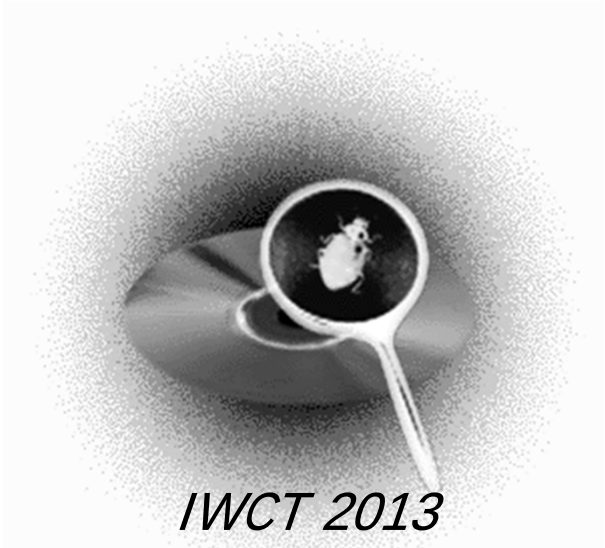
Combinatorial Test Architecture Design Using Viewpoint diagram



IWCT 2013
(International workshop on Combinatorial Testing)
in conjunction with ICST 2013 in Luxembourg

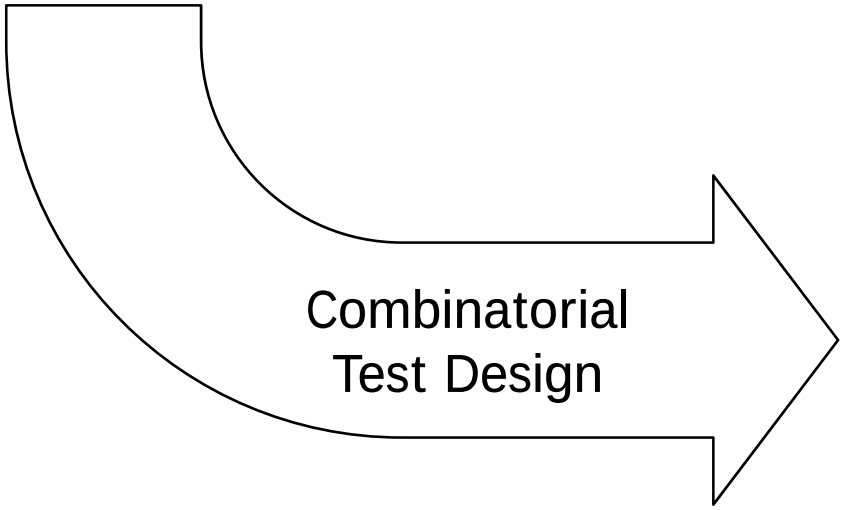
NISHI, Yasuharu
The university of Electro-Communications, Tokyo

Today's presentation

- In this presentation
  we'd like to share our experience of design CT
  - It's just abstract represents such as design patterns
    because NDA obstruct some detail explanations :-(
- This presentation is mainly on
  parameter-level "design patterns" of CT
  - For a large-scale and complicated software
    we also introduce our methodology which consists of:
    - » notation (NGT)
    - » process model (VSTeP)
    - » techniques (design patterns, quality characteristics etc.)

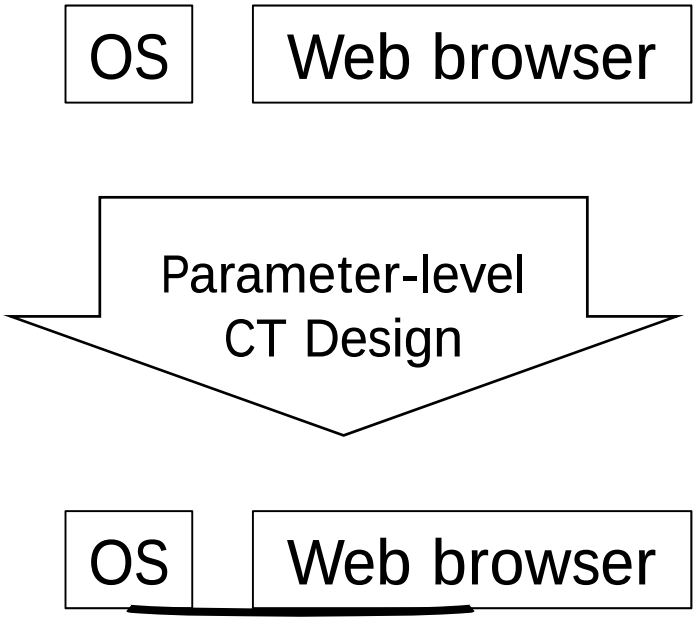
Term: Parameters, Values and Test cases

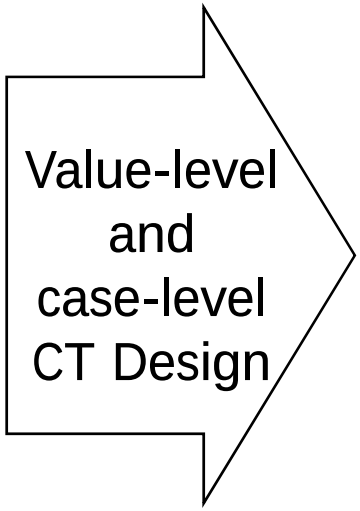
Parameter	OS	Web browser
Value	Windows Vista	Internet Explorer
	Windows 7	Firefox
		Chrome



ID	*Test cases*
1	Vista - IE
2	Vista - Firefox
3	Windows Vista - Chrome
4	7 - IE
5	7 -Firefox
6	7 - Chrome

