More Important than Techniques

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SIGiST 2012

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Seriously…

How to design a Test?

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IEEE 829-1998

A test case specification shall have the following structure:

a) Test case specification identifier;
b) Test items;
c) Input specifications;
d) Output specifications;
e) Environmental needs;
f) Special procedural requirements;
g) Intercase dependencies.

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IEEE 829-2008

Level Test Case Outline (full example)

1. Introduction (once per document)

1.1. Document identifier

1.2. Scope

1.3. References

1.4. Context

1.5. Notation for description

2. Details (once per test case)

2.1. Test case identifier

2.2. Objective

2.3. Inputs

2.4. Outcome(s)

2.5. Environmental needs

2.6. Special procedural requirements

2.7. Intercase dependencies

3. Global (once per document)

3.1. Glossary

3.2. Document change procedures and history

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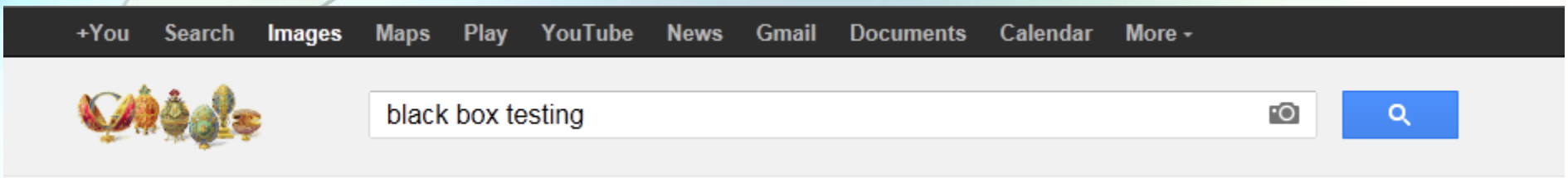

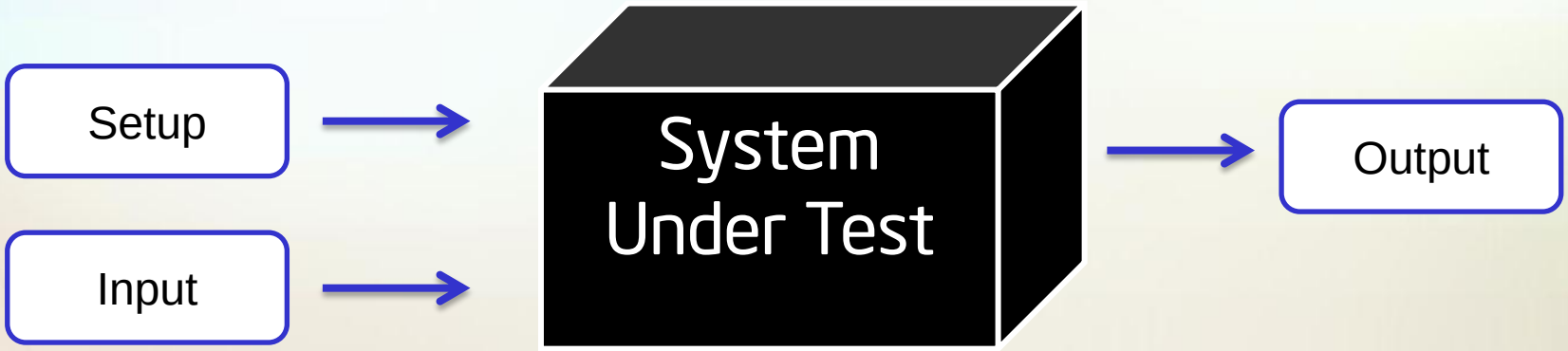

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The ISTQB Test Techniques

- Equivalence Partitioning
- Boundary Values Analysis
- Decision Table Testing
- State Transition Testing
- Use Case Testing
- Experience-based Testing
- Etc. etc.

Source: ISTQB, Foundation level syllabus

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The "standard" Test Design

Apply Input

Expected Results

Teardown

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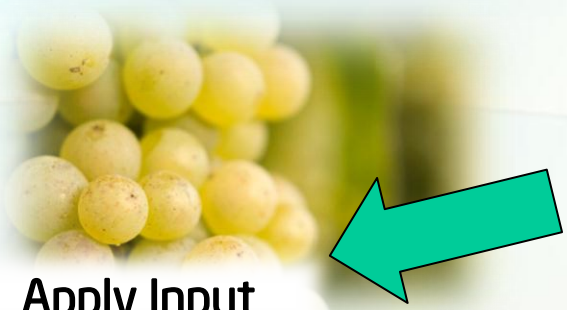
The "standard" Test Design



Test Techniques

- Equivalence Partitioning
- Boundary Values Analysis
- Decision Table Testing
- State Transition Testing
- Use Case Testing
- Experience-based Testing
- Etc. etc.

Teardown

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So…

How to design a Test?

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Outline

- Input and Output basics

- Preconditions, Postconditions
- Foreground, Background
- What's the limit?
- Test flow
- Test your test

- Summary

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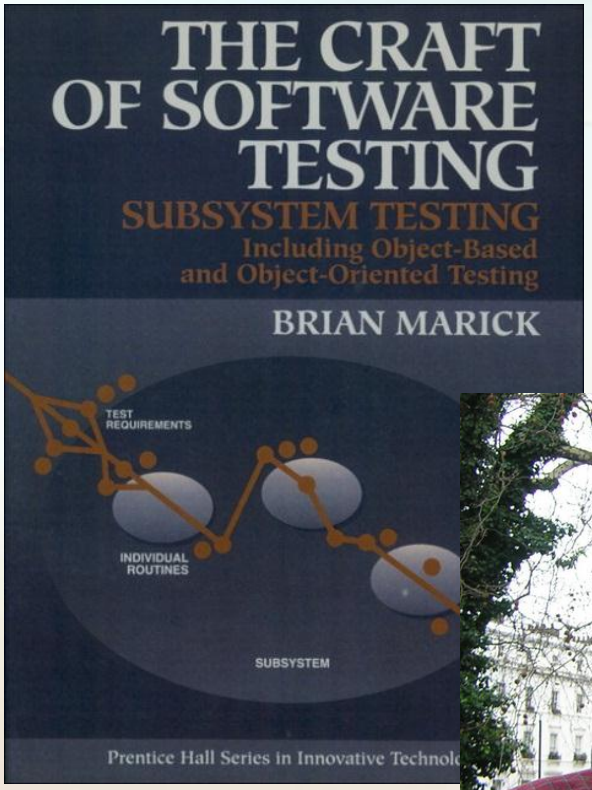
המביא דבר בשם אומרו מביא גאולה לעולם

אבות ו' ו



Whosoever tells a thing in the name of him that said it, brings redemption to the world

Ethics Of The Fathers 6, 6

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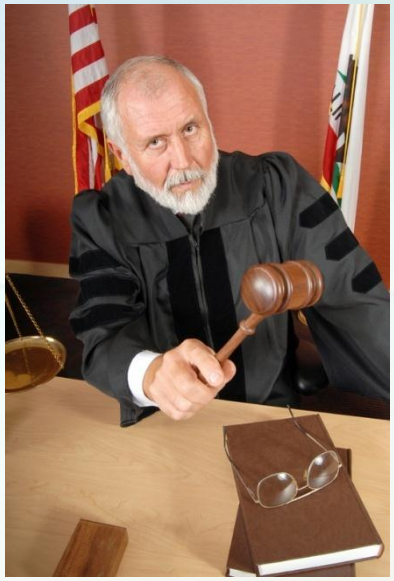
Disclaimers



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Input

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Input basics: Valid

Range

Enumeration

Input

Combinations (if applicable)

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Input basics: Invalid

Range

Enumeration

Combinations (in rare cases!)

Input

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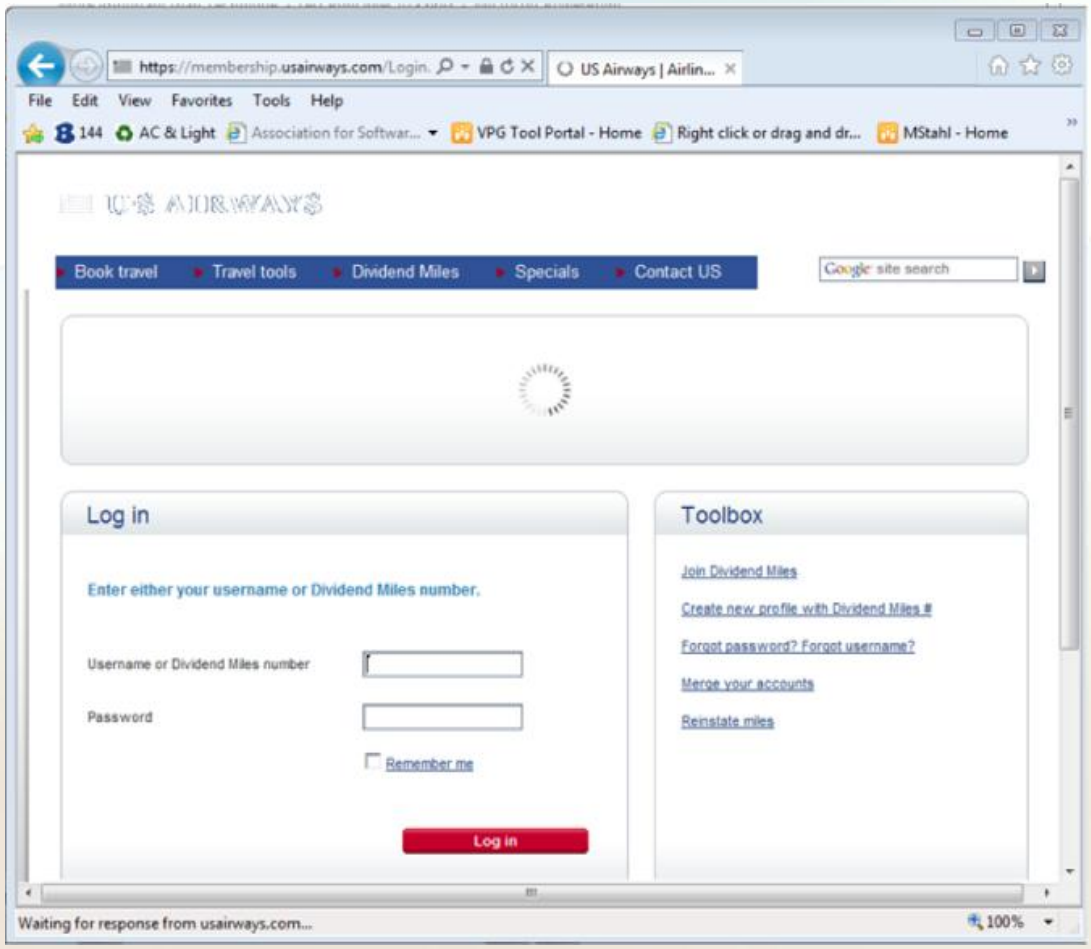
Input basics: Invalid



