A Study on an Approach for Analysing Test Basis Using I/O Test Data Patterns

13th Apr. 2015

InSTA 2015 Graz, Austria

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Agenda

1. INTRODUCTION

2. ISSUES OF TEST ANALYSIS IN BLACK BOX TESTING AND OVERVIEW OF THE TEST ANALYSIS METHOD

3. AN APPROACH TO DETERMINE SPEC-ITEM BY I/O TEST DATA PATTERNS

4. AN EXPERTIMENT OF TEST ANALYSIS USING I/O TEST DATA PATTARNS

5. CONCLUSION

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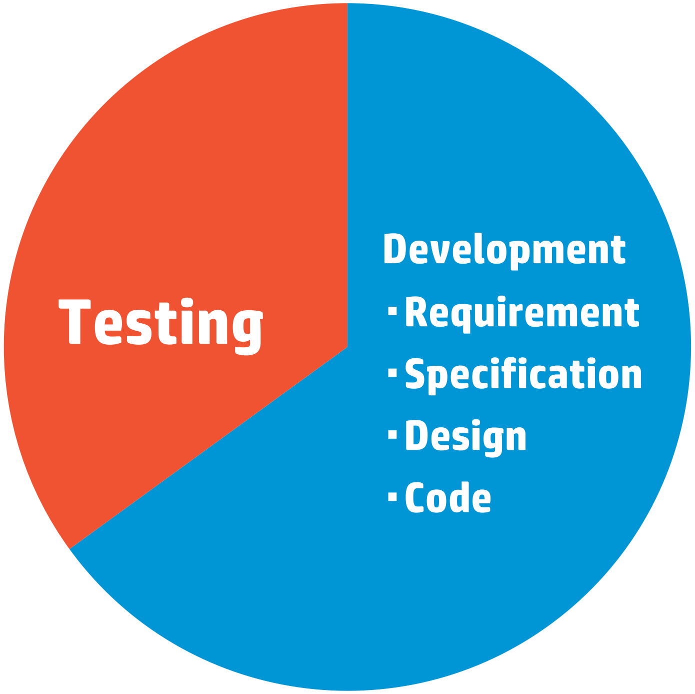
1. Introduction

Software testing in software development occupy 28% to 35% of the total software development effort in Japan.

There are some cases that testing occupy more than 90%



Software testing is a key activity to ensure adequate balance among Q,C,and D.

[1] IPA, White paper on software development data in 2014-2015: METI; 2014 (In Japanese).

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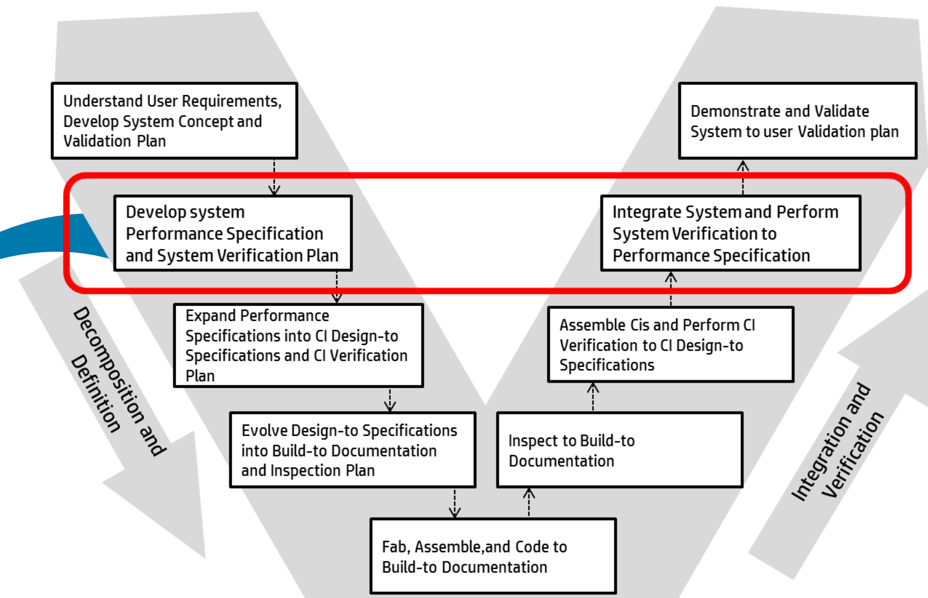
2.1. Issues of Test Analysis in Black Box Testing

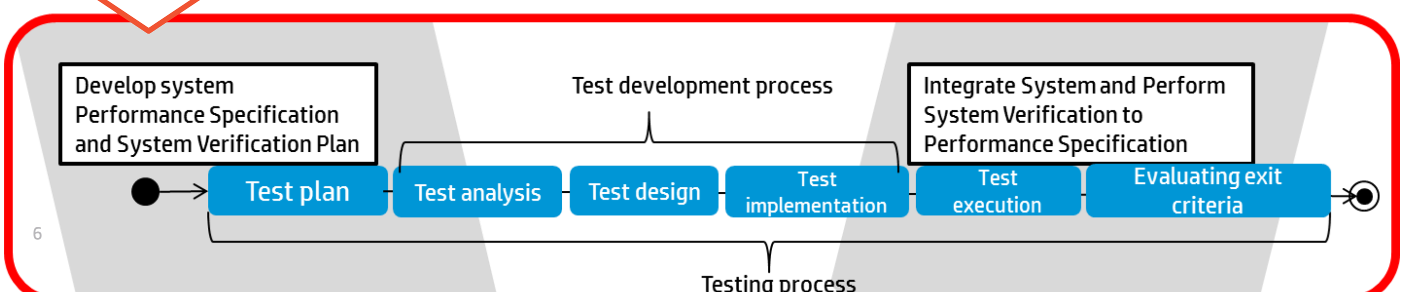
Development Lifecycle and Test Process

- Software testing is performed in multiple verification levels during the development life-cycle. These verification levels are depicted in the V model.
- This proposal is focused on the black box testing performed at the system-level verification, enclosed in a red frame.



V model (Forsberg,1995 et.al)

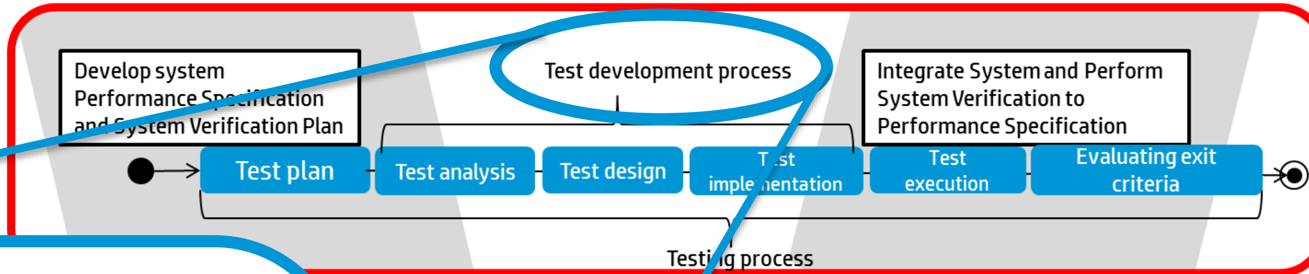
Testing performed at each level depicted in the V model has a process similar to the development process.