Our idea: modeling only parameters and combinations

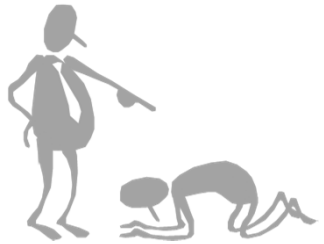




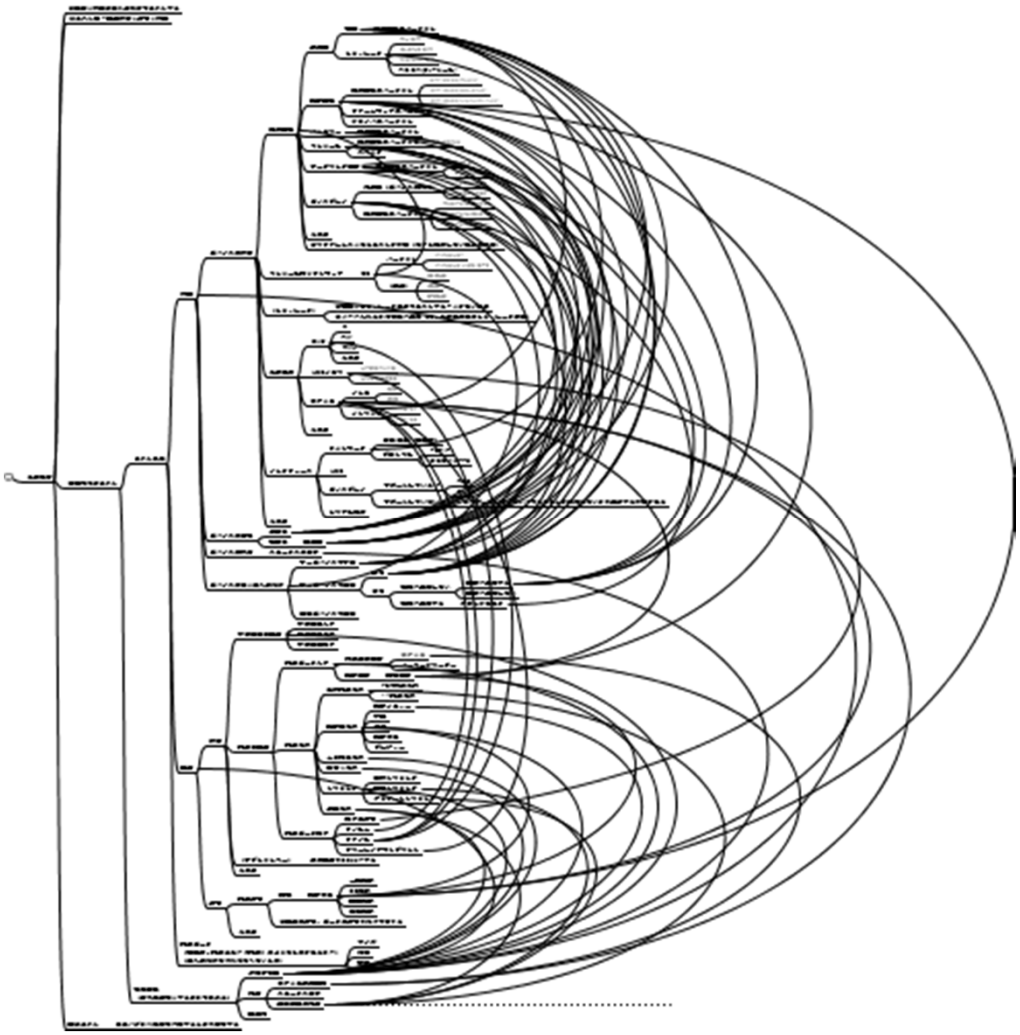
ID	*Test cases*
1	Vista - IE
2	Vista - Firefox
3	Windows Vista - Chrome
4	7 - IE
5	7 -Firefox
6	7 - Chrome

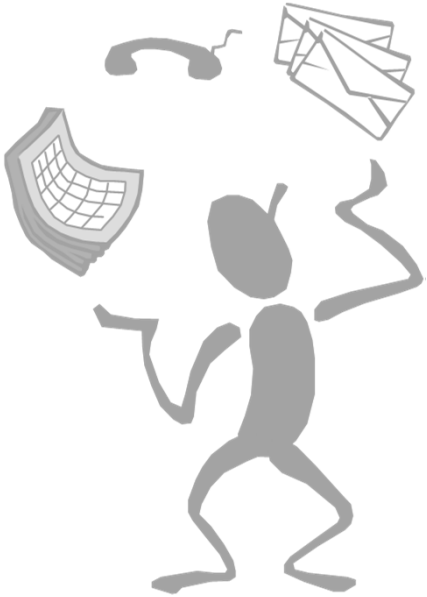
Complicated and large numbers of combination

- Test engineers tend to design CT cases without deep consideration, sometimes with fear
  - They're often troubled with combinatorial bugs and have to design CT
  - They have useful tools e.g. PICT, AETG, Allpairs
  - They consider "Is this parameter necessary for CT?"
    - » Boss says "Do you take the responsibility when bugs appear on the market if you reduce CT cases?" :-(
  - They throw all sort of parameters into their CT tool without deep consideration and get huge CT cases actually
    - » Ex) Sometimes I hear a question "how to make L256 OA?"
- Test engineers can feel relaxed with huge CT cases but will lose their sense or purpose of test design
  - Whether each parameter is necessary for CT?
  - Whether each combination is necessary to test?
  - They don't have any technique for deep consideration



As a result... :-(



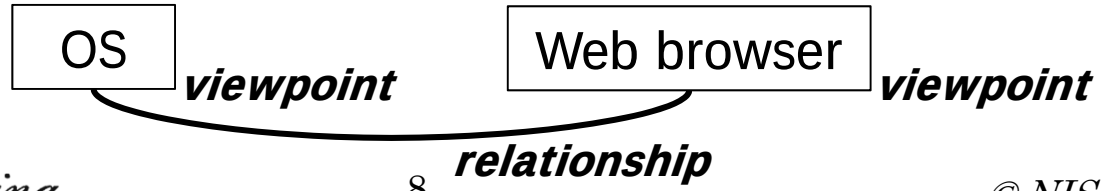


Three strategies for reduction of CT design

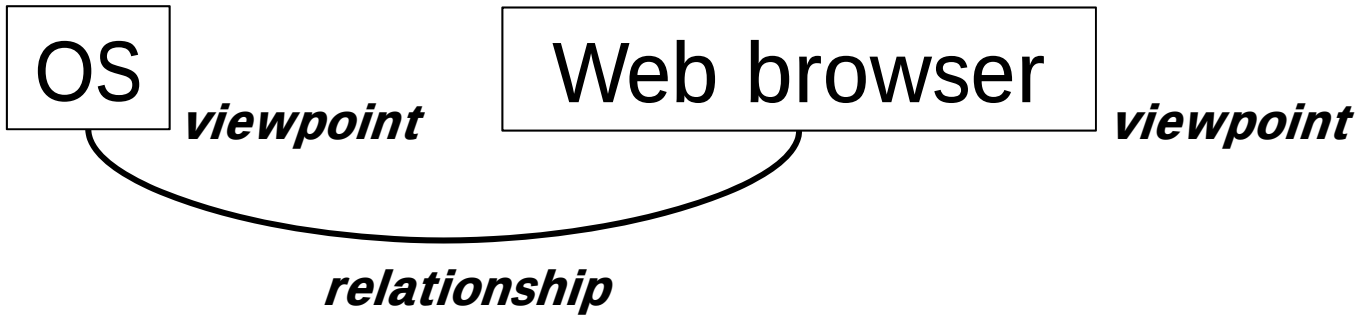
- Reduction of CT cases is one of important research theme
  1) Test cases reduction
     - » To reduce test cases with fixed parameters and fixed values by all-pairs, orthogonal arrays etc.
     - » Ex) from 256 (2^8) cases to 8 cases with an L8 orthogonal array
     - » Actively researched by researchers !
  2) Test values reduction
     - » To reduce values with fixed parameters by equivalence partitioning etc.
     - » Ex) from 12 months to 3 types of months, i.e. long, short and Feb.
  3) Test parameters and combinations reduction: our research
     - » To reduce parameters or combinations by re-consideration ;-)
     - » EX) Decide not to test combinatorially between OSs and Web browsers

Technique for deep consideration of CT design

- Test engineers should have technologies to deeply consider necessities of parameters and combinations for CT
  - Model is a technology for deep consideration in software engineering
  - We proposed NGT, Notation for Generic Testing, for test modeling
- "Viewpoint diagram" can be a technology for modeling of parameters and combinations for CT
  - Viewpoint diagram is one of diagrams of NGT
  - Viewpoint diagram fundamentally consists of boxes and lines
  - Boxes represent parameters, called "viewpoints"
  - Lines represent combinations, called "relationships"
  - Viewpoint diagram hides values and can make test engineers concentrate their attention to parameters and combinations



