

# Tessy

**A software tool to automate the unit testing of embedded software**

**Frank Büchner**  
**Hitex Development Tools GmbH**  
**[frank.buechner@hitex.de](mailto:frank.buechner@hitex.de)**



## Some Questions

---

- Does testing waste too much of your time?
  1. Do you manually test your software?
  2. Do your test efforts for small bug fixes consume more time than the actual bug fixes themselves?
  3. Do you have to maintain a proprietary test environment?
  4. Do you manage the test data by yourself?
  5. **Are you continuously in doubt whether you've tested enough?**


## Some Questions

---

- Are you required to develop in accordance with standards?
  1. Are you required to plan the tests in advance?
  2. Are you required to do unit testing?
  3. Are you required to do regression testing?
  4. Are you required to document all tests?
  5. Are you required to check your test coverage?

# Contents

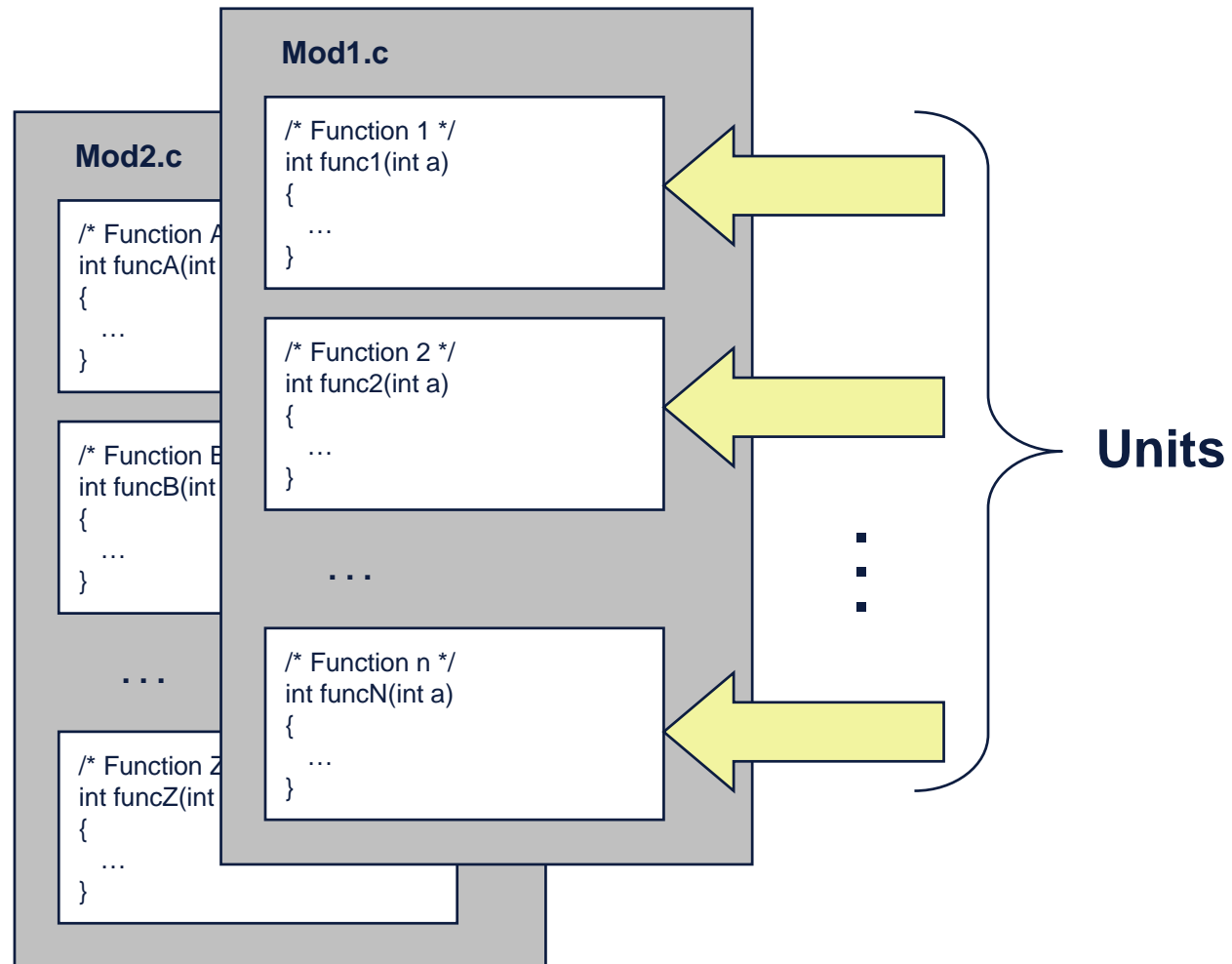
---

1. Introduction / Some Questions
2. Unit Testing In Standards
-  3. Unit Testing Of C Programs
4. Unit Testing With Tessy
5. Advanced Topics
6. Conclusion



# Unit Testing Of C Programs

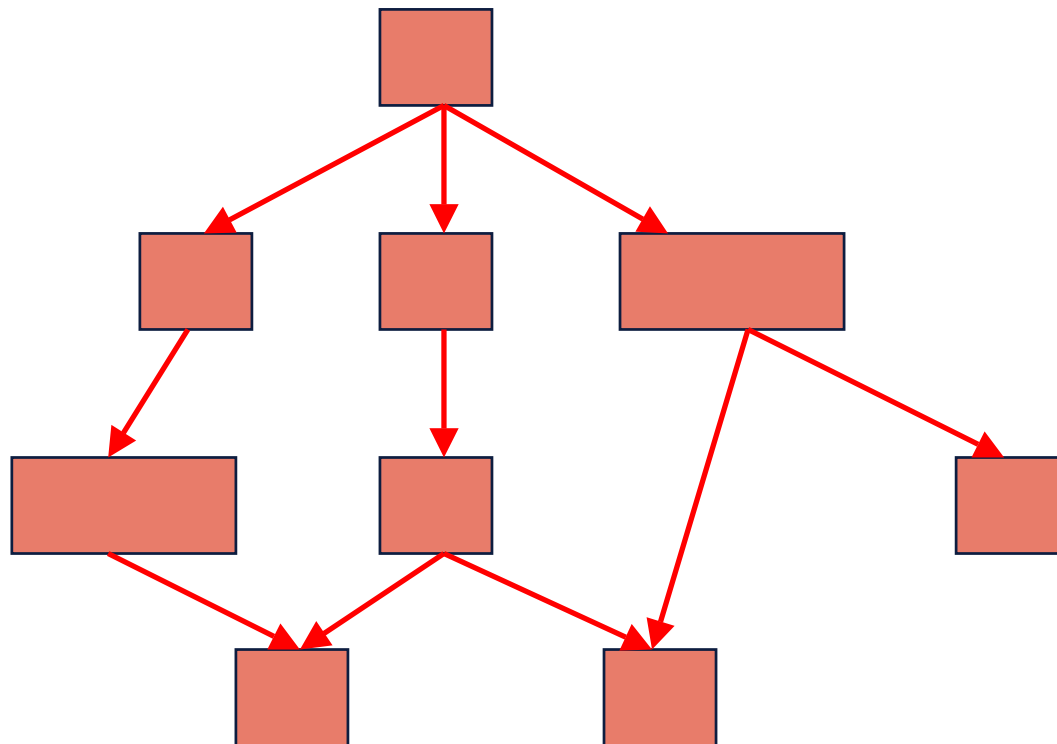
## ■ What is an “unit” ?