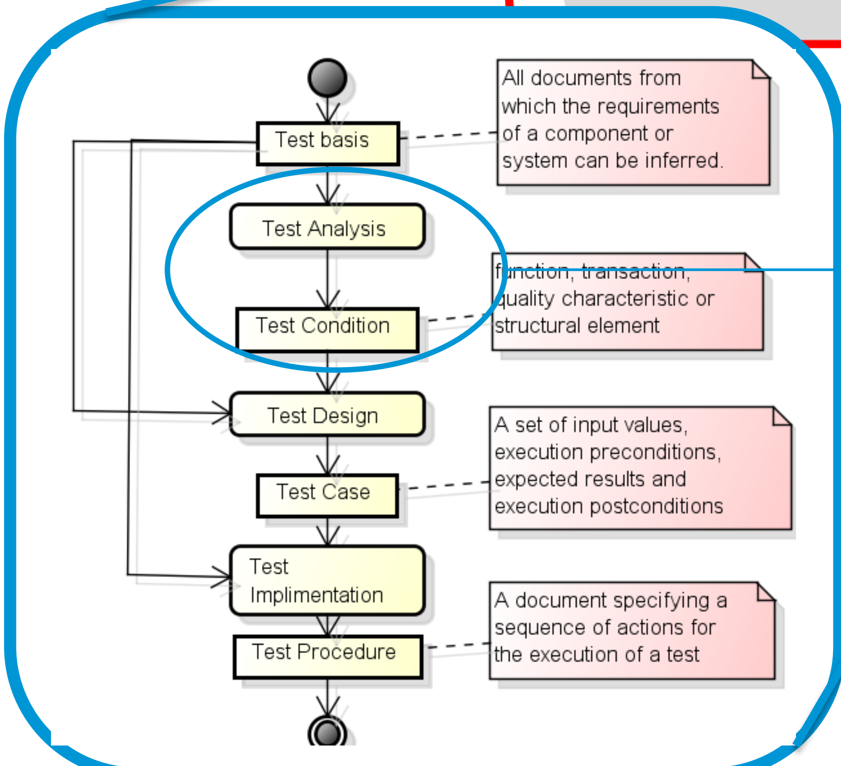
2.1.Issues of Test Analysis in Black Box Testing(Cont.)

Test development process and Test analysis

- Three activities, test analysis, test design, and test implementation in the test process are also called <u>Test development process</u>.



A part of V-model



<u>Test analysis</u>

An activity of selecting and organising items to be covered by the test .

2.1.Issues of Test Analysis in Black Box Testing(Cont.)

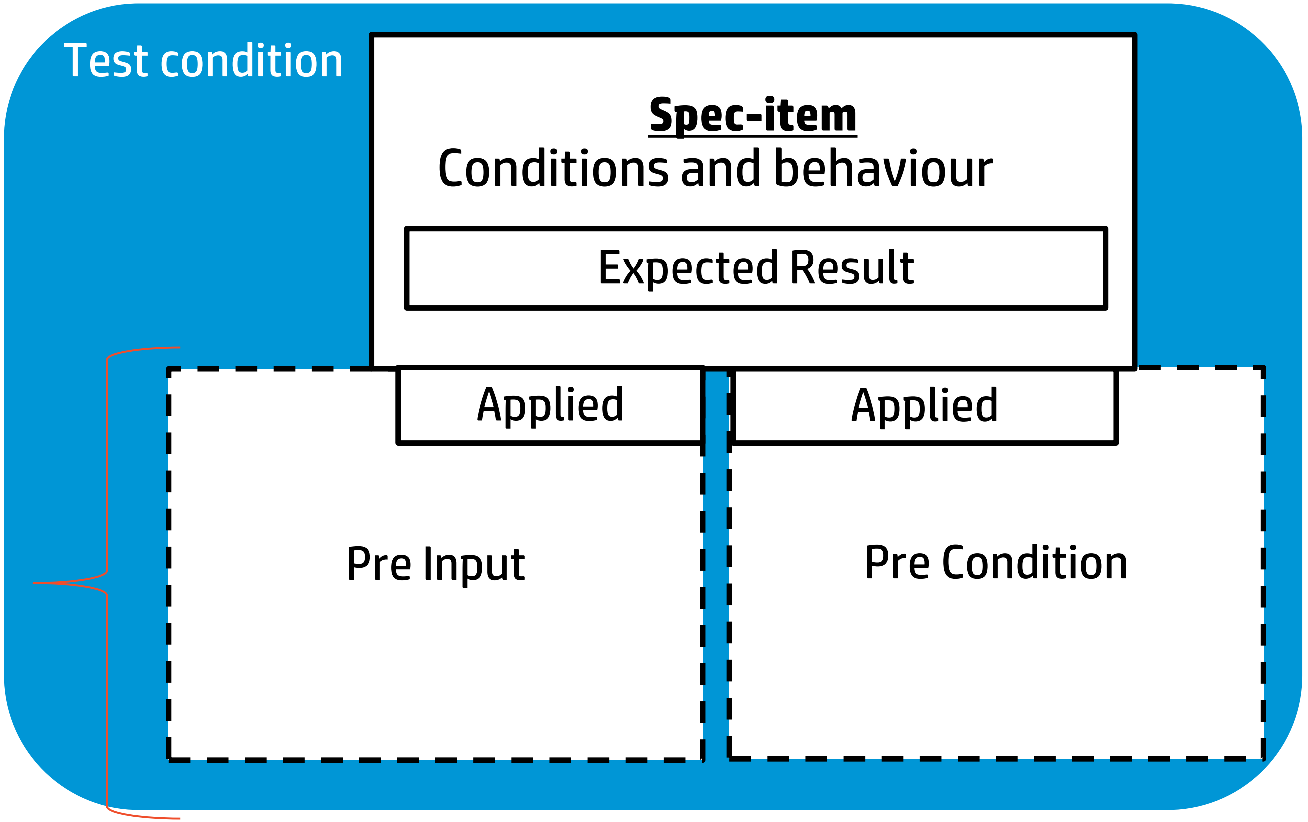
"Test condition" is the output of test analysis.

- **Test cases are derived based on test conditions.**

Many items can be said "Test condition" .