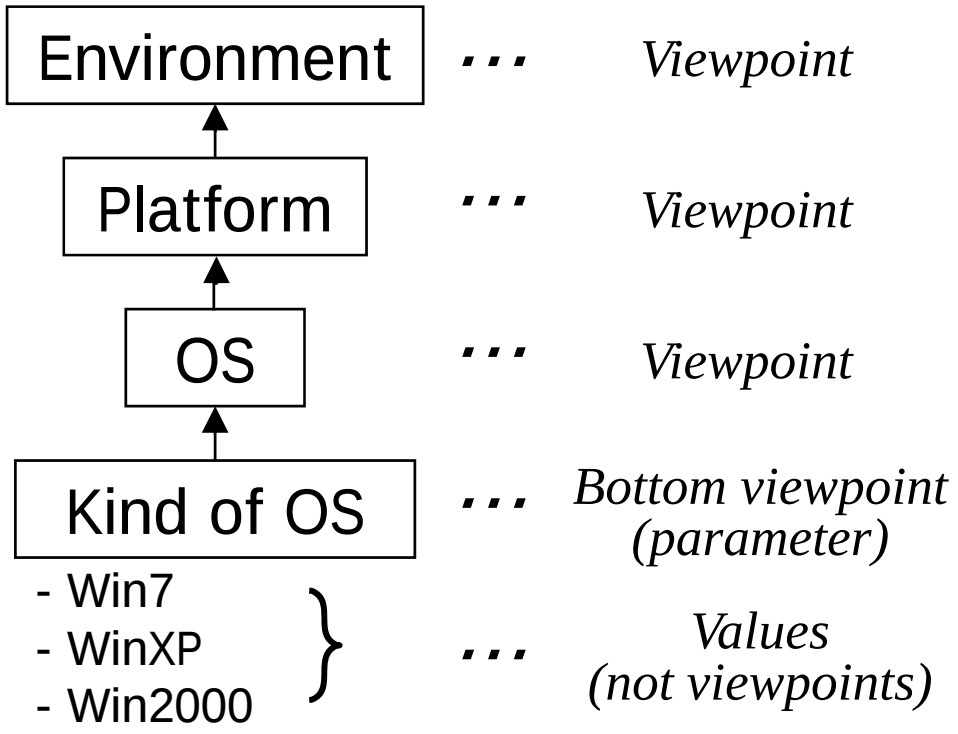
Viewpoint diagram and test cases



ID	*Test cases*	*OS*	*Web browser*
1	Vista - IE	Windows Vista	Internet Explorer
2	Vista - Firefox	Windows Vista	Firefox
3	Vista - Chrome	Windows Vista	Chrome
4	7 - IE	Windows 7	Internet Explorer
5	7 -Firefox	Windows 7	Firefox
6	7 - Chrome	Windows 7	Chrome

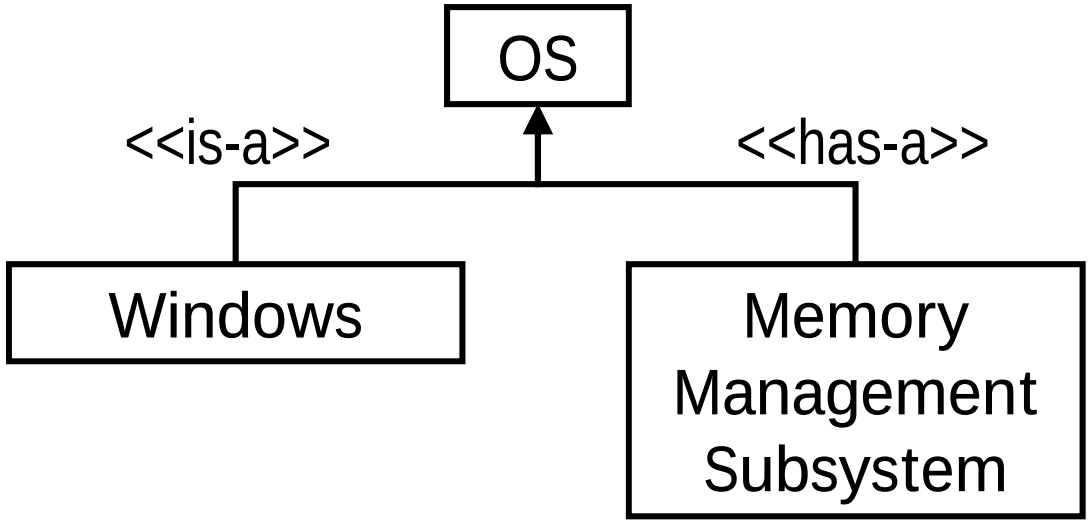
Hierarchical relationships of viewpoints

- For convenience of modeling, viewpoints can be in hierarchy
  - Arrows with a closed head represent "hierarchical relationships"



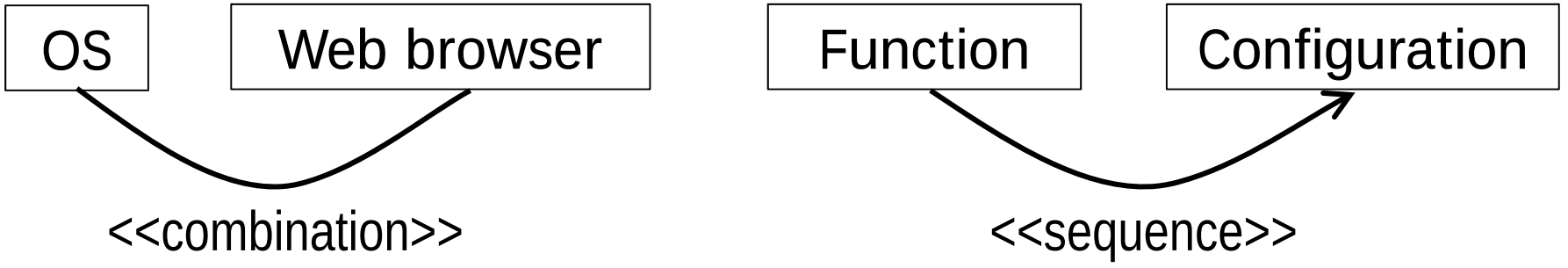
Types of Hierarchical relationship

- Hierarchical relationships can bear several meanings
  - is-a relationship: inheritance
  - has-a relationship: possession
  - There may be other hierarchical relationships
  - Relationships can represent their meanings with <<stereotype>>

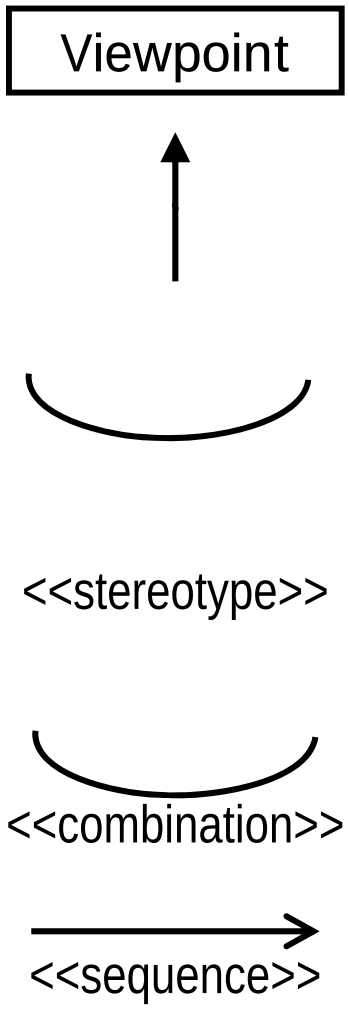


Interactive relationships of viewpoints

- Viewpoints can relate each other with interactive relationships
  - Non-hierarchical relationships are necessary: Interactive relationships
  - They can also bear several meanings: combination, sequential etc.
  - Lines without arrowhead represent “combinatorial relationships”
  - Arrows with an open head represent “sequential relationships”
  - Relationships can represent their meanings with <<stereotype>>
  - In this presentation interactive relationships without stereotypes represent combinatorial relationship