Invalid Combinations (in rare cases!)

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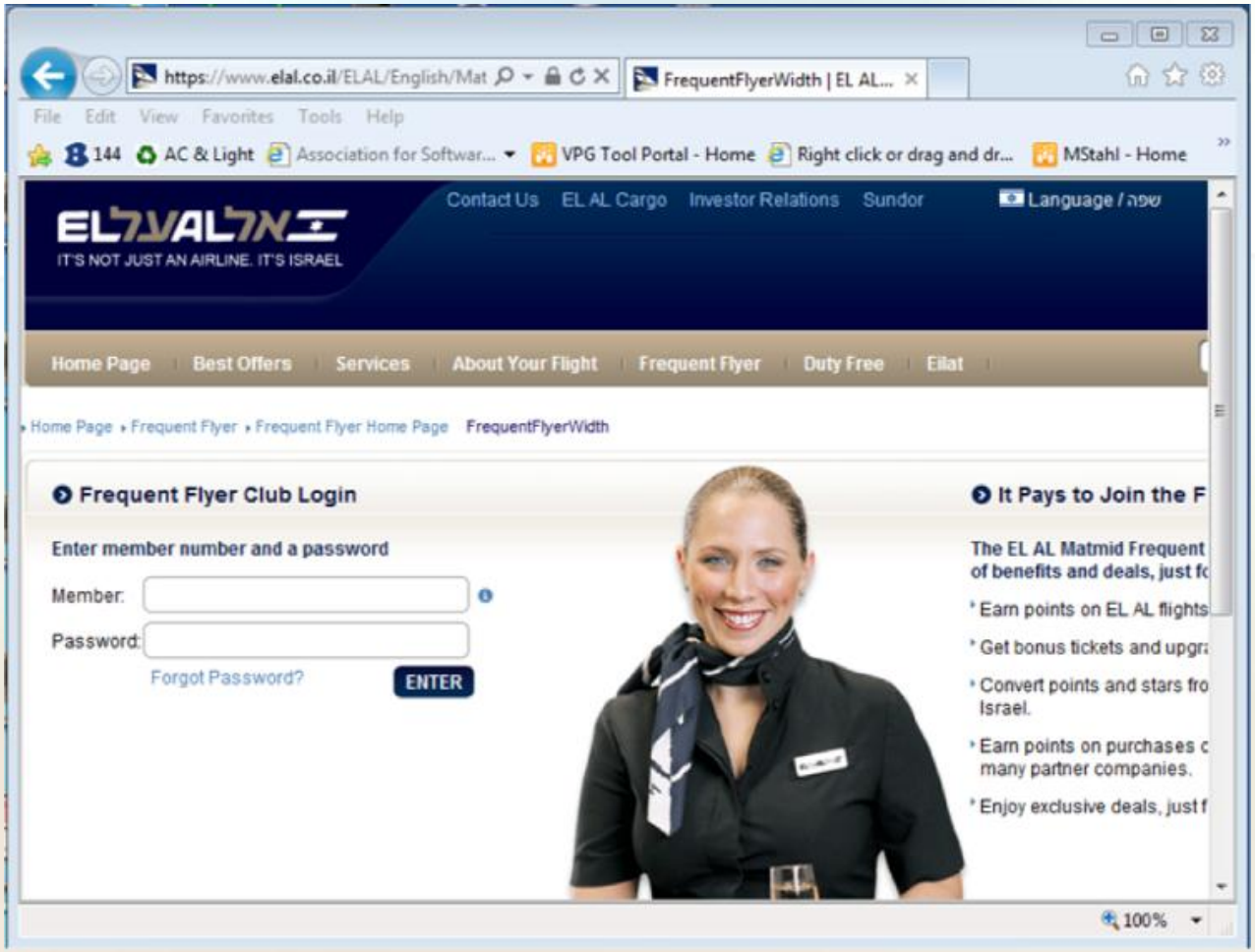
Input basics: Invalid



Invalid Combinations (in rare cases!)

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Output

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Output basics: Valid

Range

Output

Enumeration

Error codes or messages

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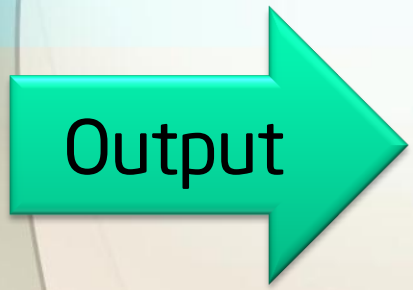
Output basics: Invalid



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A "Wider" look at Input: Preconditions

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Input is one part of Preconditions

Environment

Input

System under test

Input

Configuration

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Preconditions are Assumed or Validated

Validated

Assumed

Input

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Assumed Preconditions

The system has the needed fonts

The system has a printer

The user can read

There IS a user

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The Environment: Control, Set, Cause or Monitor?

Environment

Control

Set

Cause

Monitor

Input

System under test

Input

Configuration

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The Environment:
~~Control, Set, Cause or Monitor?~~

Environment

Control *Set* *Cause* *Monitor* *Ignore*

Input

System under test

Input Configuration

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A "Wider" look at Output: Postconditions

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Output is one part of Postconditions

Output

Environment

System under test

Output

Configuration

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Postconditions have Variants and Invariants

Output

Variants

Invariants

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Post Conditions: Variants and Invariants

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Creating Preconditions

Obvious:

- User inputs
- CLI arguments

Less obvious:

- Configuration (Files, Windows registry)
- API calls
- Sensors
- The Environment
  - OS, HW, installed stuff, interrupts
  - External stuff (temperature, radiation, comm…)

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Checking Postconditions

- Variants:
  - "Expected Results"
  - Configurations; Environment
- Invariants:
  - Configurations; Environment
  - System resources
    - Memory
    - File handles
  - Pay special attention after Exceptions!

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Checking Postconditions

- Background
  - Known state – before the test
- Foreground
  - Stuff that changes

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Checking Postconditions

Before:

After:

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Checking Postconditions

Before:

After:

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Checking Postconditions

- Set background value to highlight change

- Set inputs to highlight mistakes
  - 2+2 = 2*2 !
  - 2-2 = 2-2 !

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Output: Background and Foreground

```
Int Foo(int x)  {

   int status = SUCCESS;

   if (x > 1000) retVal = ERROR_OUT_OF_RANGE
   else          process(x, &status);

   return status;
}
```

What if process() does nothing ?

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Output: Background and Foreground

```
Int Foo(int x)  {

   int status = UNUSED_VALUE;

   if (x > 1000) retVal = ERROR_OUT_OF_RANGE
   else          process(x, &status);

   return status;
}
```

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Output: Background and Foreground

Array testing:

```
char src[16]={0}, dst[16]={0};
// src gets value from user
strncpy(src, input, sizeof(input));
// src is copied to dst
strncpy(dst, src, sizeof(dst));
```

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Output: Background and Foreground

Array testing:

```
char src[16]={0}, dst[16]={0};
// src gets value from user
strncpy(src, input, sizeof(input));
// src is copied to dst
strncpy(dst, src, sizeof(dst)); //bug!
```

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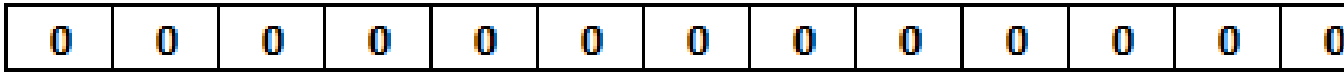
Output: Background and Foreground

Array testing:

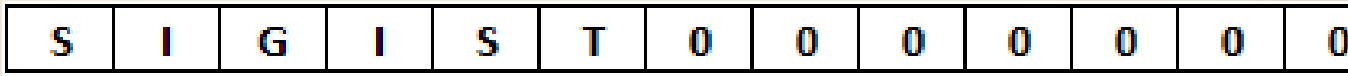
Incorrect test:

1. Enter “SIGIST” in input field
2. Verify dst = “SIGIST”

dst before:



dst after:



Test Result = PASS // ☹

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Output: Background and Foreground

Array testing:

Correct test:

1. Set dst to {A}
2. Enter "SIGIST" in input field
3. Verify dst = "SIGISTAAAAAAAAAA"

dst before:

dst after:

Test Result = FAIL // ☺

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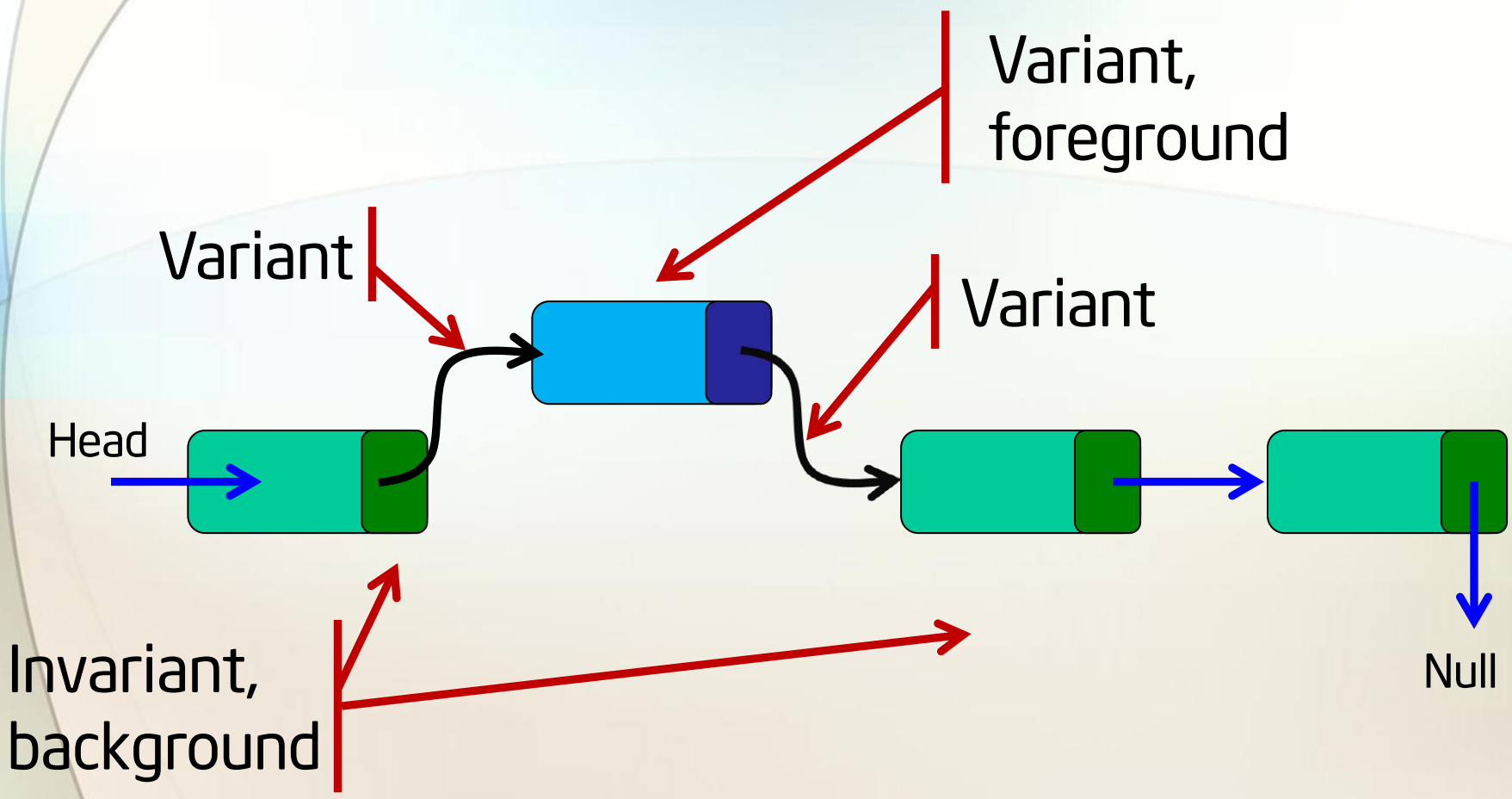
Everything together: Linked-list "Add"



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Output: Non-functional attributes limits

Set/Verify execution conditions

Set background

Apply Input

DUT

Check Output

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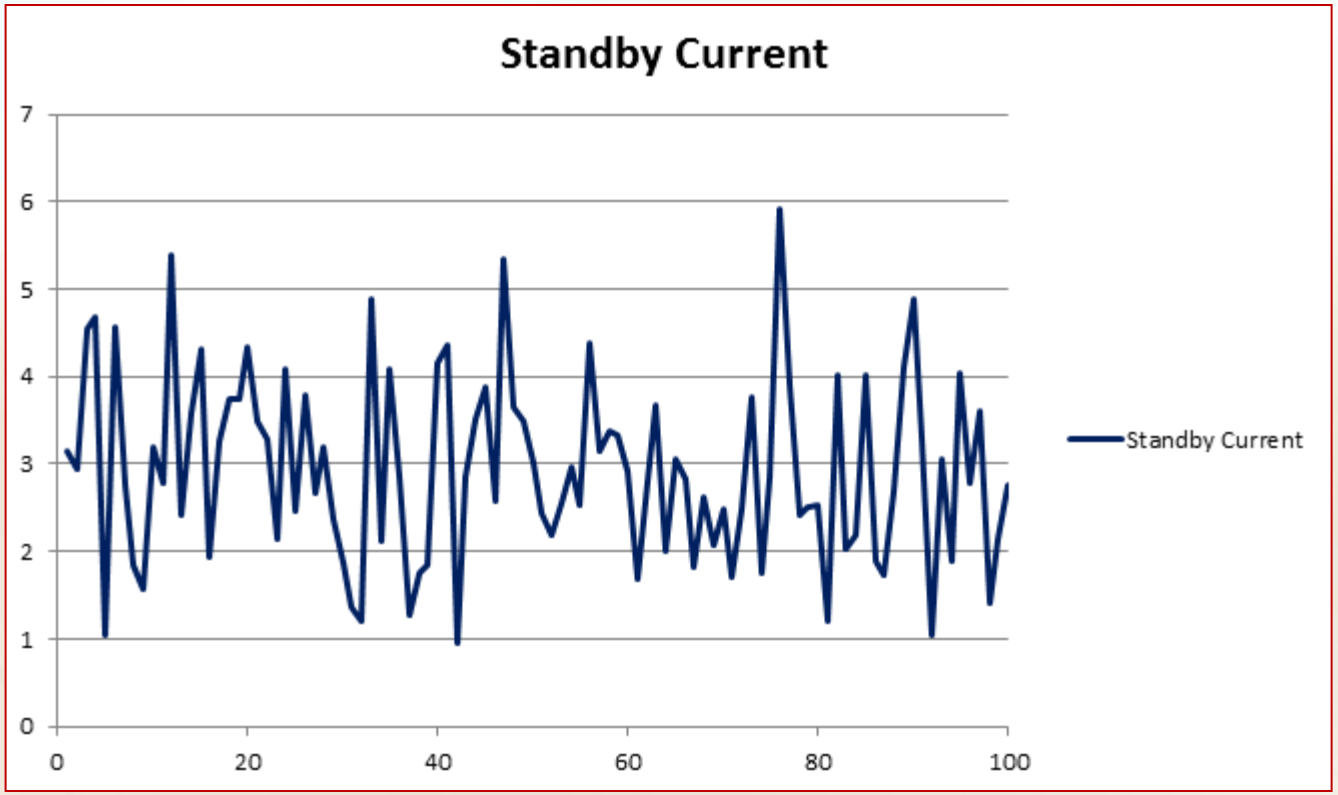
What's the limit?

Spec: Standby Current < 15.0



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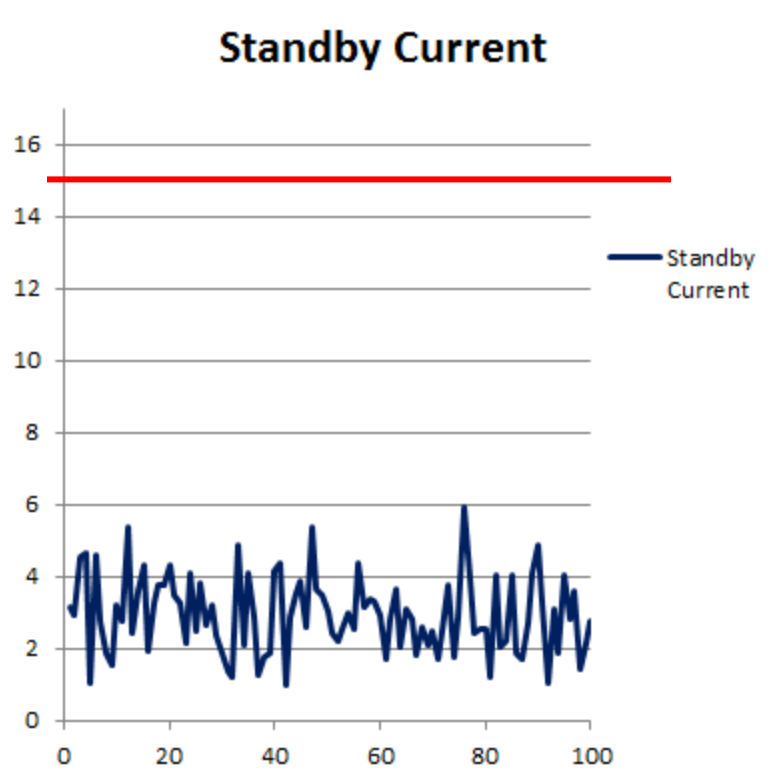
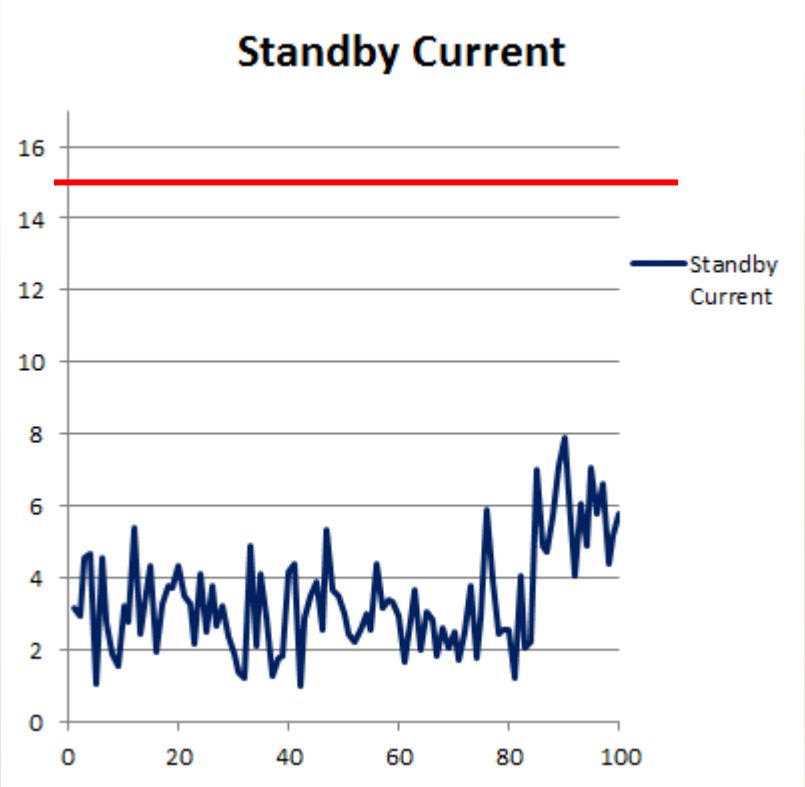
What's the limit?