# Unit Testing Of C Programs

## ■ Software application, initial

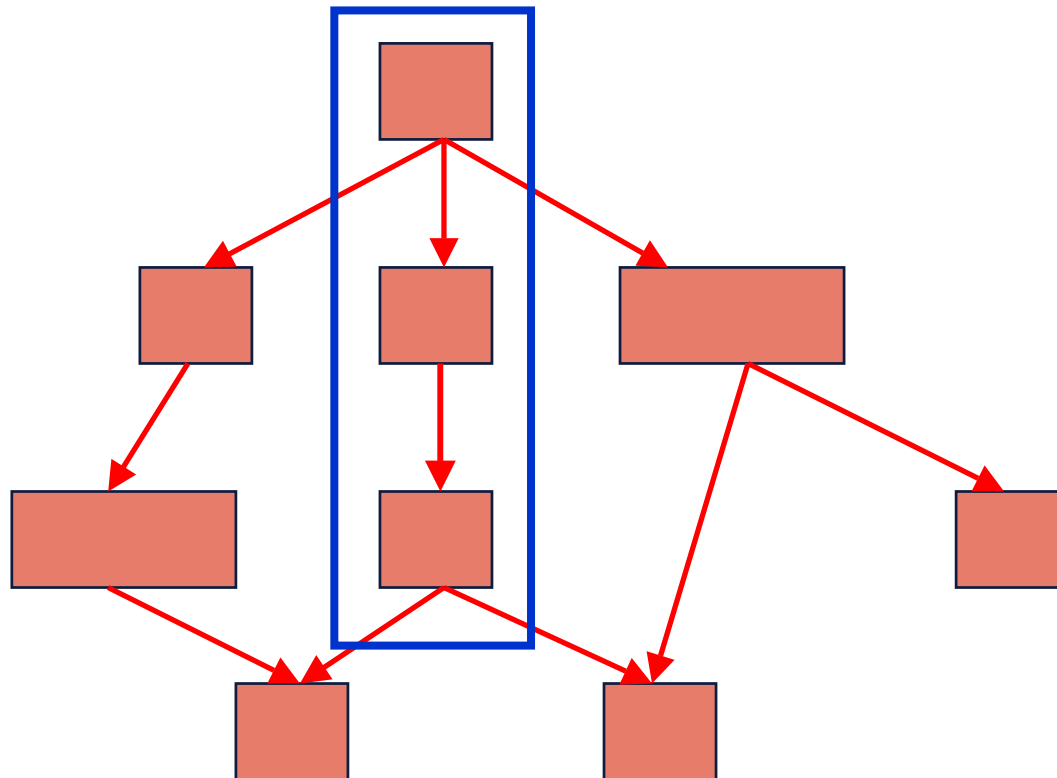
- Function call, untested
- Unit, unit test not passed