Notation of viewpoint diagram in NGT



... *Viewpoint*

... *Hierarchical Relationship*

... *Interactive Relationship*

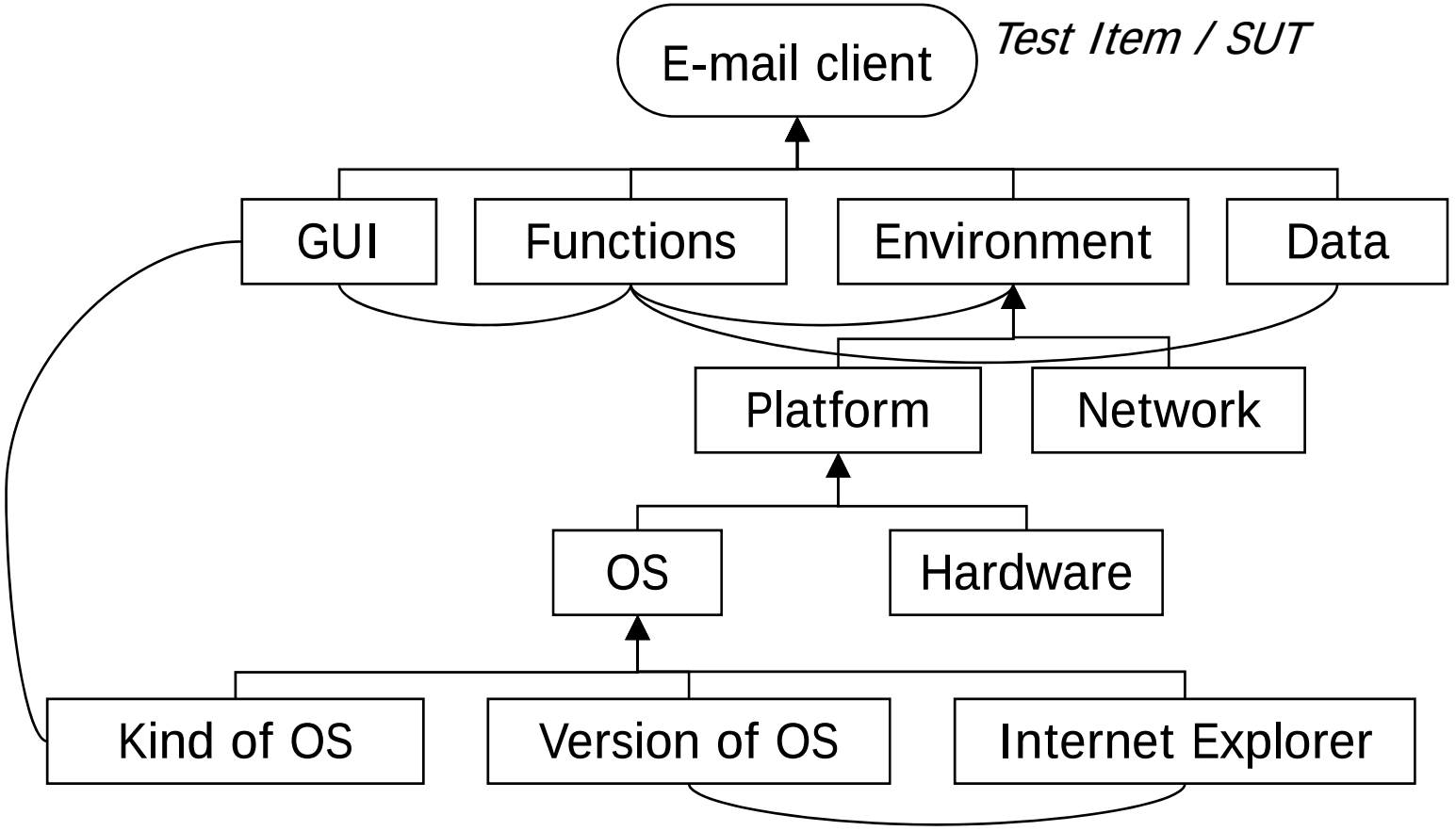
... *Stereotype*

... *Combinatorial Relationship*

... *Sequential Relationship*

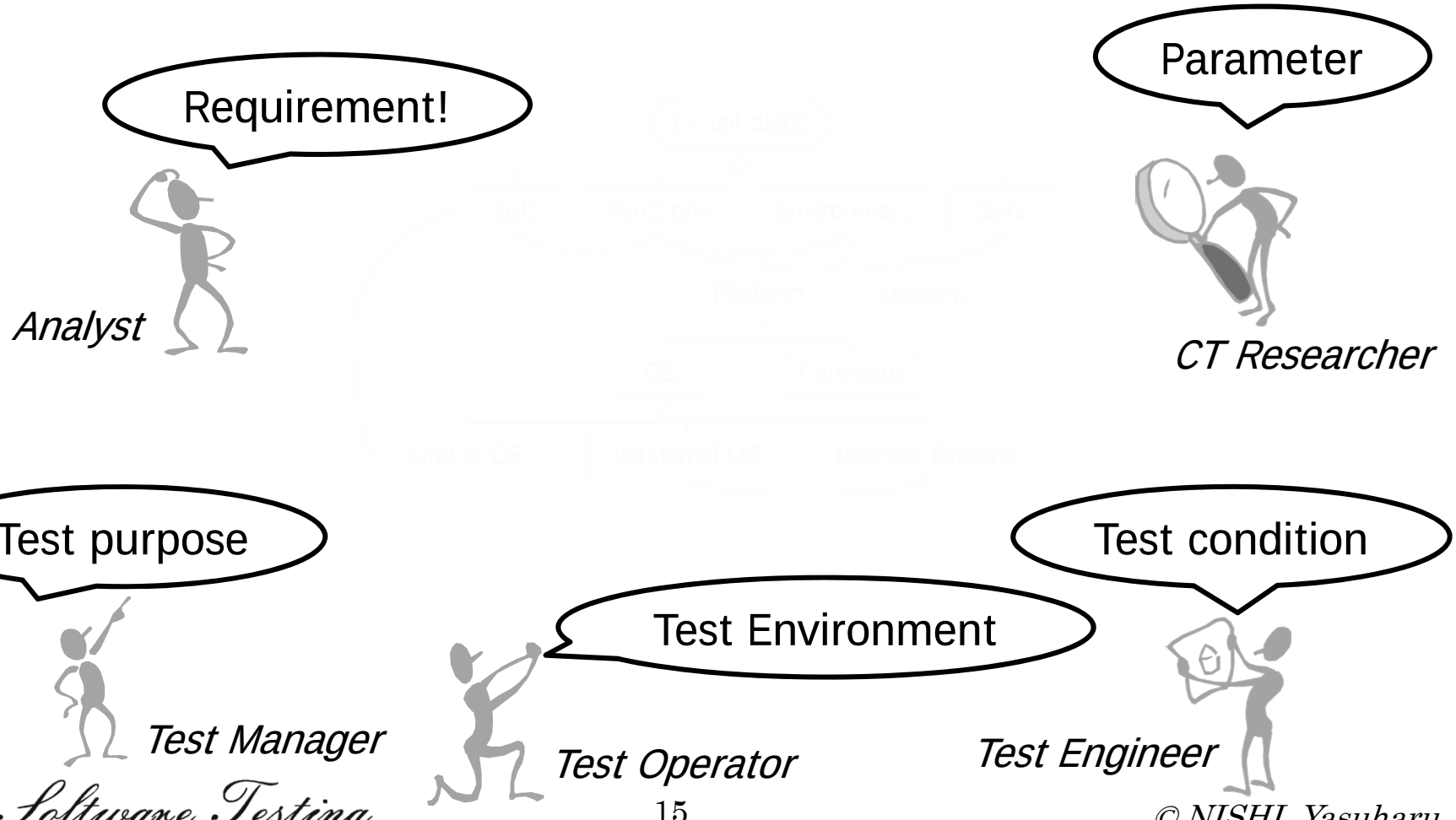
Drawing tools for mindmaps are useful

Example of part of viewpoint diagram



Why “viewpoint” ?