- **Deriving test cases for black box testing, pre-conditions and pre-inputs to execute AUT are selected and combined based on specification-items (spec-items) .**

Test design technique can be applied to design appropriate these combination.



2.1. Issues of Test Analysis in Black Box Testing(Cont.)

Issues of Test Analysis in Black Box testing

- The test condition, which is an output of test analysis, is a generic term for elements such as functions, transactions, quality characteristics, and structure elements.
- Therefore it is necessary to structure in order to sort out relationships between each element. That is also called test suite architecture.
- However, in research and practice, structuring of test conditions in the test analysis stays just experiences and heuristics.

Table 1. Examples of typical test analysis

Level1	Level2	Level3	Level4	Level5	Test conditions
Print	Setting	Copies	-	-	In case of printing 100 copies.
Setting	Print properties	General	Anomaly conditions	Error massage	Massage "print copies are over 99" is appeared.

Examples of Table 1 contain the following issues.

- The category "Setting" appears both in Level 1 and Level 2.
- The number of levels is not constant, thus there is a variance in meaning of each level.
- The expected result is not indicated in the upper row.
- The same specification is written on both upper and lower rows.

2.2. An Approach of Test Category based Test analysis

A set of rules for a test analysis method for black box testing utilising Test-Categories based on the Application Under Test (AUT) and fault knowledge have been proposed.

Overview of the method

The logical structure of a feature

Test –Category

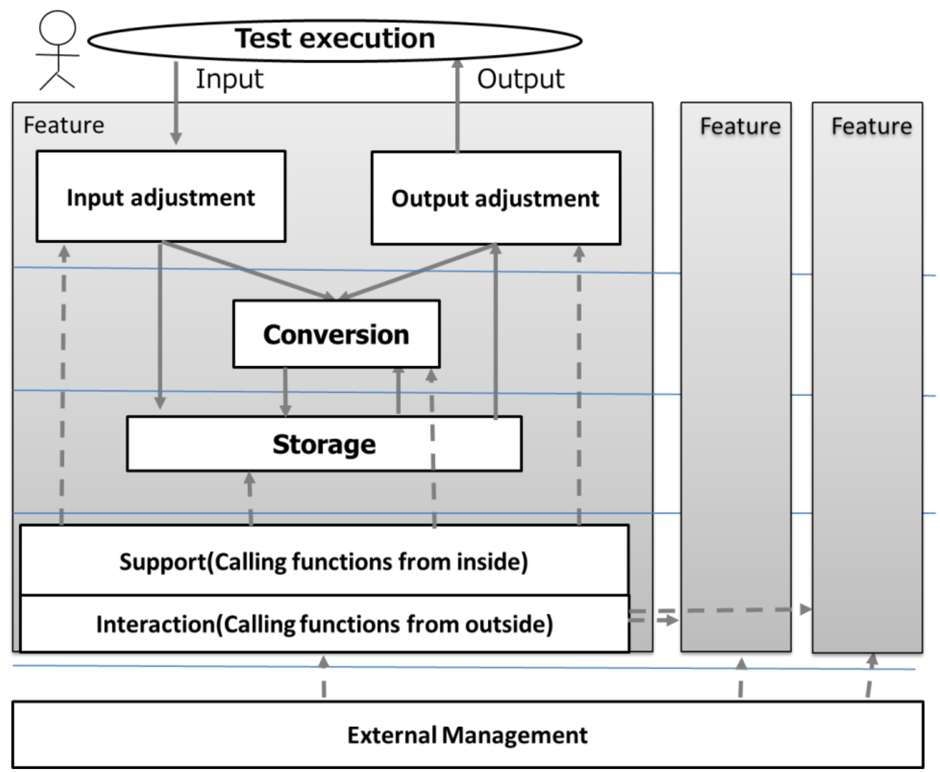
The procedure and document format

2.2.1. The logical structure of a feature

- **AUT is organaised to a feature list**
  - **In order to use the logical structure of a feature as a guide, specification of AUT is organaised to a feature list.**

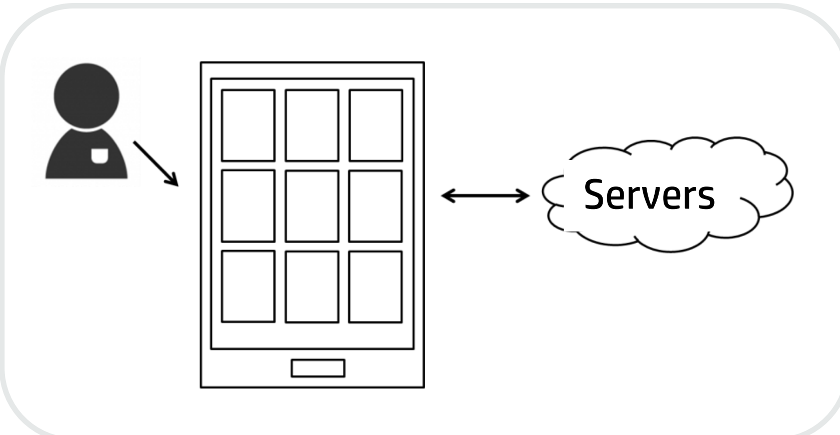
- **Internal structure of AUT is inferred using this reference model.**

- **It can be used to test the feature in a MECE way . Each box in the logical structure can be a useful guide to determine the required test conditions.**



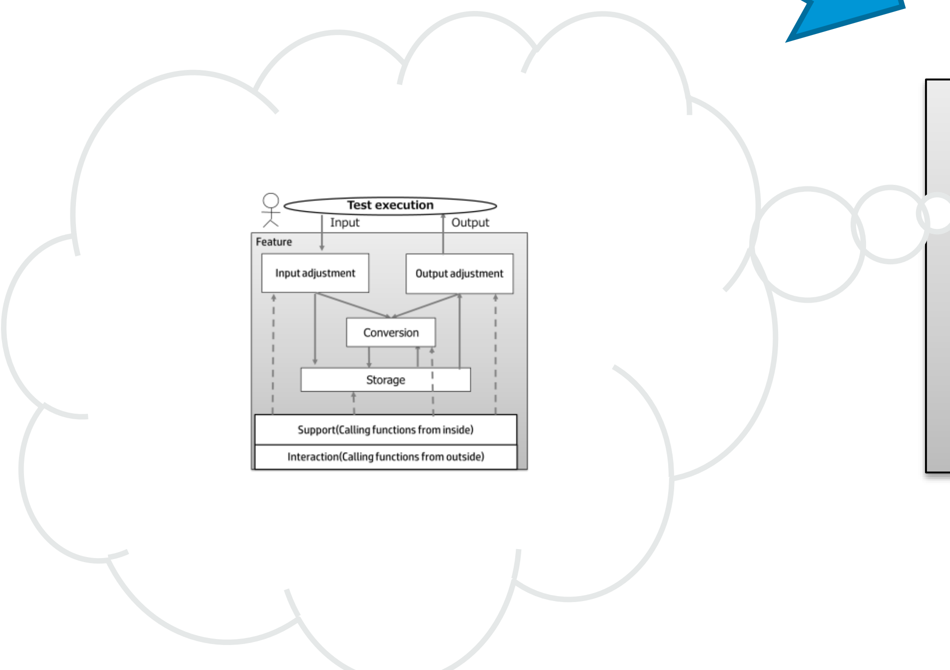
2.2.1. The logical structure of a feature