# Unit Testing Of C Programs

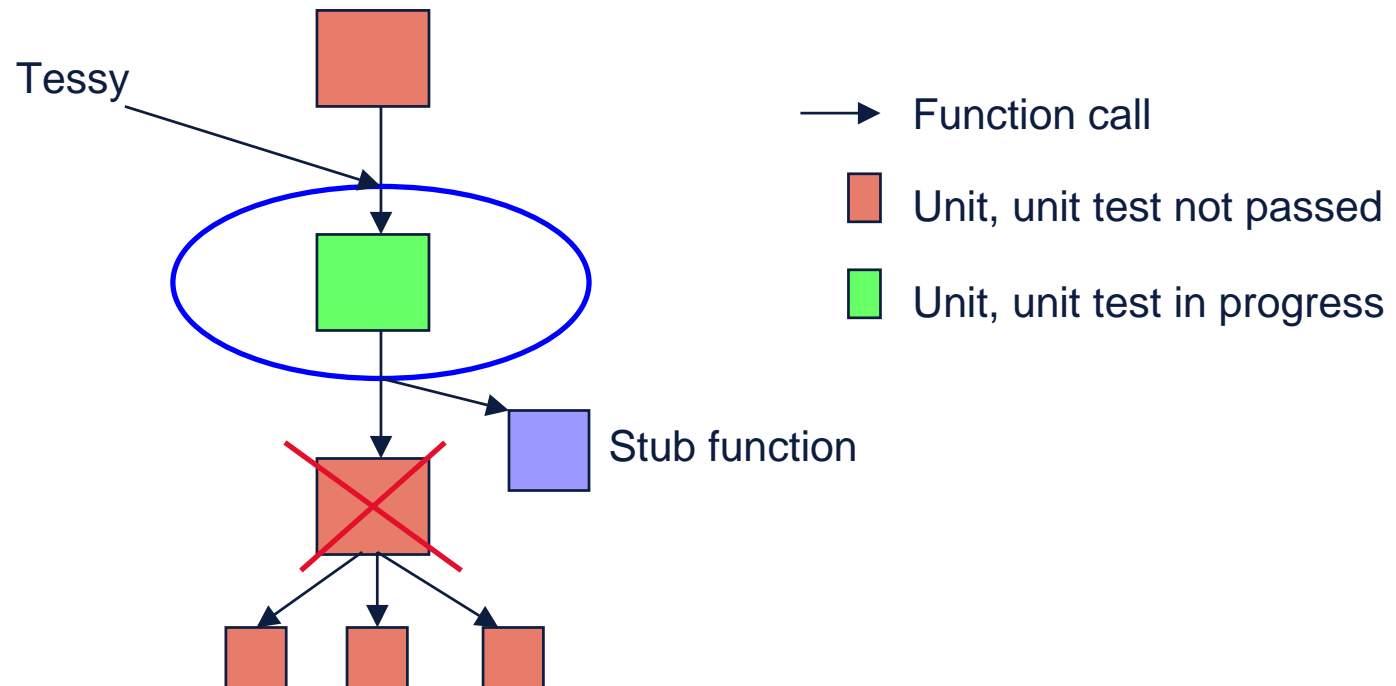
## ■ Software application, initial

- Function call, untested
- Unit, unit test not passed



# Unit Testing Of C Programs

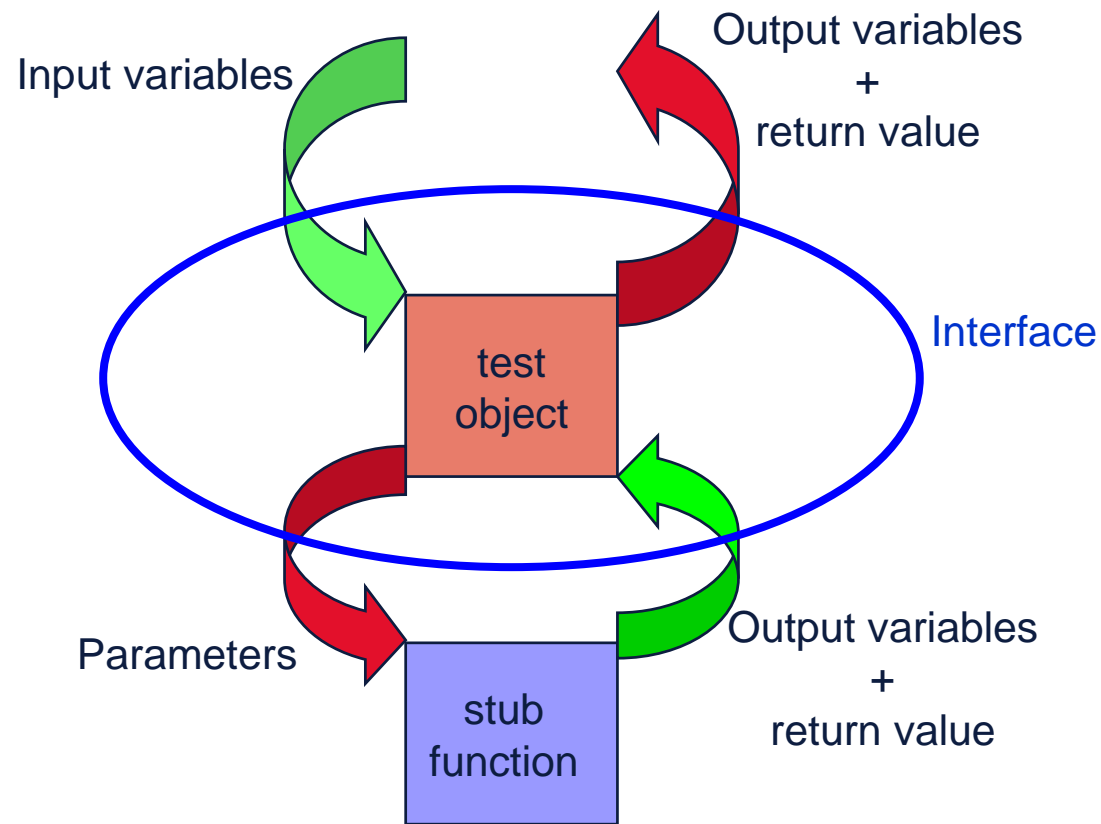
- All units are tested **one by one**, **comprehensive** and **isolated** from each other