Spec: < 15.0





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Test the Capability

- Expected Results:
  - Based on capability – not on Spec*
- Rationale:
  - Increase the test sensitivity
  - Find the real limit

* Unless the capabilities are worse than Spec…

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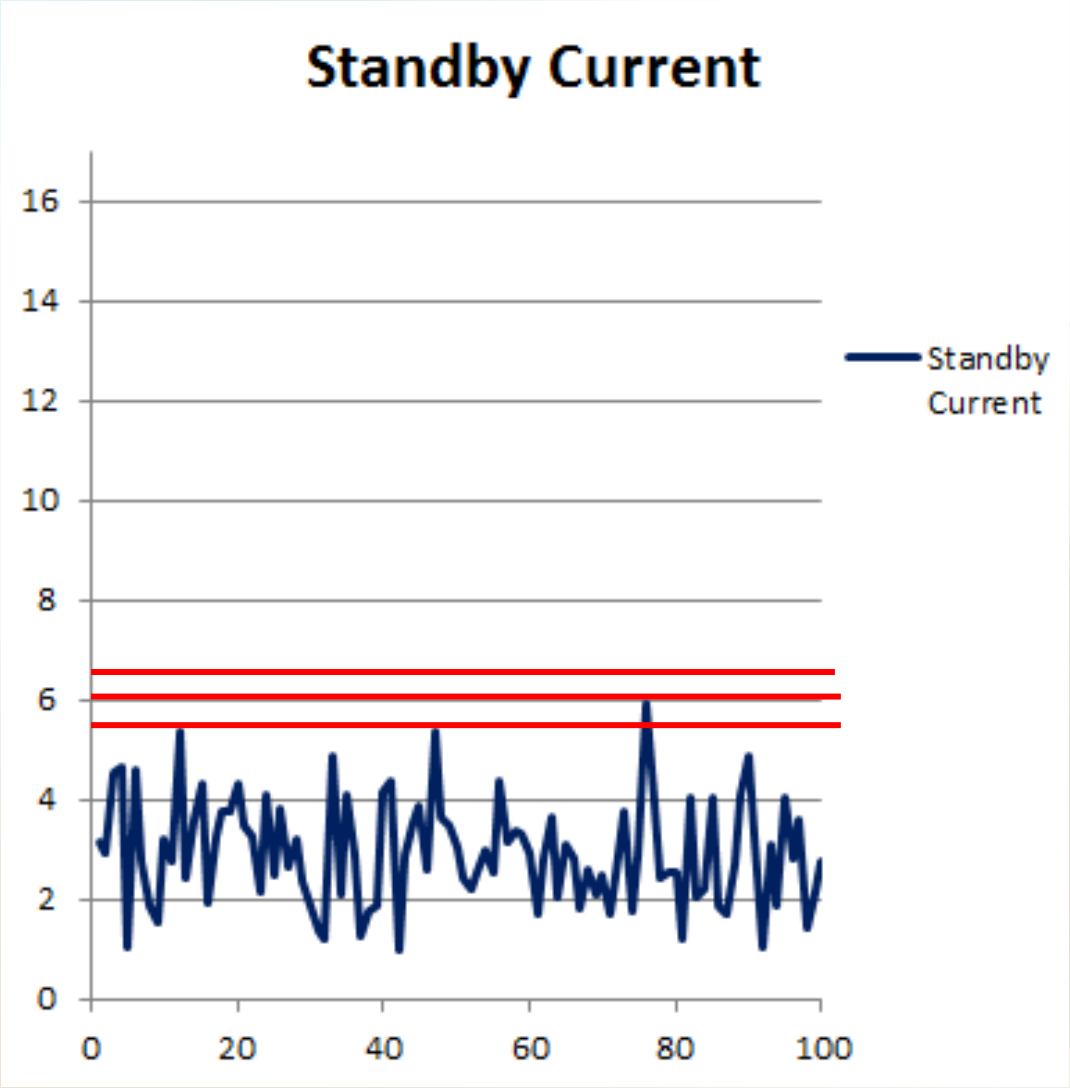
Increasing the test sensitivity

Fail if > 5.5?

6?

6.5?



Risk: False alarms

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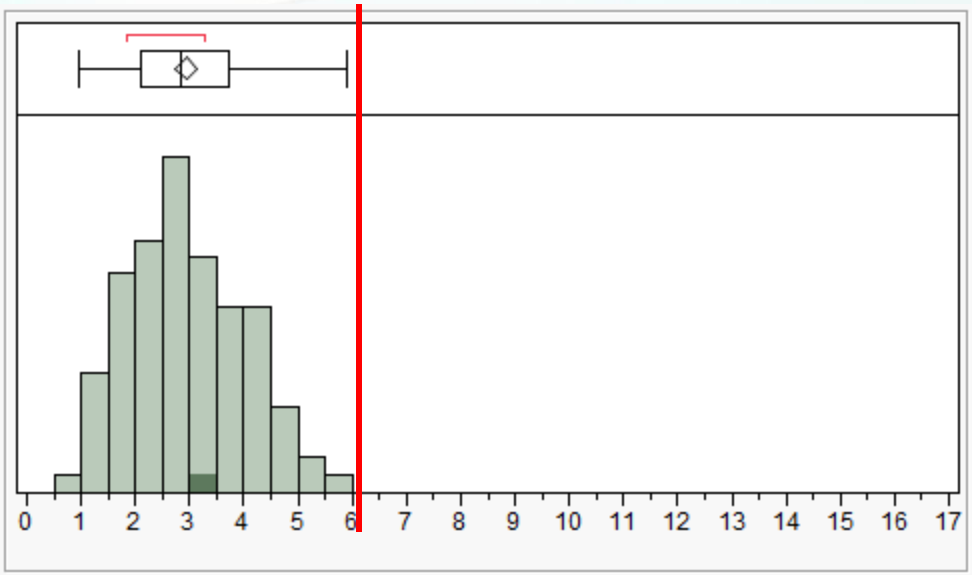
Increasing the test sensitivity

Spec: < 15.0

Where to put the test limit?



Quantiles

100.0%	maximum	5.91164
99.5%		5.91164
97.5%		5.3671
90.0%		4.36426
75.0%	quartile	3.7218
50.0%	median	2.84308
25.0%	quartile	2.1151
10.0%		1.67605
2.5%		1.04148
0.5%		0.95798
0.0%	minimum	0.95798

Moments

Mean	2.9371787
Std Dev	1.0666257
Std Err Mean	0.1066626
Upper 95% Mean	3.1488204
Lower 95% Mean	2.725537
N	100

Mean+1σ = 4; Mean+2σ = 5; Mean+3σ = 6

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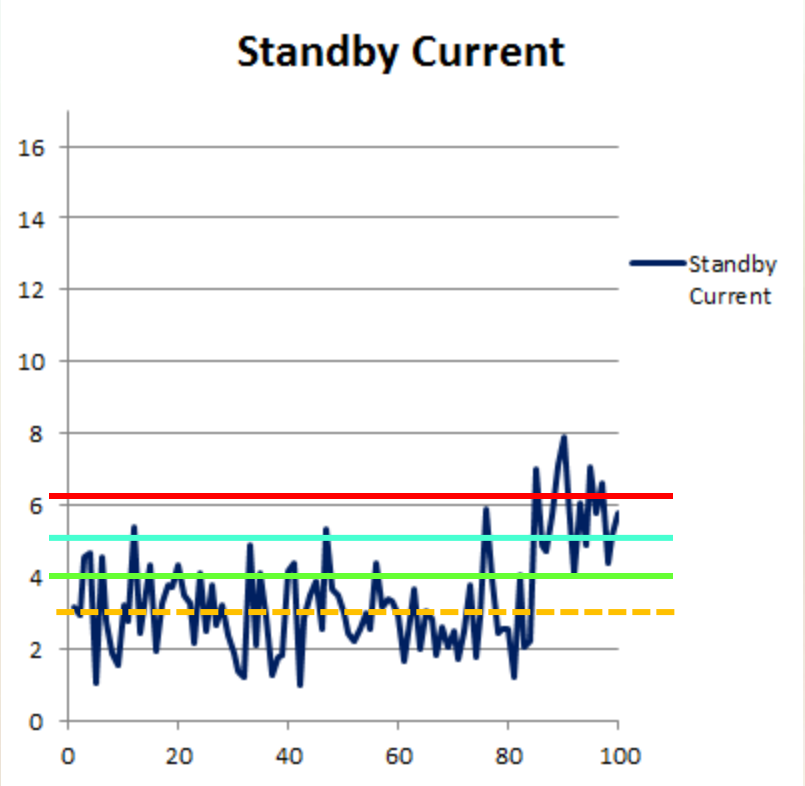
What's a Fail then?