- The word “viewpoint” is independent of roles

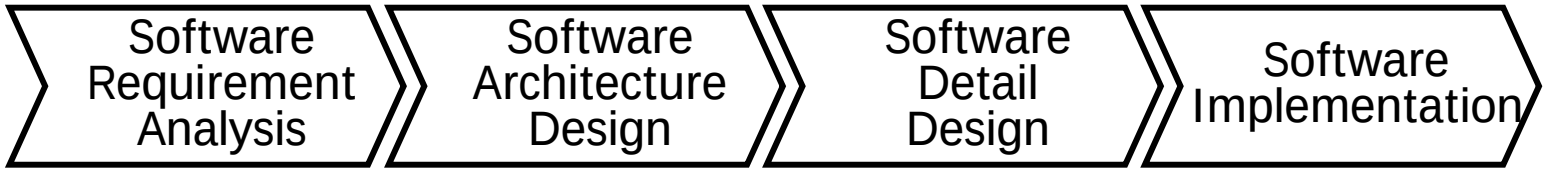


Test architecture design

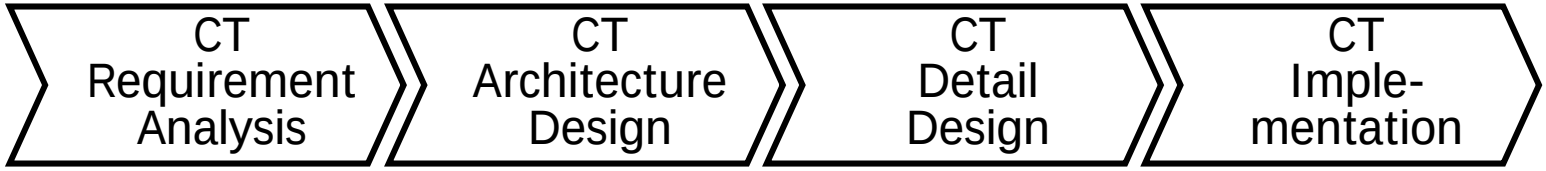
- CT consists of two layers of design:
  - Value/case-level design (Test detail design)
    - » To extract values with fixed parameters by equivalence partitioning etc.
    - » To design test cases with fixed parameters and fixed values by all-pairs, orthogonal arrays etc.
    - » Using CT design technique/method
  - Parameter/combination-level design (Test architecture design)
    - » To find out appropriate parameters and combinations
    - » To consider which parameters and combinations are suitable for the current test project
    - » Making CT design modeling
- They are similar to detail design and architecture design in software development
  - They are both important !

CT engineering process

- CT should consist of engineering process similar to software development
  - CT-RA and CT-AD is traditionally called “test planning”



Typical software development process

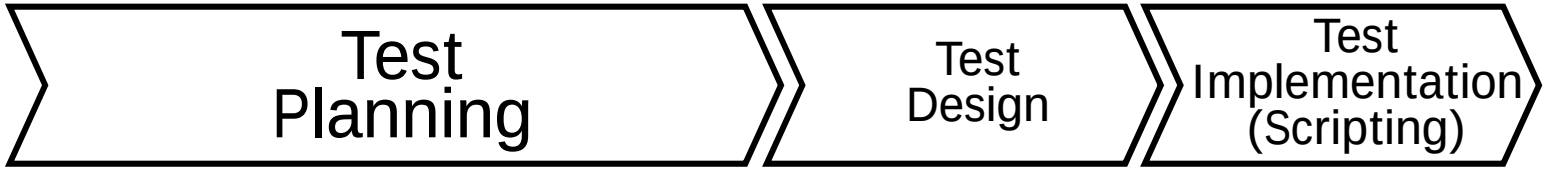


CT engineering process

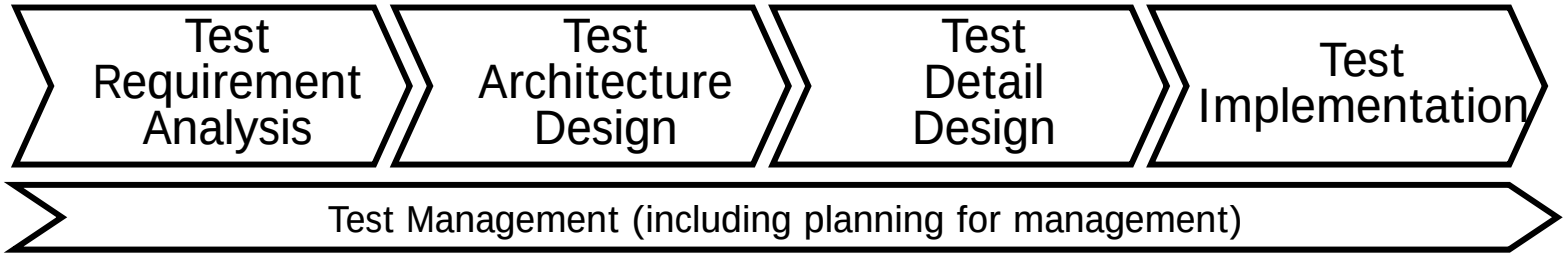
Experiment	P1	P2	P3	P4	P5	P6	P7
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2

VSTeP: Viewpoint-based Test Process

- We proposed VSTeP, a generic process model for Viewpoint-based test architecture design not limited to CT
  - Especially for a large-scale and complicated software



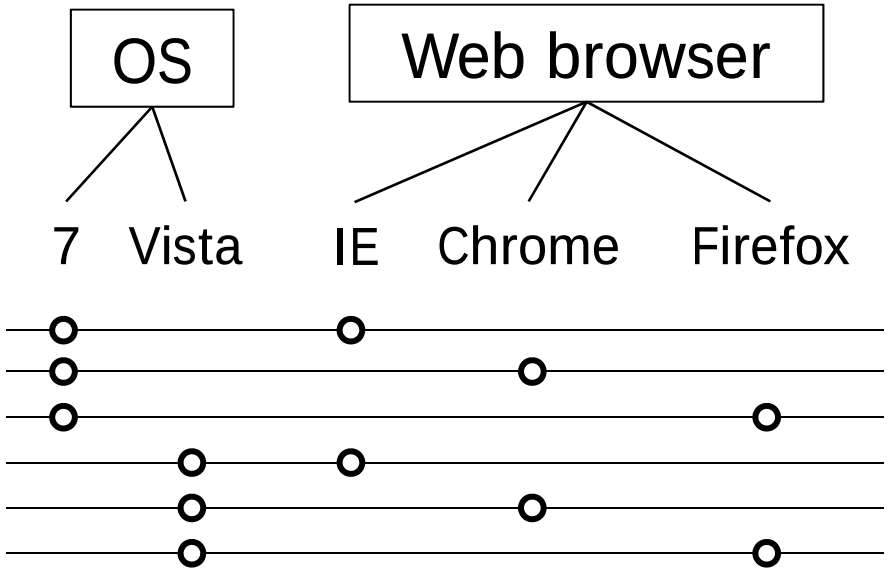
Part of typical test process



VSTeP: Viewpoint-based Test Process

Viewpoint diagram is simple enough

- Viewpoint diagram is simple enough to make a test architecture design model
  - More simple than classification tree