- Isolation → reproducibility → prerequisite for regression test

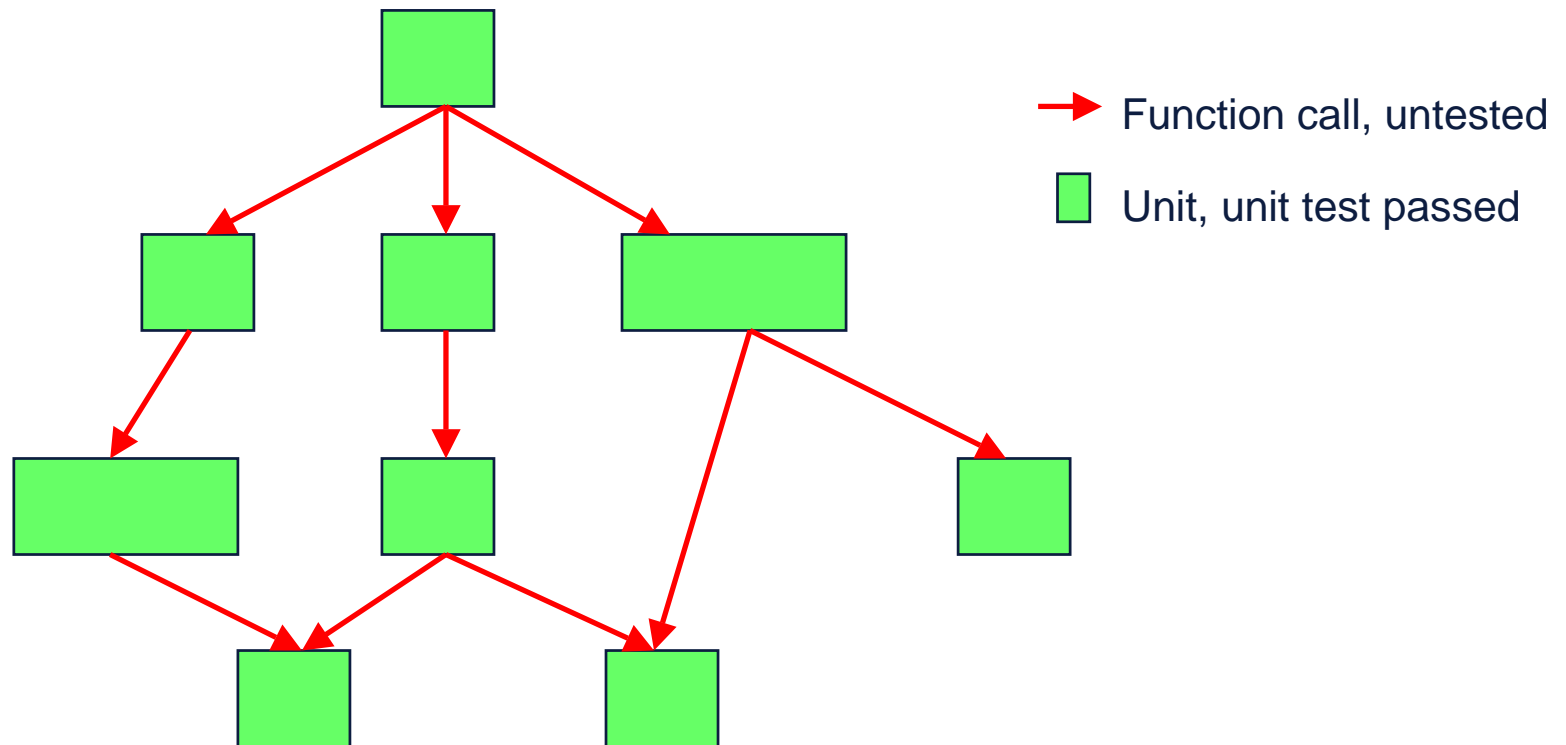
# Unit Testing Of C Programs

- Unit testing checks, if input values yield expected output values



# Unit Testing Of C Programs

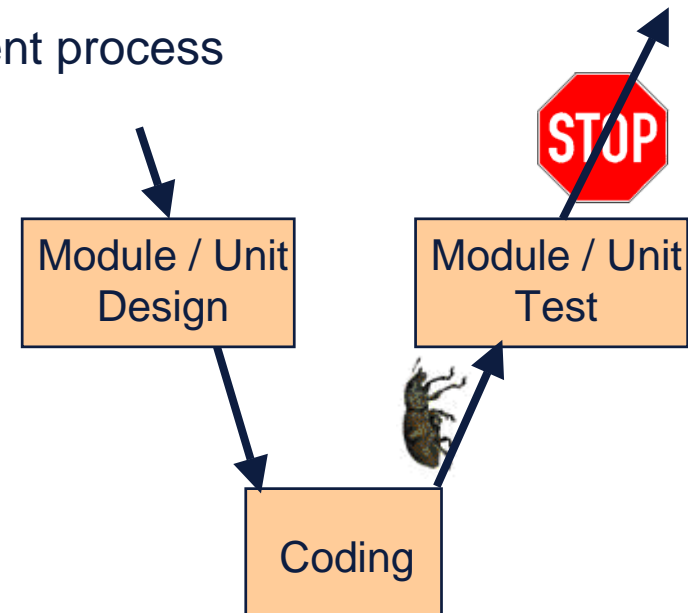
- After unit testing, all units are considered tested (separately)