Use Process Control methods and rules

Example: Fail if:

- One measurement above +3σ
- Two consecutive points falling above the +2σ limit
- Three consecutive points falling above the +1σ limit
- Seven consecutive points falling above the centerline
- Ten consecutive points falling below the centerline
- …

Source: Wikipedia - Western Electric rules



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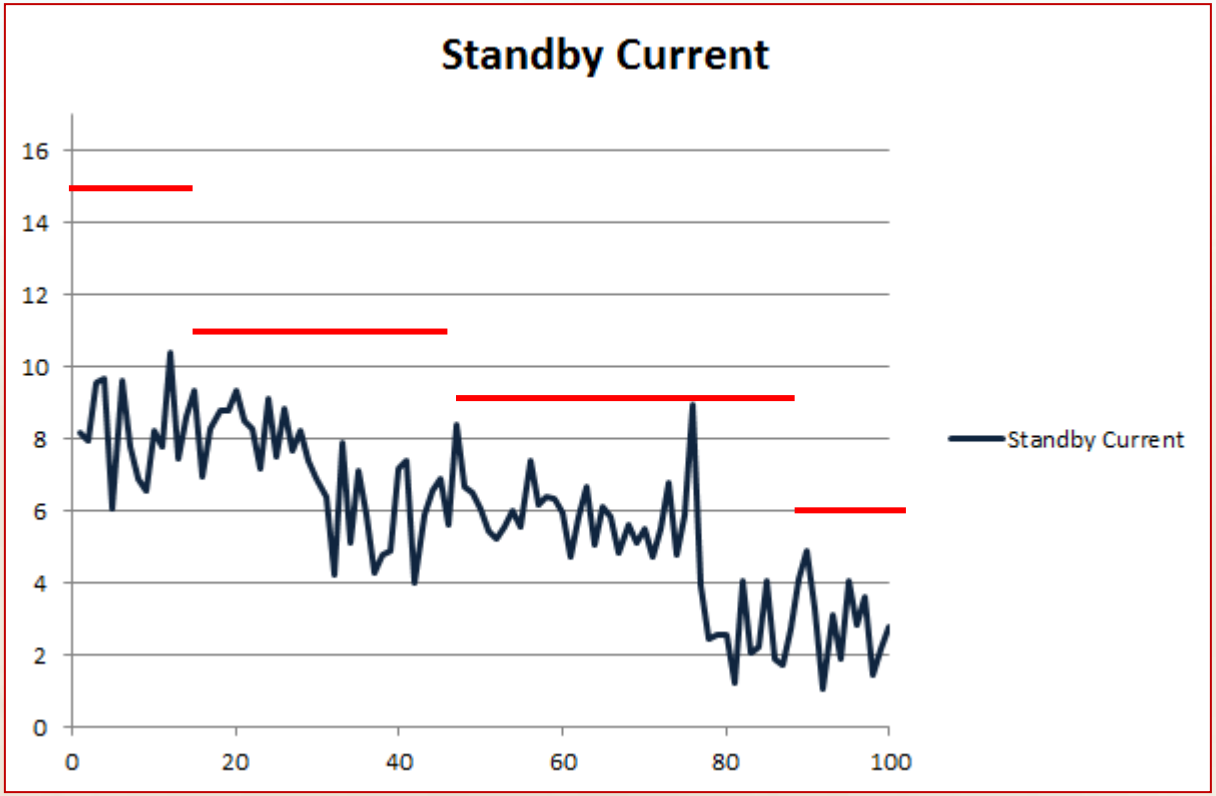
"Tighten the Screws"

Spec: < 15.0

How much regression do you allow?



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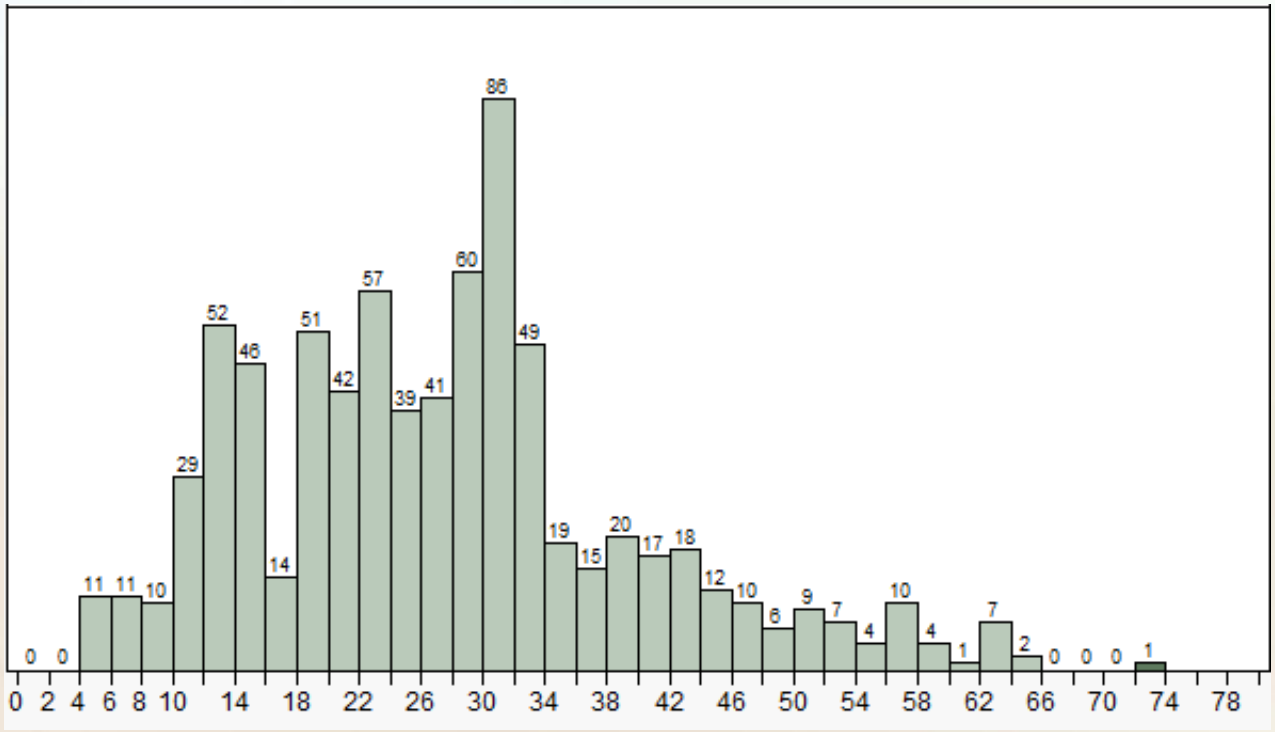
Example – real case (Atom processor)

- Some measurements ☺
- The spec: PASS if below 50%
- Capability (760 measurements):



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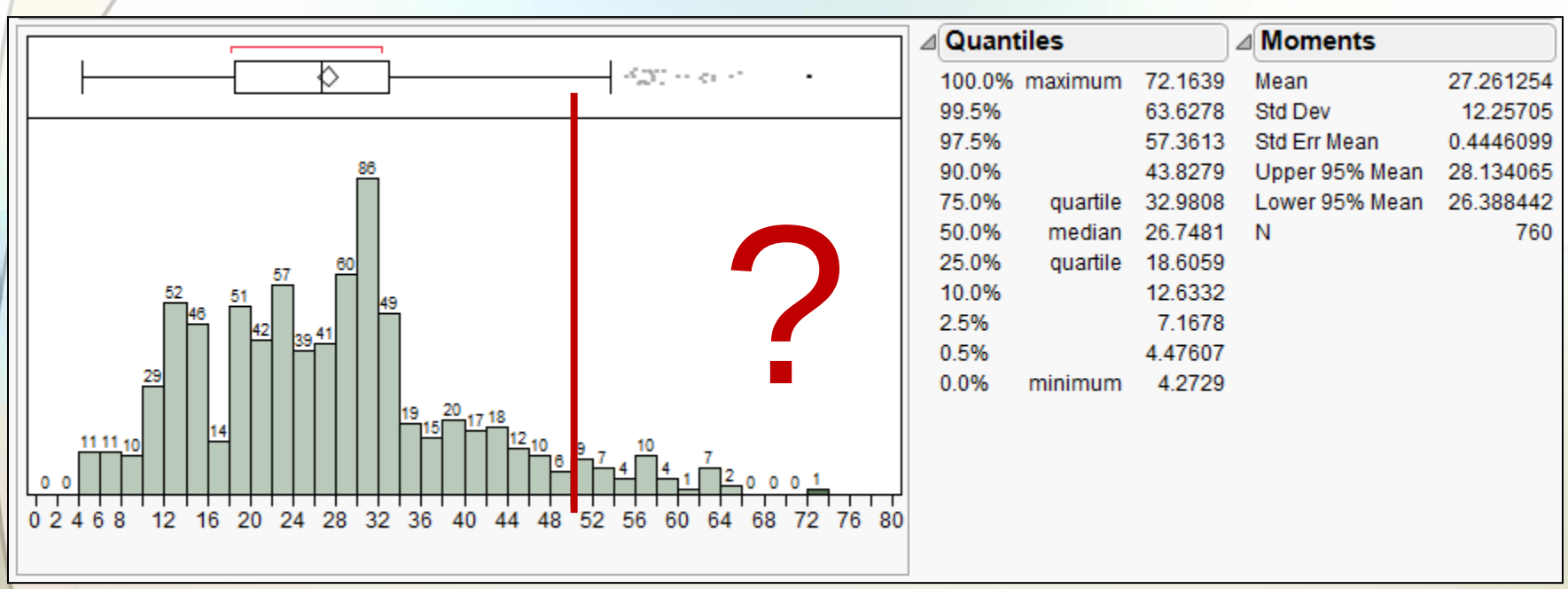
Where would YOU put the limit?