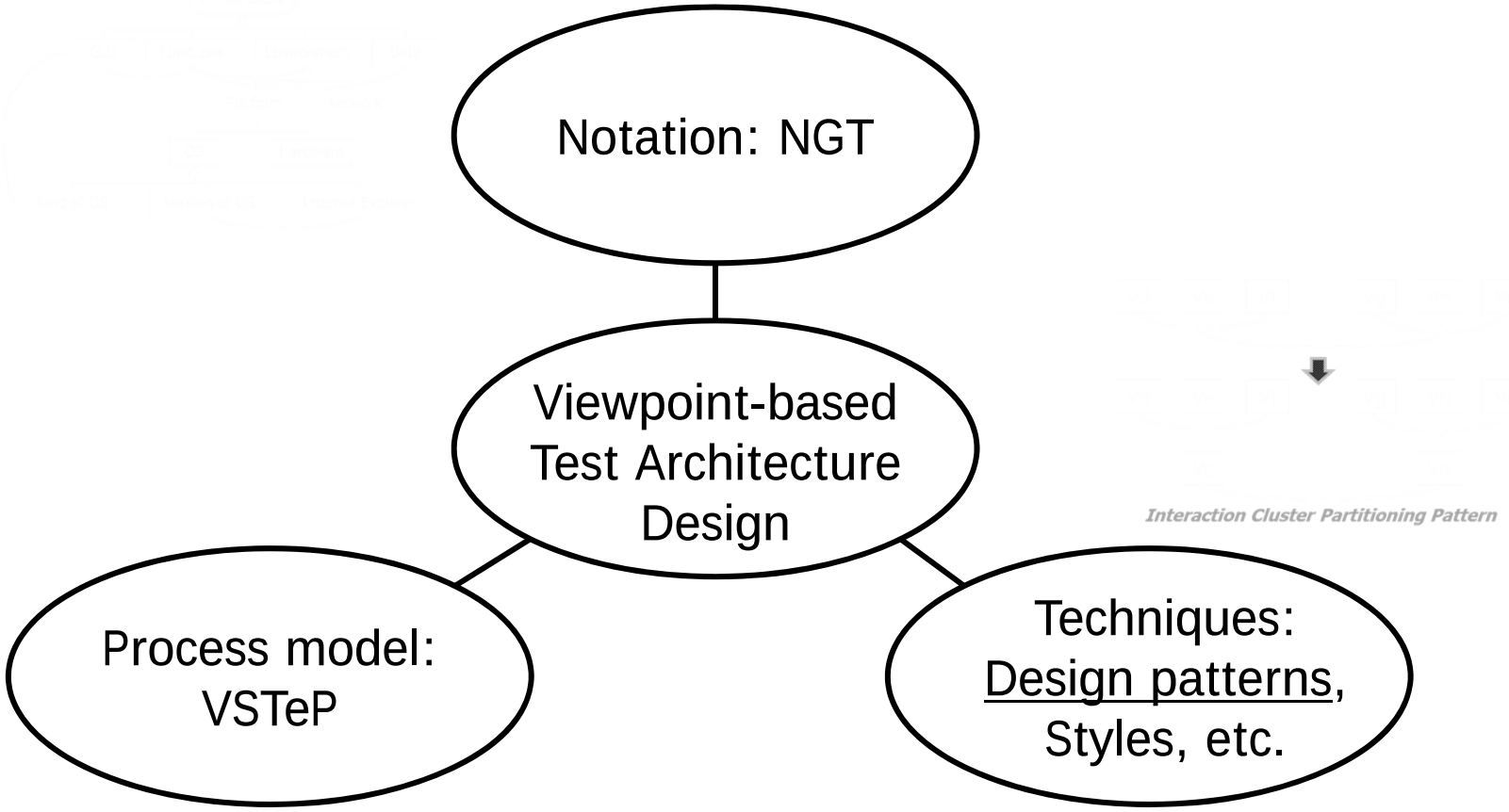
Classification Tree

Viewpoint diagram

Techniques for test architecture design

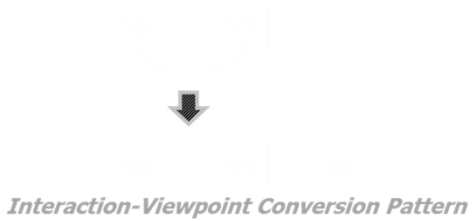
- Design patterns for test architecture design
  - Part of model which can simplify complicated design
- Styles of test architecture design
  - Typical set of top viewpoints
    - » User, spec, design and bug
    - » Functionality, reliability, usability and efficiency
    - » etc.
- Quality characteristics of test suite
  - Maintainability of test cases
  - Automate-ability of test cases
  - etc.
- Product line engineering of test suite
  - Well-organized scheme of re-use of test cases

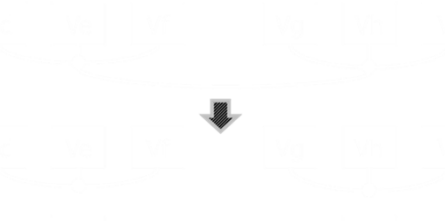
Overview of our methodology



CT Design patterns on viewpoint diagram

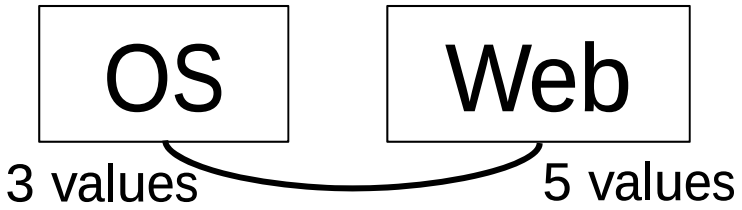
- This research shows four CT design patterns on viewpoint diagram
  - Interaction-Viewpoint Conversion Pattern
  - Interaction Cluster Partitioning Pattern
  - Interaction Demotion Pattern
  - Interaction Necessity Analysis pattern





Interaction-Viewpoint Conversion Pattern

- you can refine the viewpoint model and reduce test cases
  - if you can specify the source of combinatorial bugs is an overwritten shared DLL and accept risks of bugs from other sources