AUT

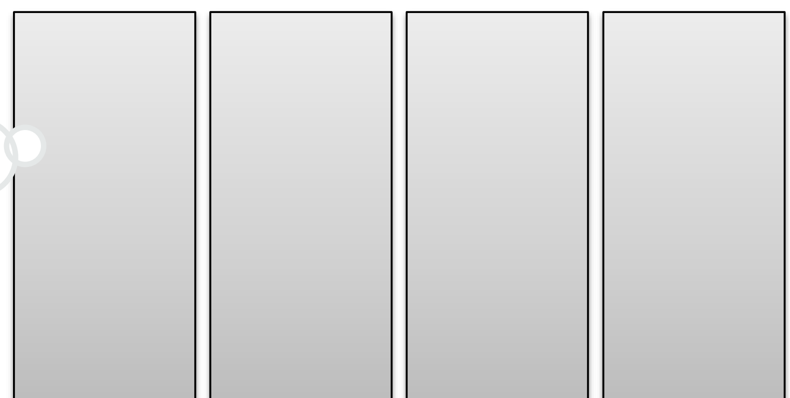


- A set of Specifications of AUT is organaised to a feature list

  In order to use the logical structure of a feature as a guide, specification of AUT is organaised to a feature list.



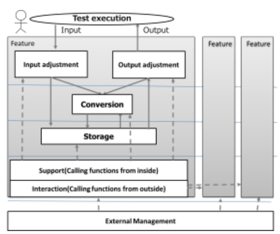
Feature List



2.2.2. Test-Category

Test-Category

- **In order to have a consistent interpretation of determining test conditions, a name specialised for the AUT is put in each box of the logical structure.**
- **In order to ensure for clearly understanding the meaning of Test-Category , potential failures and/or faults which may arise for Test-Category are discussed.**



Knowledge of AUT

Knowledge of faults experienced in the past

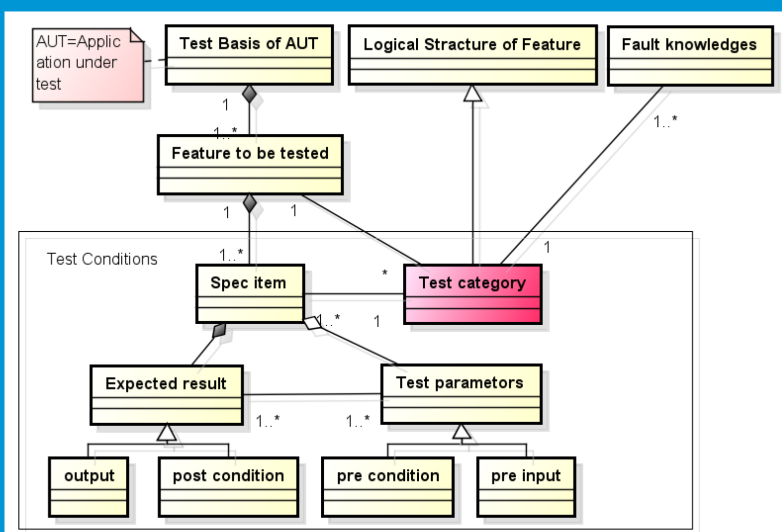
Logical Structure	Test categories	Meaning (fault assumed)
Input adjustment	UI input	Validation rules to the input form. Screen control
	Operation	Rules of screen transition, Start process
Output adjustment	UI display	Results displayed, Output control
	Printing	Printed information, Format
Conversion	Execution conditions	Business rules
	Calculation	Fee calculation
Storage	Data search	Filter combinations, Search results
	Data Insert/Update/Delete	Data handling
Management	Reflection	Data handling reflected on other functions
Support	Error handling	Error message, Recovery operations

Building consensus on the decided Test-Categories

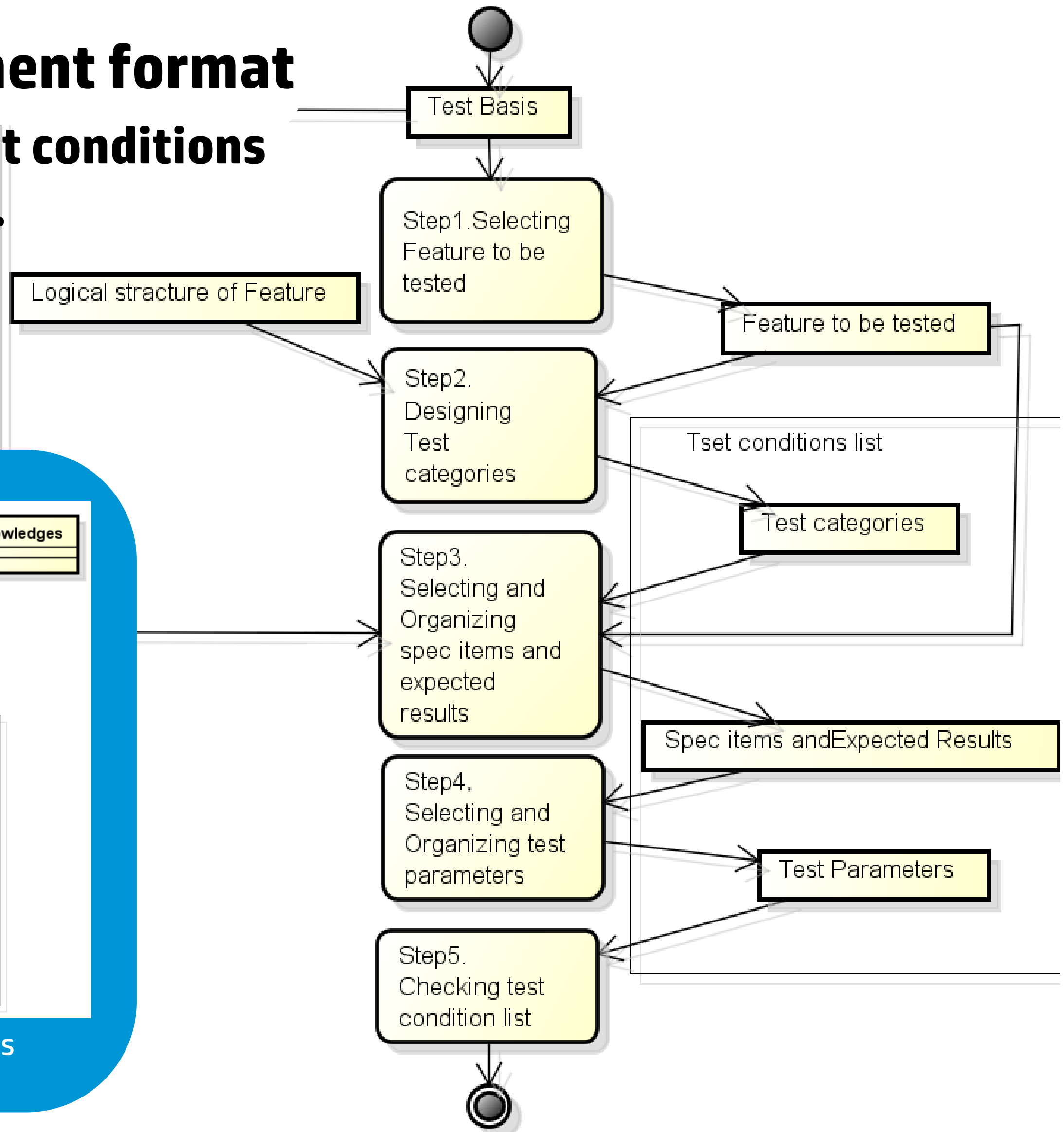
2.2.3. The procedure and document format