# Unit Testing Of C Programs

## ■ Benefits of unit testing

1. Reduces complexity of test case specification ("divide-and-conquer")
2. Easy fault isolation, fast error detection
3. Finds errors early in the development process
4. Saves money
5. Gives confidence



# Unit Testing With Tessy

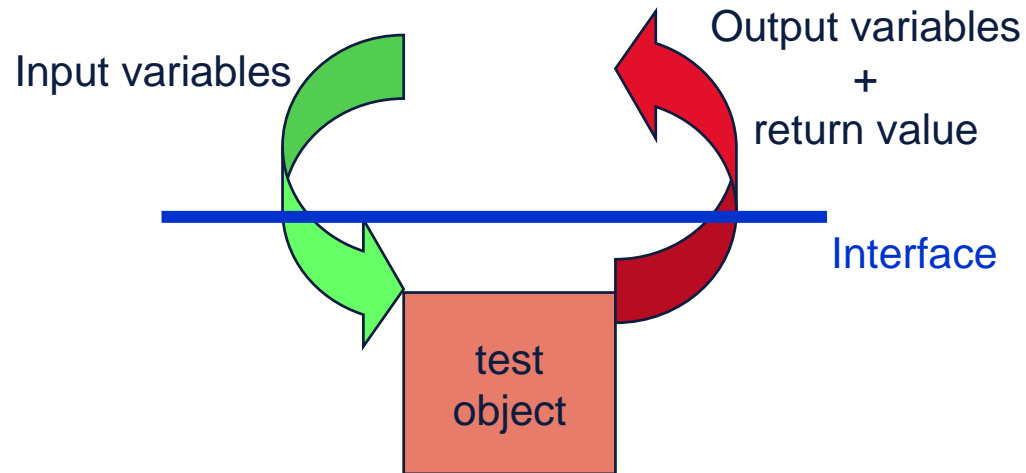
## ■ Tessy ...