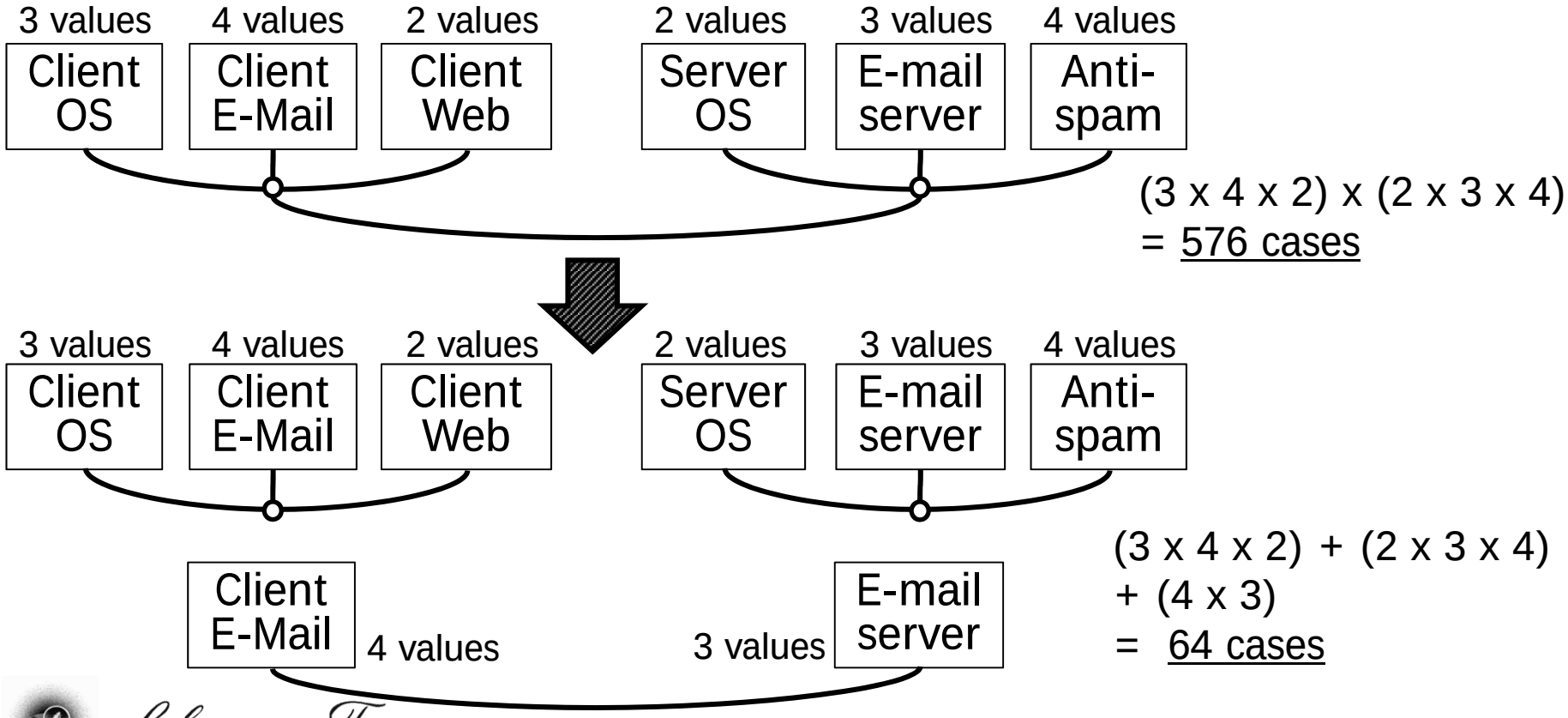


3 x 5
= 15 cases

3 + 5 + 2
= 10 cases

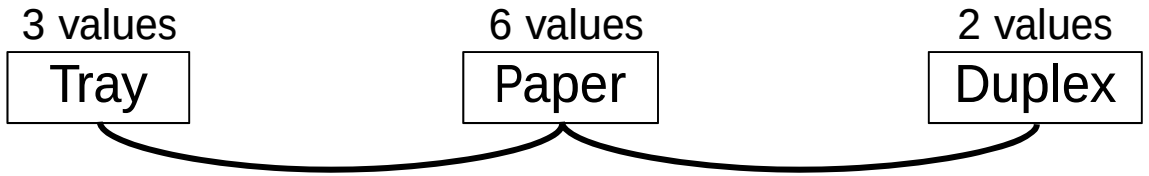
Interaction Cluster Partitioning Pattern

- you can refine the viewpoint model and reduce test cases
  - if you can specify the source of combinatorial bugs is e-mail protocols and accept risks of bugs from other sources



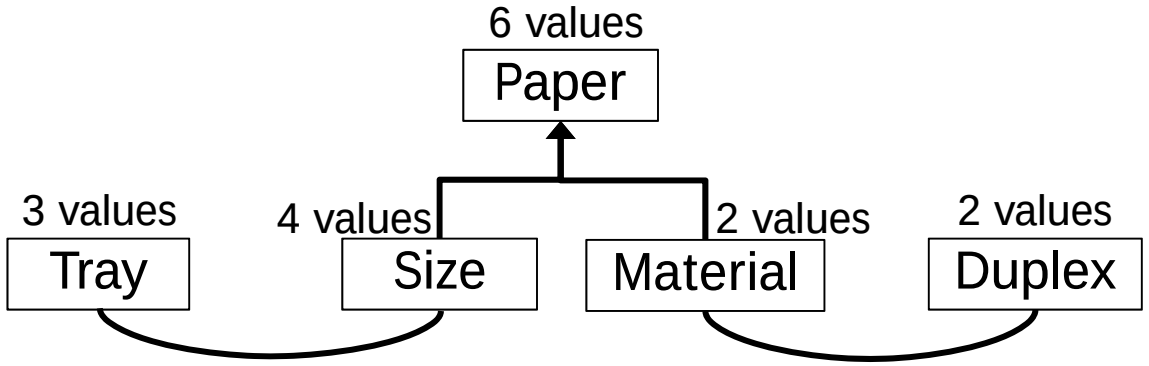
Interaction Demotion Pattern

- you can refine the viewpoint model and reduce test cases
  - if you can separate effects of sizes on trays and materials to duplex modes and accept risks of bugs from separation



(3 x 6) x (6 x 2)
= 30 cases

Paper
A4, WF
A4, WC
A5, WF
A5, WC
A3, WF
A6, WF



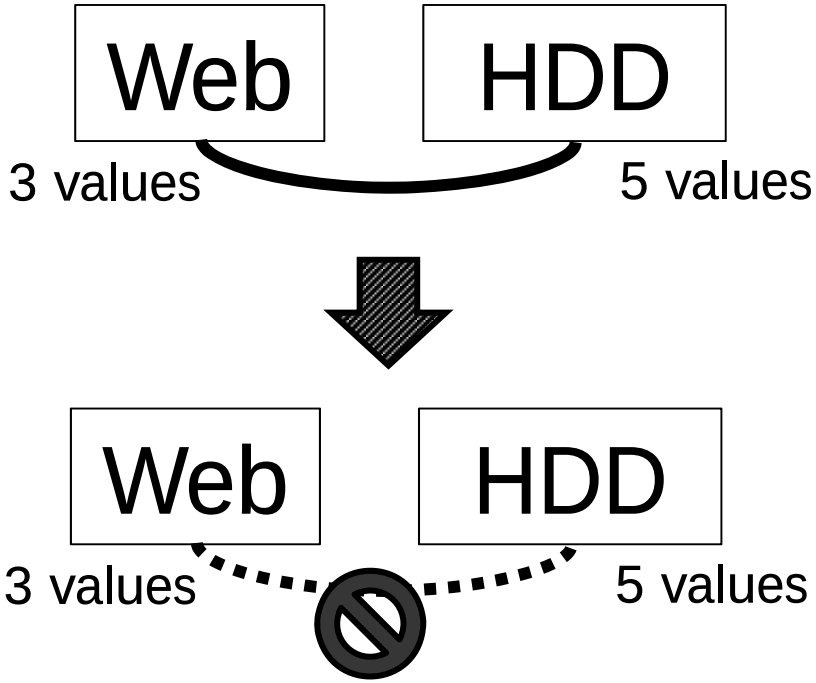
(3 x 4) + (2 x 2)
= 16 cases

Size
A3
A4
A5
A6

Mat.
WF
WC

Interaction Necessity Analysis pattern

- you can refine the viewpoint model and reduce test cases
  - if you're certain that behavior of web browsers doesn't depend on kinds of HDD and accept risks of bugs from dependency of them