The procedure and document format

- **Things used to determine test conditions from a test basis are defined.**



The outputs are eliminated by layering elements based on the test case structure.



2.2.4. The Main benefit of this method

The Main benefit of this method

- **Higher test coverage overall, delivering higher quality testing**
  - **By implementing the set of rules it will be easier to determine the necessary test conditions.**

Our hypothesis

The following issues currently make determining the necessary test conditions difficult:

1. Certain aspects of specification are not written if they are thought to be obvious.
2. Specification is not completely written within single target section in a document. (for example: a behavior about a combination of functions)

  - **When many testers are involved in test development and proceed according to the procedure and document format, all of the testers can carry out their work according to the same set of rules.**

The developed suite of test conditions are more comprehensive and do not contain duplicates

2.2.5. Experiments to confirm efficiency of the method

Two types of experiments have been performed

1. **comparing quantity of spec-item determined by test analysis between a groups introduced the method and a group not introduced the method [4].**
2. **Other experiment is that comparing quantity of spec-item determined by test analysis between before acquisition the method and after acquisition the method in one group [5]**

- **In both previous studies, in order to be introduced this method, it has been confirmed that particular spec-item's determination for deriving test cases can be done with less omission.**

However, the method that has been proposed in previous studies haven't been defined analysis steps exactly.

In this study, a set of I/O data in test execution is focused on as a comprehensive AUT model to be clear analysis steps.

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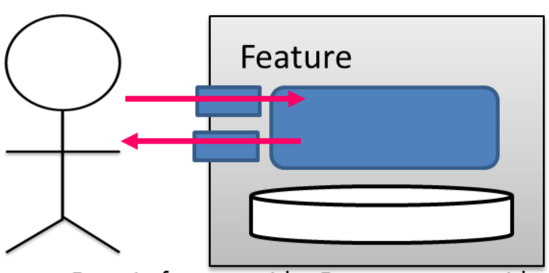
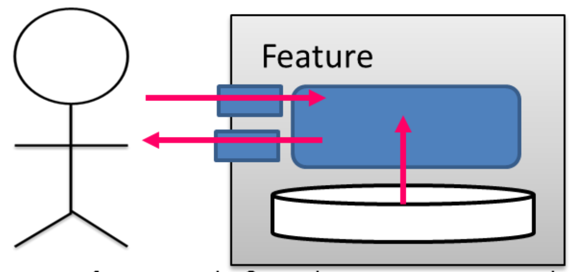
3. AN Approach to Determine Spec-items by I/O test data patterns

Patterns of I/O data for test execution

In order to make sure of covering AUT enough in test analysis, a set of patterns of inputting and outputting data into/from the AUT (I/O data patterns) is focused as a comprehensive AUT model. This set of patterns is added to the test-category method to achieve analysing test basis can be more comprehensive.

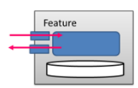
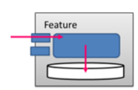
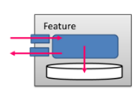
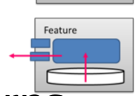


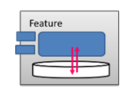
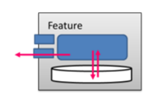
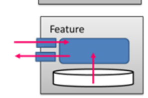
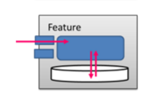
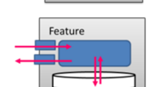
Data-in from outside. Data-out to outside.



Data-in from outside & inside. Data-out to outside.

The total combined patterns of inputting and outputting data into/from the AUT can be summarised into the nine patterns

		Input	Output
	P1	Outside	Outside
	P2	Outside	Inside
	P3	Outside	Outside Inside
	P4	Inside	Outside

		Input	Output
	P5	Inside	Inside
	P6	Inside	Outside Inside
	P7	Outside Inside	Outside
	P8	Outside Inside	Inside
	P9	Outside Inside	Outside Inside

