQ-03_DISPACHING	%DAY
ORDERS0012			%INVOICE
ORDERS0012			%ITEMS
ORDERS0012			%PRICES
ORDERS0012			%SUM

Consistency Checking

Consistency Checking

+-----+-----+			
S Y S T E M C O N S I S T E N C Y M E T R I C R E P O R T			
LANGUAGE: GERMAN/UML/C++/TCS		DATE: 22.06.13	
SYSTEM: LAGERHALTUNG		PAGE: 3 of 19	
+-----+-----+			
E N T I T Y C O U N T S			
+-----+-----+			
Number of System TestCases		=====>	356
Number of Requirements to be tested		=====>	151
Number of Requirements with TestCases		=====>	124
Number of Code Components to be tested		=====>	229
Number of Code Components with TestCases		=====>	80
+-----+-----+			
R E L A T I O N C O U N T S			
+-----+-----+			
Number of TestCase/Requirement Relations		=====>	699
Number of TestCase/Component Relations		=====>	10086
+-----+-----+			
D E F I C I E N C Y C O U N T S			
+-----+-----+			
Number of Requirements with no TestCase		=====>	27
Number of Code Components with no TestCase		=====>	149
+-----+-----+			
C O V E R A G E M E T R I C S			
+-----+-----+			
Requirement	Test Coverage Rate	=====>	0.821
Code Component	Test Coverage Rate	=====>	0.349
+-----+-----+			

Conclusions

- Quality beings with the Consistency of the Architecture
- Software artifacts like Requirements, Use Cases, Design models, Code Units and Test Cases should be related to one another.
- The relations are captured through the static analysis of the code, the models and the documents.
- The system entities and their relationships should be stored and maintained in a relational Repository
- The goal is traceabilty from top to bottom as well as from bottom to top.