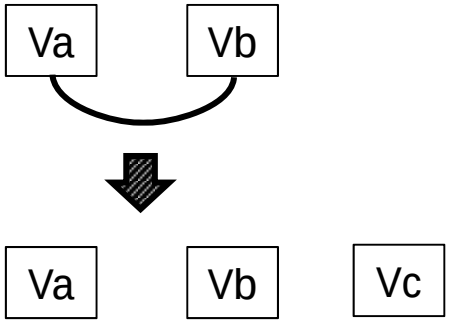


3 x 5
= 15 cases

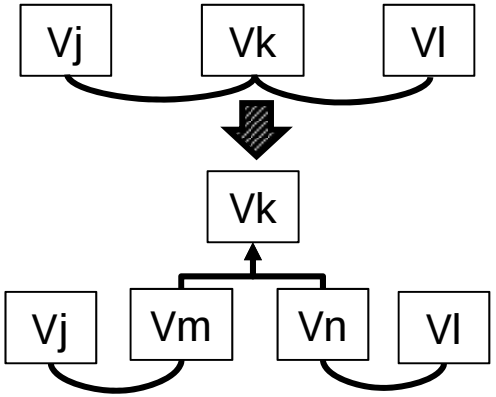
3 + 5
= 8 cases

We share four CT design patterns

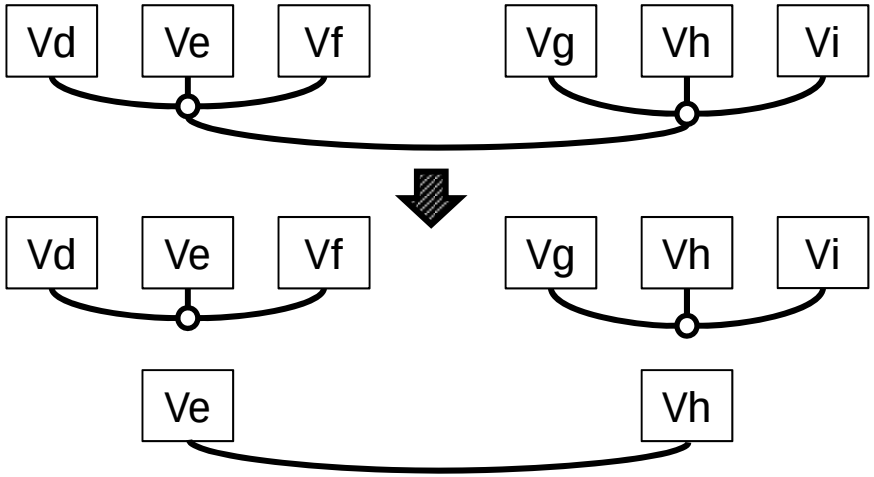
- You can find more patterns in your CT design ! :-)



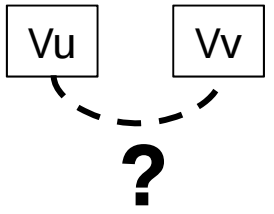
Interaction-Viewpoint Conversion Pattern



Interaction Demotion Pattern



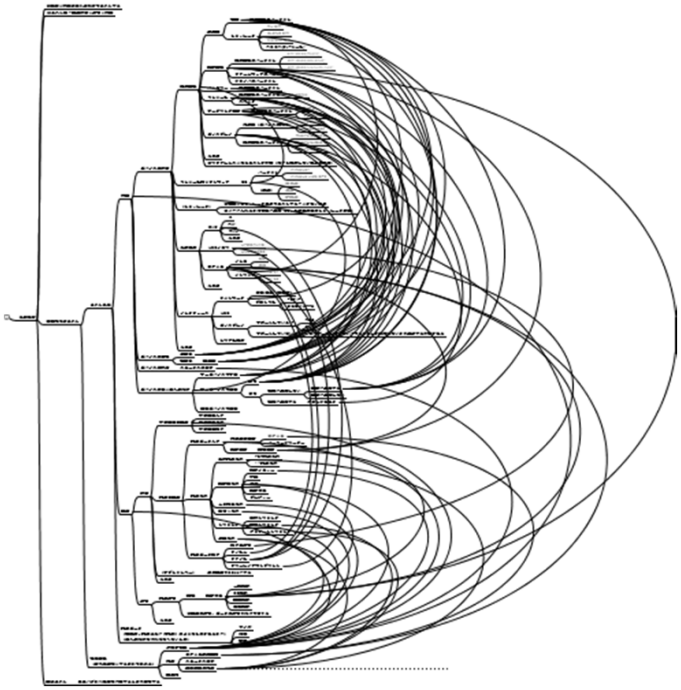
Interaction Cluster Partitioning Pattern



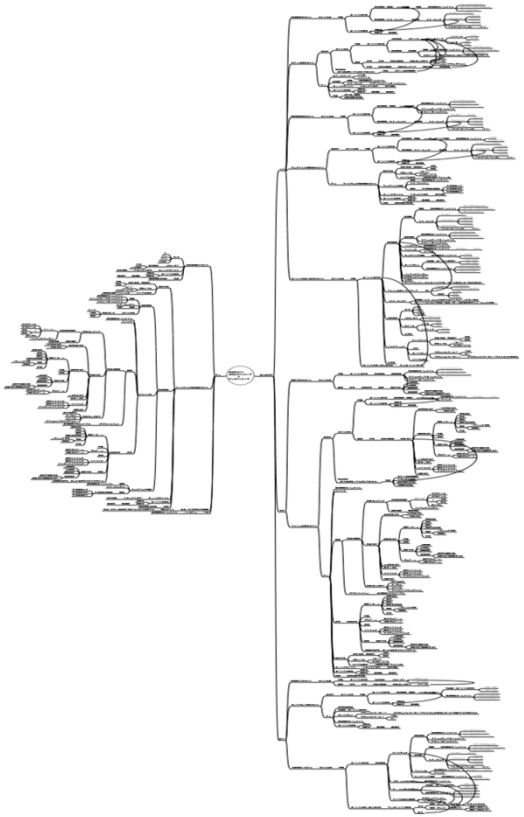
Interaction Necessity Analysis Pattern

Example of test architecture refinement

- Several patterns can refine test architecture
  - Both are the same meaning model of semi mission critical software
  - I refined the left model to the right model using several patterns
  - I'm sorry for insufficient explanation due to NDA :-(



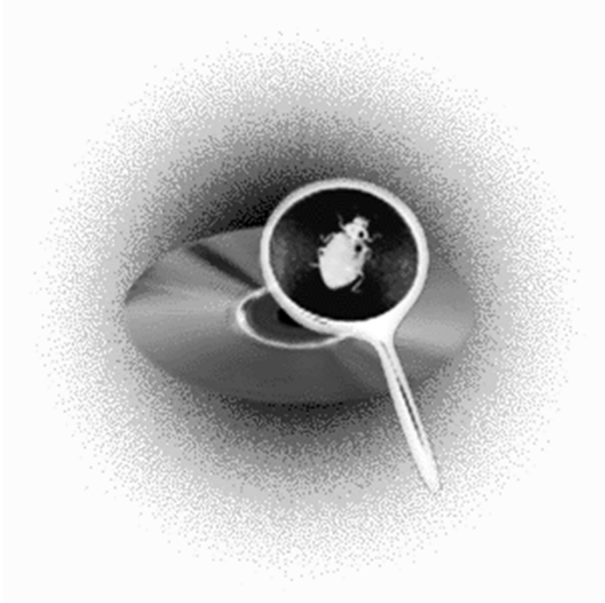
Refine with
several patterns



Conclusion

- Parameter-level / test architecture design for CT is important
  - especially for a large-scale and complicated software
- “Viewpoint diagram” is a technology
  for parameter-level / test architecture design for CT
  - We show NGT, notation for viewpoint diagram,
    and VSTeP, a process model focusing on test architecture design
- We share four design patterns
  on test architecture level for CT to reduce CT cases
- You can research CT technique on test architecture level
  - more design patterns for CT
  - high-maintainabliity CT parameter-level design
  - etc.

Thank you for your kind attention



NISHI, Yasuharu
http://blues.se.uec.ac.jp/
Yasuharu.Nishi@uec.ac.jp