3.1. I/O data patterns and Logical structure of a feature

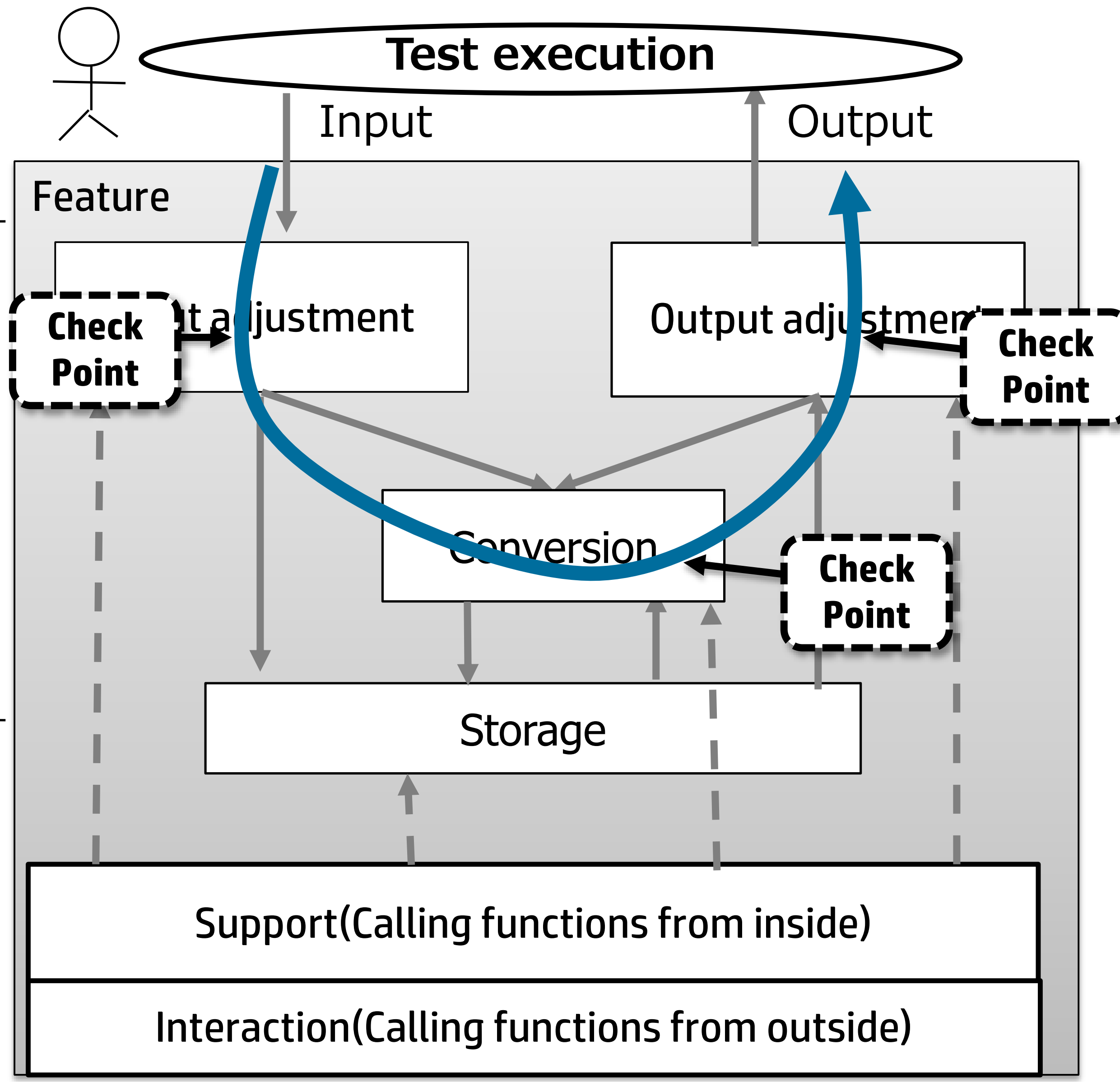
Each pattern of I/O test data patterns is confirmed which aspect of logical structure of a feature can correspond to logically. Confirming result is described in the Table below.

		Input Adjustment	Output Adjustment	Conversion	Storage	Support	Interaction
Input	Outside	P1, P2, P3		P1, P2, P3			
	Inside			P4, P5, P6	P4, P5, P6		
	Outside Inside	P7, P8, P9		P7, P8, P9	P7, P8, P9		
Output	Outside		P1, P4, P7				
	Inside				P2, P5, P8		
	Outside Inside		P3, P6, P9		P3, P6, P9		

3.1. I/O data patterns and Logical structure of a feature

In a case of
P1 data pattern

It can be analysed by I/O data patterns in test execution



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	Inside			P4, P5, P6	P4, P5, P6		
	Outside Inside	P7, P8, P9		P7, P8, P9	P7, P8, P9		
Output	Outside		P1, P4, P7				
	Inside				P2, P5, P8		
	Outside Inside		P3, P6, P9		P3, P6, P9		

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Output	Outside		P1, P4, P7				
	Inside				P2, P5, P8		
	Outside Inside		P3, P6, P9		P3, P6, P9		