Mean+1σ = 39.5

Mean+2σ = 52.25 ☹

Mean+3σ = 64 ☹ $#^%&#@!!!

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Additional info

Different results due to different scenario

x

Scenario	1	2	3	4	...	19
Run 1	##	##	##	##		##
Run 2	##	##	##	##		##
Run 3	##	##	##	##		##
Run 4	##	##	##	##		##
Run 5	##	##	##	##		##
Run 6	##	##	##	##		##
Run 7	##	##	##	##		##
Run 8	##	##	##	##		##
Run 9	##	##	##	##		##
Run 10	##	##	##	##		##

= 760

Different results due to "system capability"

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“Use a Larger Magnifying Glass”

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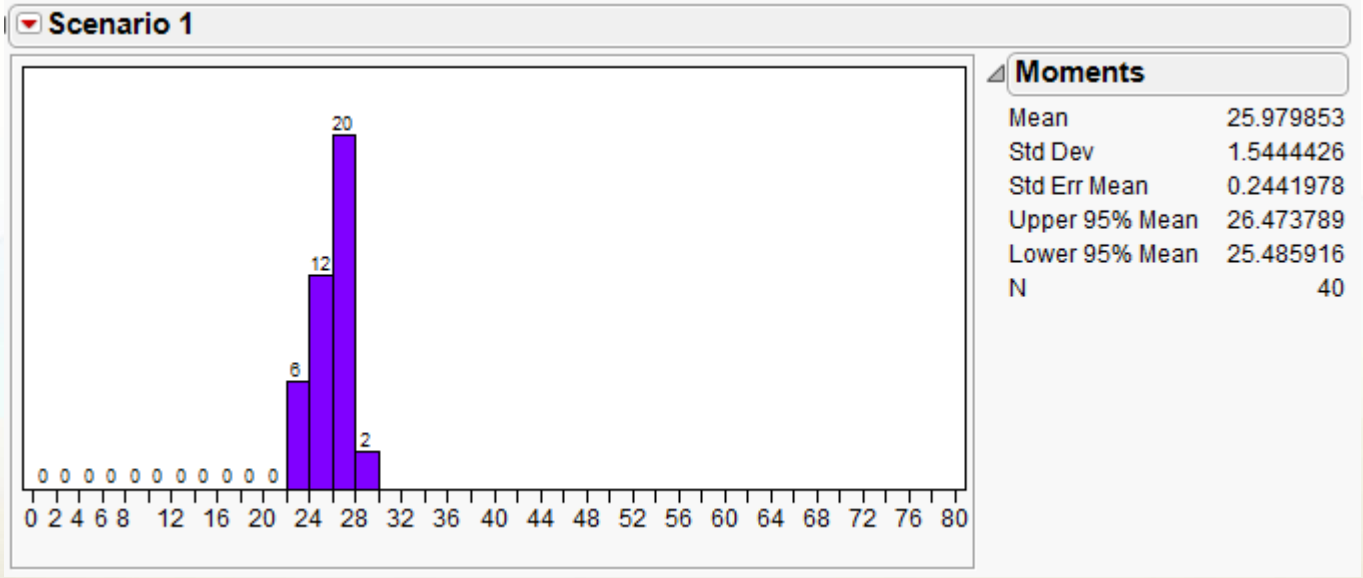
Per-scenario distribution



Mean+1σ = 27.5

Mean+2σ = 29.1

Mean+3σ = 30.6 ☺ !!!

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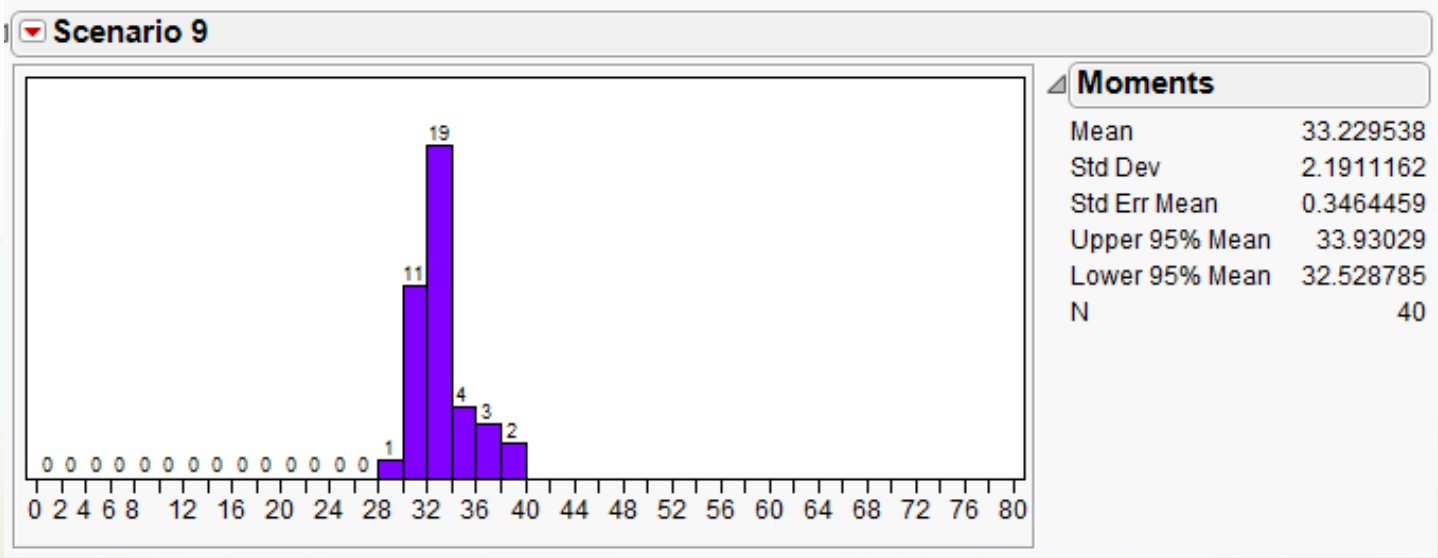
Per-scenario distribution



Mean+1σ = 35.4

Mean+2σ = 37.6

Mean+3σ = 39.8 ☺ !!!

Mean-1σ = 31.0

Mean-2σ = 28.8

Mean-3σ = 26.6

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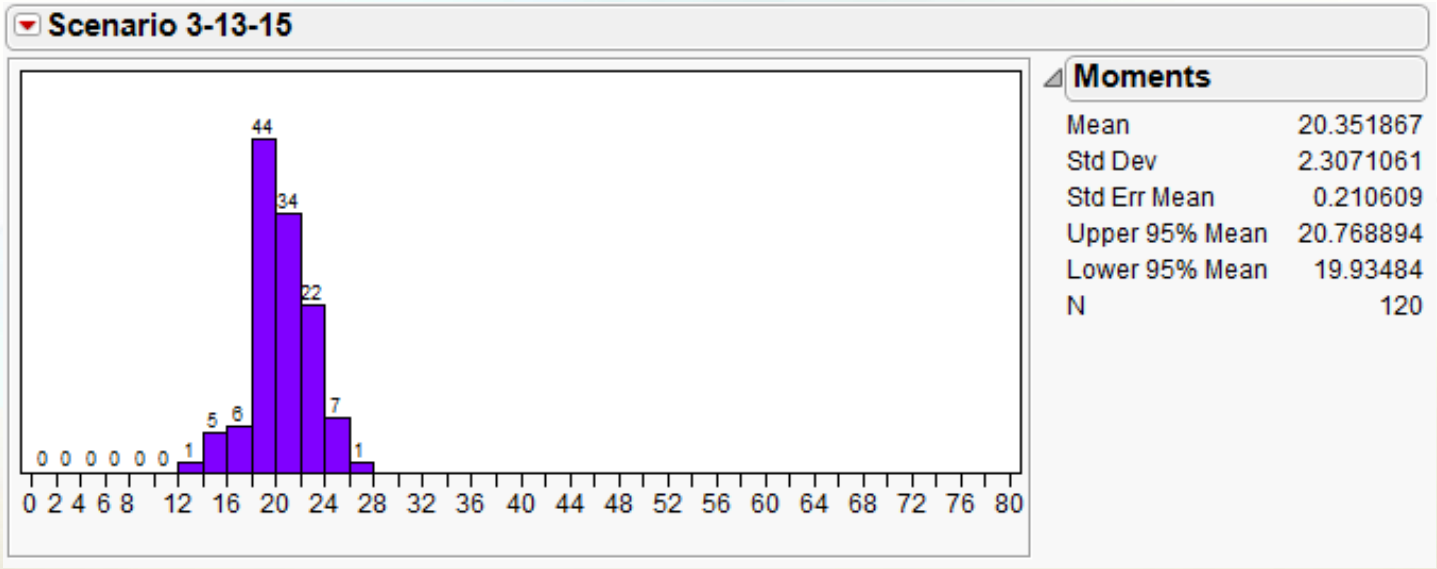
Per group-of-scenarios distribution



Mean+1σ = 22.6

Mean+2σ = 24.9

Mean+3σ = 27.2 ☺ !!!