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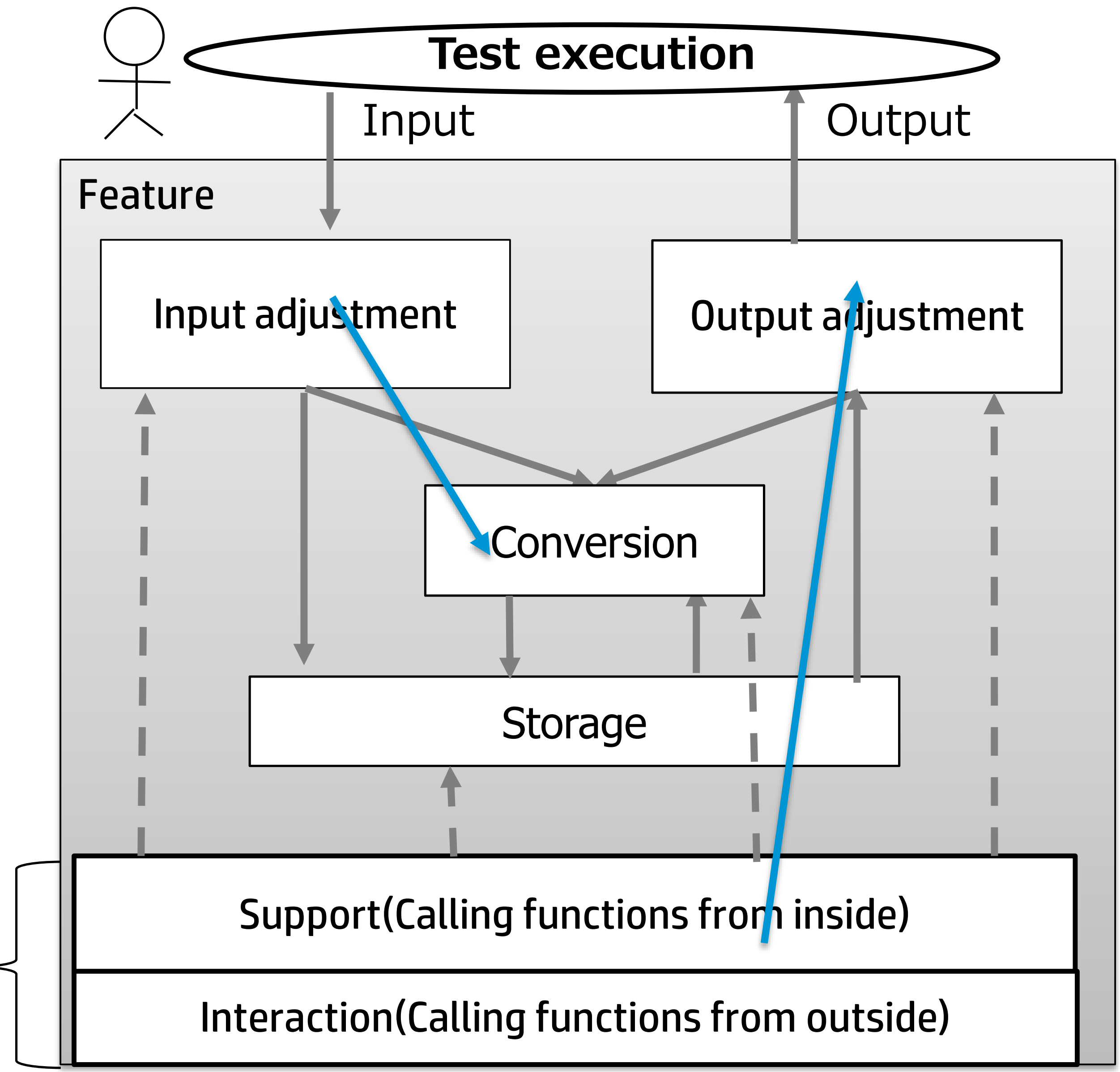
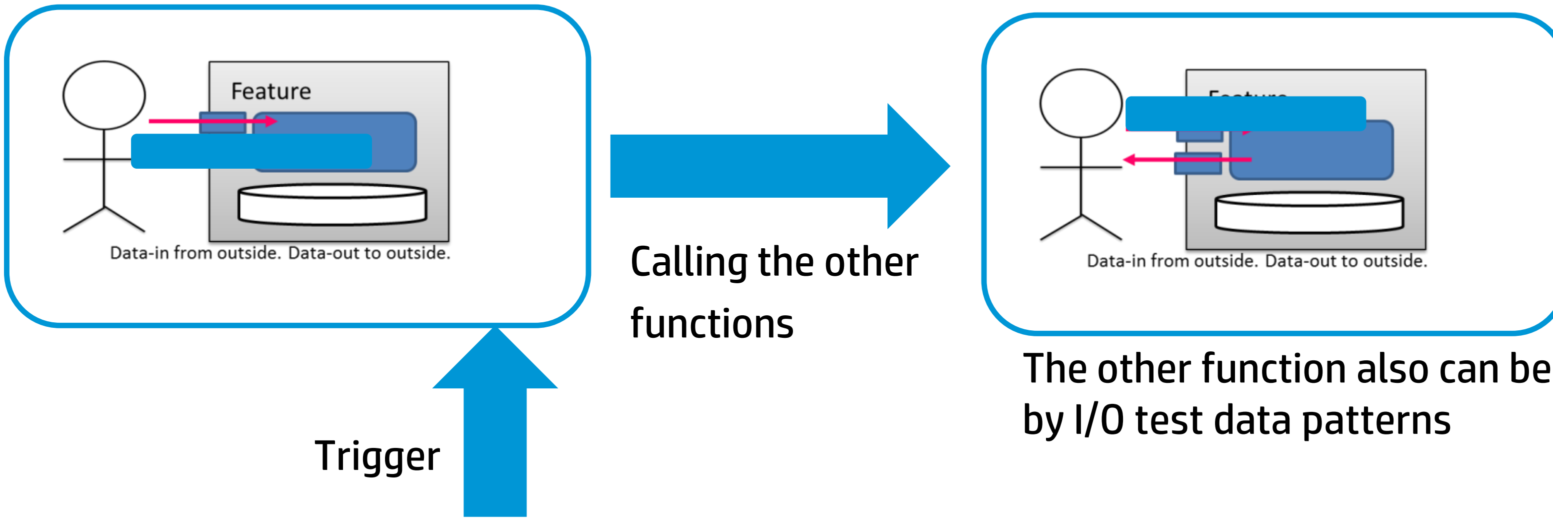


Spec-items that is other functions calling from the test executions.

The other function also can be analysed by I/O test data patterns

3.2. Consideration to Support and Interaction

Support and interaction are the classification to determine spec-items by paying attention calling the other function which relate with specific data input for the feature.



The other function also can be analysed by I/O test data patterns

Trigger / Logical Structure	Interruption	Resource sharing	Reflection to other feature.	Interlock
Support	○			○
Interaction		○	○	

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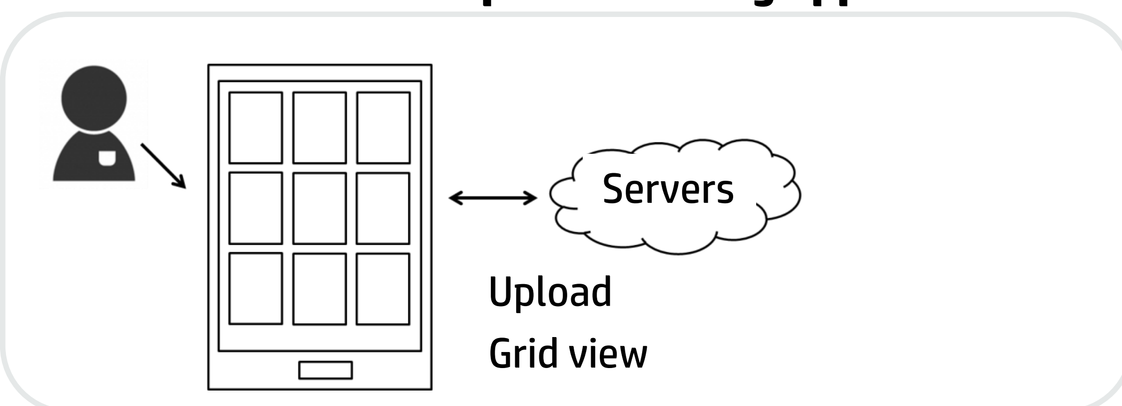
4. A experiment of test analysis using I/O test data patterns

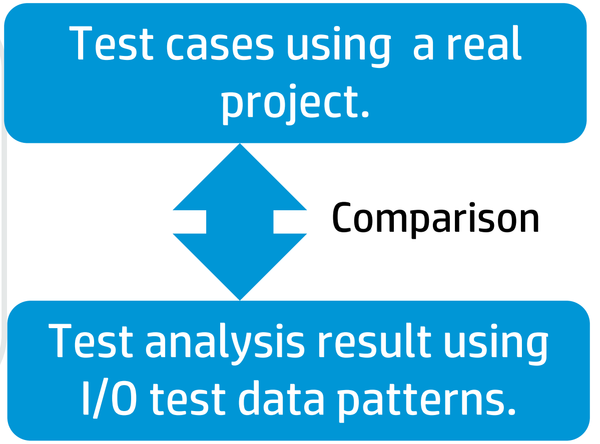
Demonstrate effectiveness of I/O test data patterns.

Objective: To confirm the proposed approach can determine spec-items comprehensively more than test design in the real project.

Evaluation: Comparing spec- items quantity between test cases used for testing in a real project and test analysis result using I/O test data patterns.

An on-line mobile photo-sharing application.





4. A experiment of test analysis using I/O test data patterns

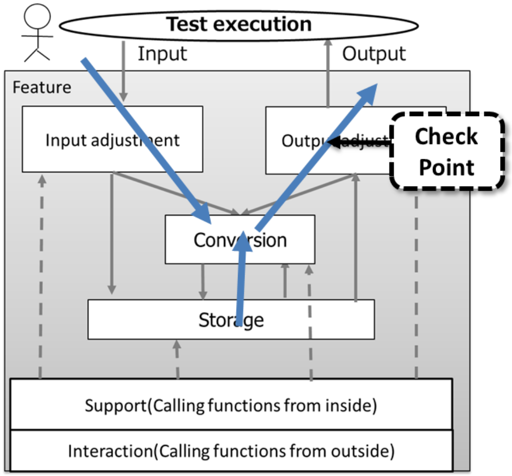
Real project test case

1. Summed up spec-items from test cases in the real project.
   - 491 cases -> 59items for Upload, 151cases -> 22 items for Grid view.
2. Making clear input data and output data for the features to be tested at system test level in test execution.
3. Adding input and output data information and classifying into I/O test data patterns.

Test Category	Spec-item	Expected Result	Input data	Output data
Image display	Change sort order	Grid view is ordered in decided sorting	Outside: Sorting data Inside: Image data	Outside: Image data Inside:

For comparing, analysing test basis using test-categories and I/O test data patterns.

- Determining test-categories
- The input data and output data are classified into test-categories.
- To simulate the flow of data that is classified into test-categories during the test execution, spec-items are determined by test-categories.
- Comparing difference.



4. A experiment of test analysis using I/O test data patterns

Experiment result

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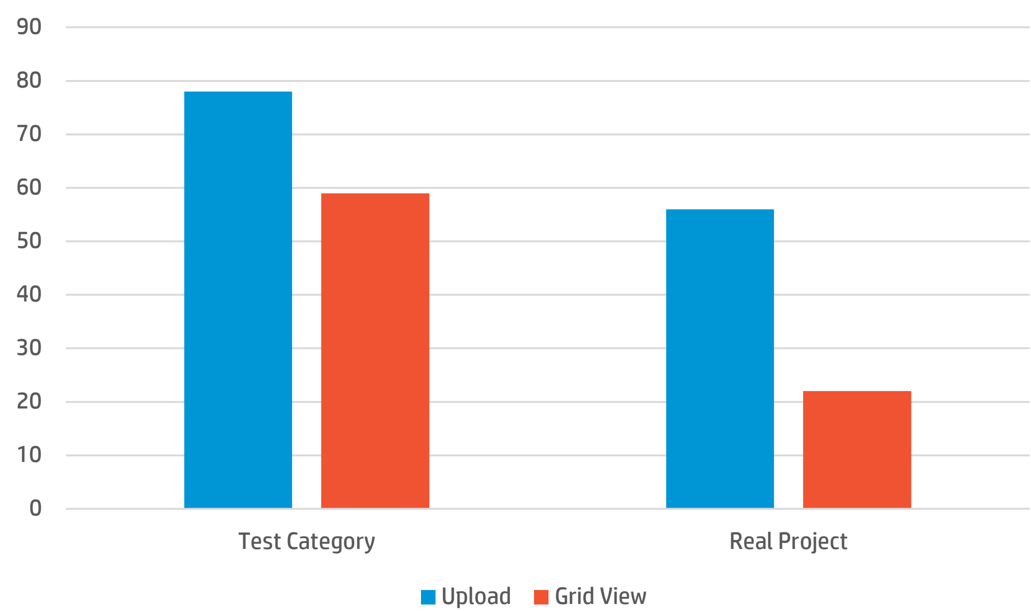

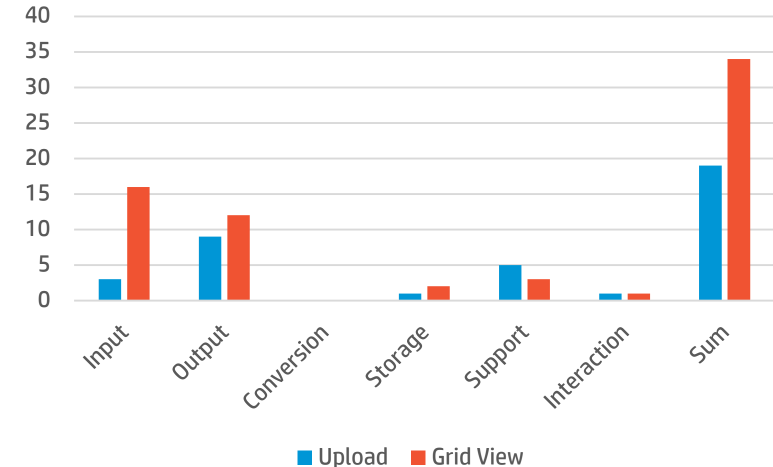

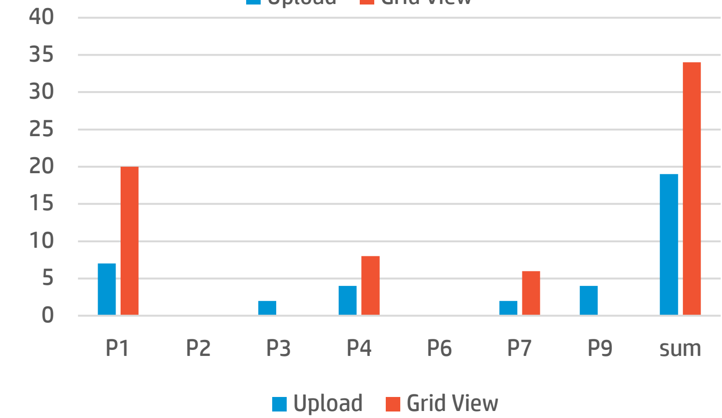

Confirming test basis comprehensively by performing a simulation of the data I / O, spec-items can be determined.
Missing spec-items are **not only combination spec-items such as classified into support or interaction**, even simple spec-items that can be classified into **Input Adjustment and Output Adjustment is also lacking**.

4. A part of spec-items that are lacked in the real project

Feature	Spec-item	I/O test data pattern	The logical structure
Upload	Message that cannot be uploaded when you upload only a duplicate image	P1	Input Adjustment
	Upload by another multiple devices with the same name image files at the same time	P3	Interaction
	Album name for the new registration in the upload window	P4	Output Adjustment
	Information change of uploaded images during upload	P9	Support

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5. Conclusion

In this paper, an approach to classify and comprehensively analysed in the aspects of the test data I / O during the test execution have proposed.

Furthermore, using the test cases used in a real project, we tried to demonstrate the proposed approach. As a result, it has been confirmed that it is possible to detect a spec-item missing.

To utilise an I/O test data patterns more, we need to obtain still many samples. Then, we want the approach to apply to real project easier.

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Thanks