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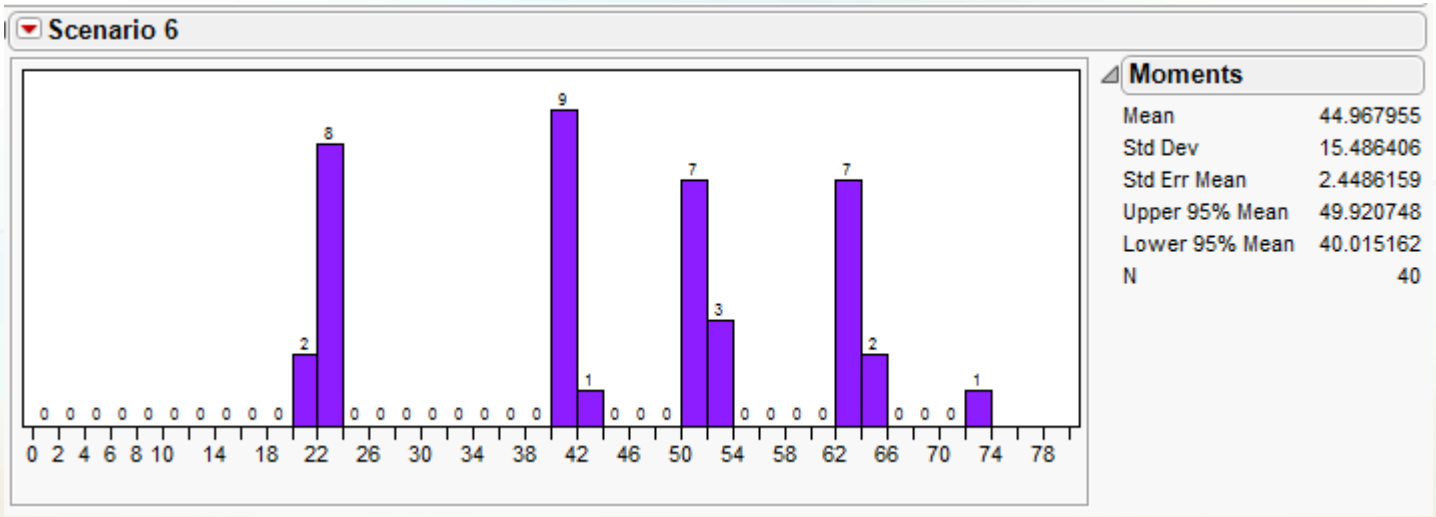
Per group-of-scenarios distribution



Something is interesting...

Or wrong...

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Setup

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Test flow (naïve)

Did "Set" work?

Set execution conditions

Apply Input

Check Output

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Validate "Set"!

Get execution conditions

(record the background)

Set to different values

(change the background)

Get execution conditions

(validate the foreground)

Set-able variables are Input!

- Apply the "Basics"
- Do you allow setting invalid values?

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Validate "Set" and "Get"!

Set test app internals to different values

(set the background)

Get execution conditions

Validate the foreground + set background for next step

Set the DUT to different values

(change the background)

Get con

(val fore

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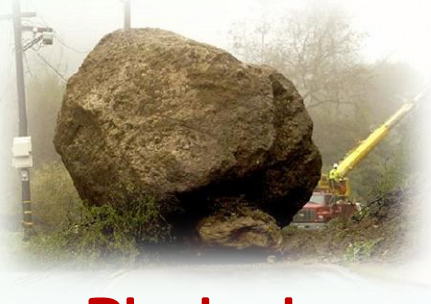
Test flow

Set execution conditions

Verify execution conditions

Fail?



Blocked!

Set background

Apply Input

DUT

Check Output

Teardown

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Teardown

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Teardown

Reset conditions to default

Clear background

Clean the environment

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Teardown & Test efficiency

- State-aware Setup
- Combine tests

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Validate your test!

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Validate your test!

Set/Verify execution conditions

Set background

Apply Input

DUT

Check Output

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Validate your test!

Set/Verify execution conditions

Set background

Apply Input

Check Output

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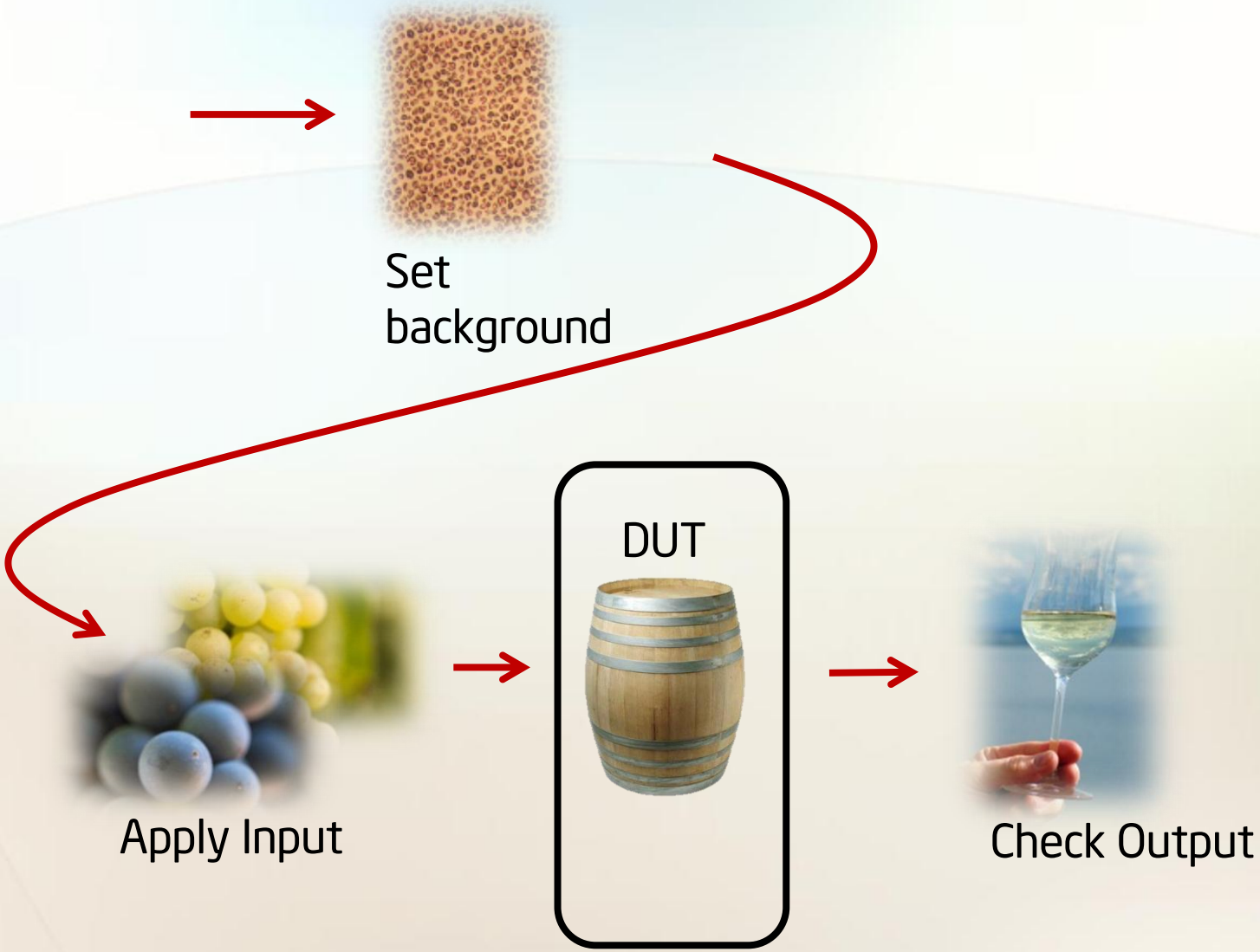
Validate your test!



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Validate your test!

Set/Verify execution conditions

Apply Input

DUT

Check Output

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Validate your test!

Set/Verify execution conditions

Set background

Apply Input

DUT

Check Output

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Validate your test!

Set/Verify execution conditions

Set background

Apply Input

DUT

Check Output

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Validate your test!

Set/Verify execution conditions

Set background

Apply Input

DUT

Check Output

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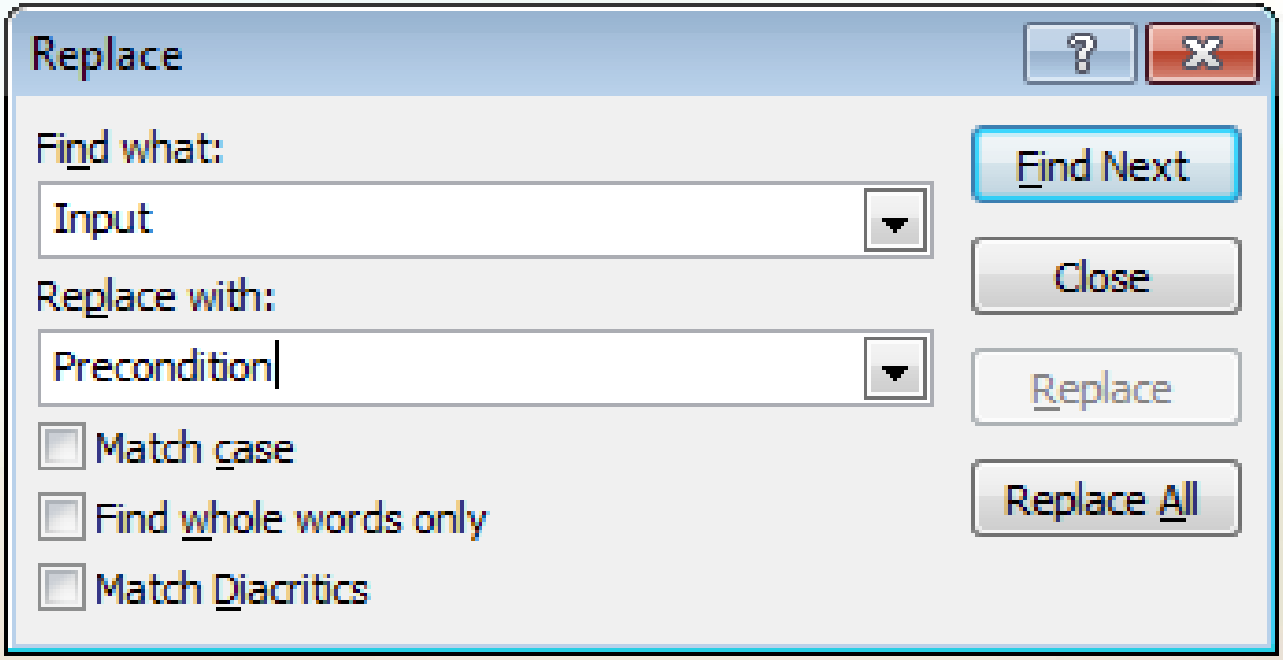
Summary



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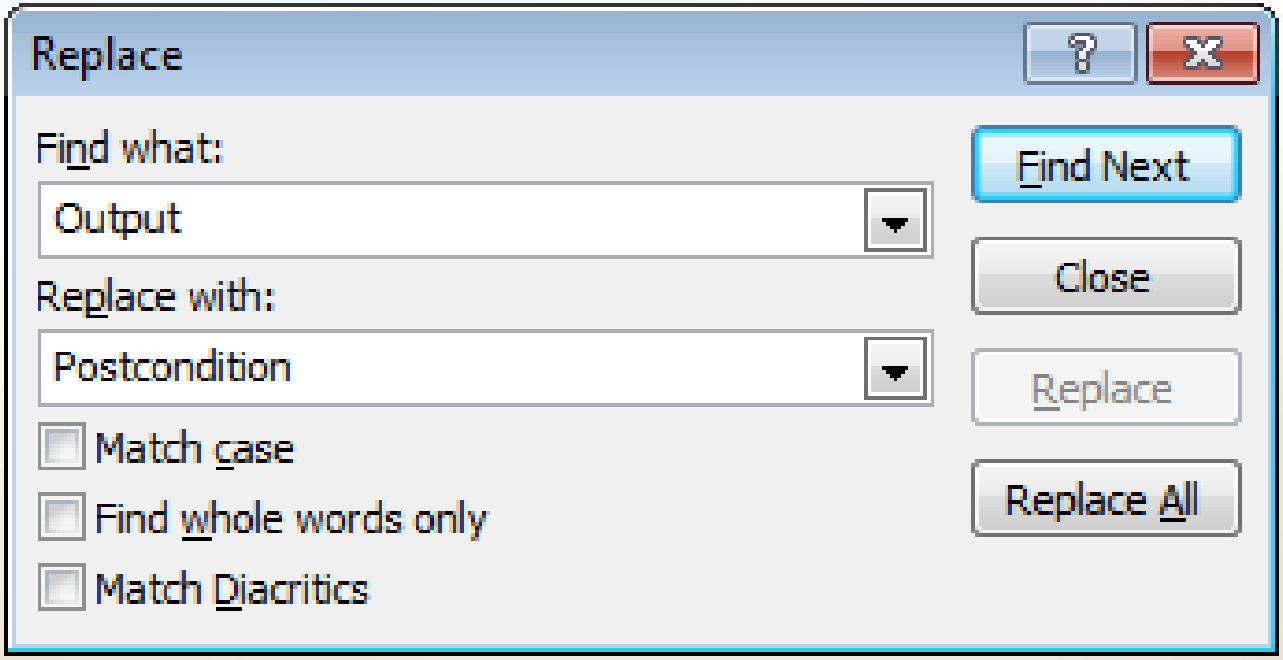
Summary



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Summary

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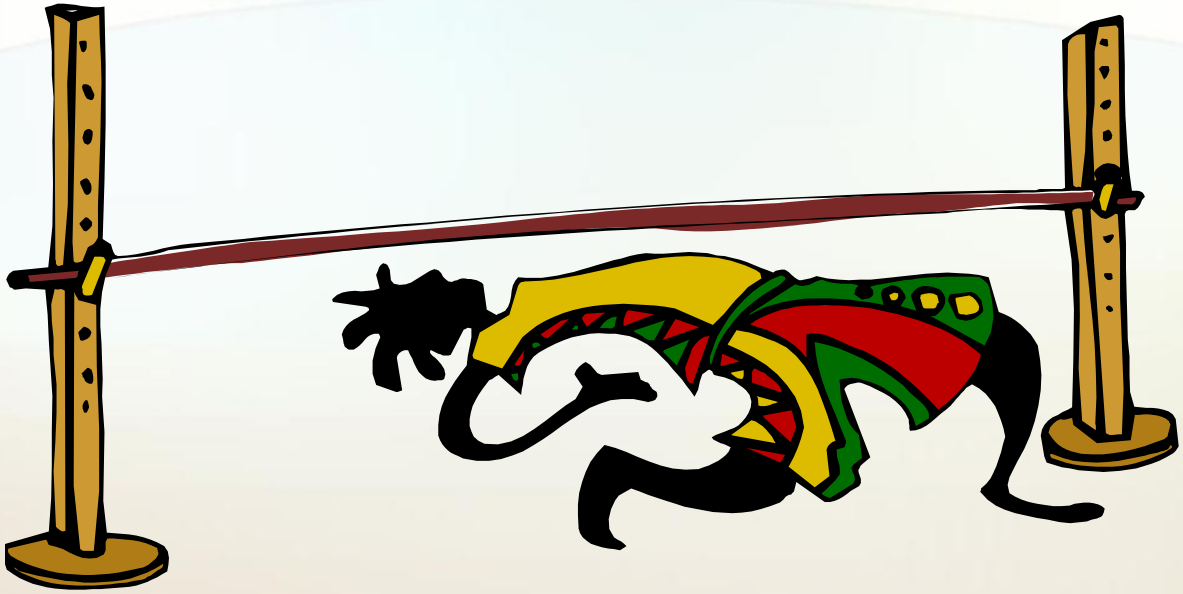
Summary



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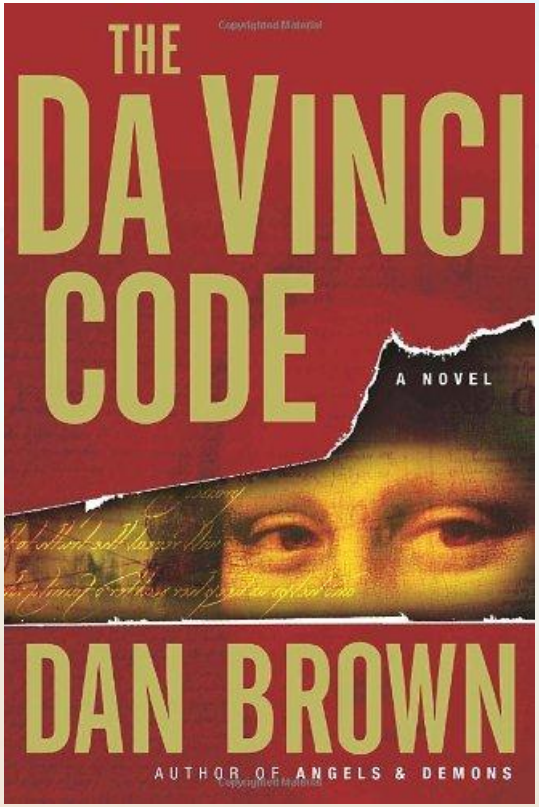
Summary



Quis custodiet ipsos custodes?

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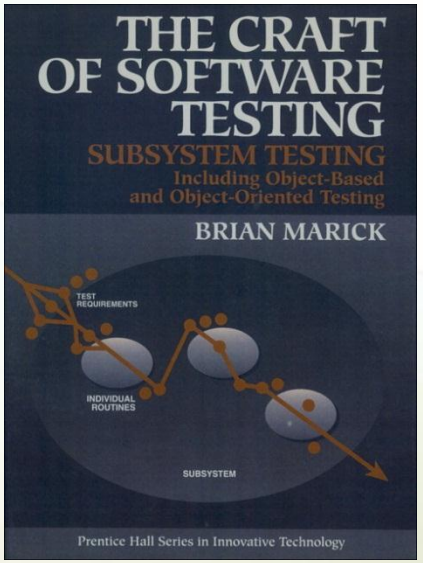
Acknowledgements / Resources

Resource:

- The Craft of Software Testing – **Brian Marick**



- Why Tests Don't Pass (or Fail), Hoffman, Doug, STPCon 2012

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Thank You!