- Analyzes the test object's C source code module
- Lists the C functions in it
- Determines the **interface** of each C function (test object, function under test)

```
Mod1.c  
  
/* Function 1 */  
int func1(int a)  
{  
    ...  
}  
  
/* Function 2 */  
int func2(int a)  
{  
    ...  
}  
  
...  
  
/* Function n */  
int funcN(int a)  
{  
    ...  
}
```

# Unit Testing With Tessy

- The interface determines the structure of a test case



*Simplified!*

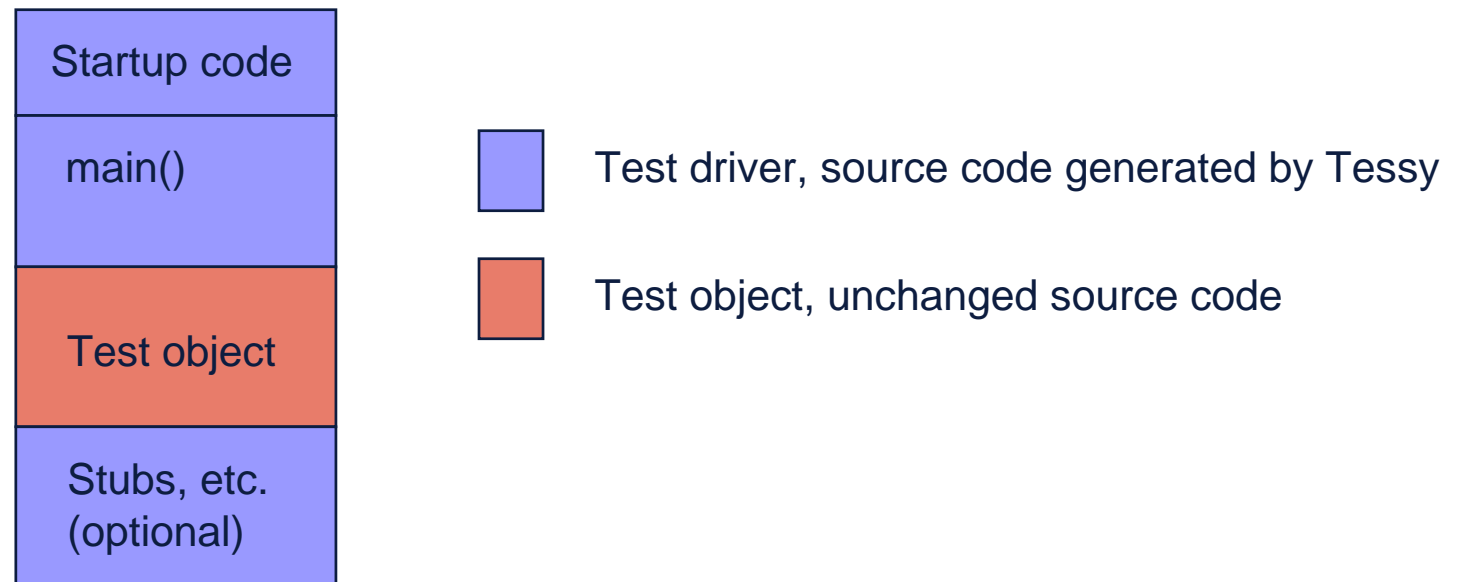
In	In	InOut	Out	Return
a	b	c	d	
5	3	4 8	17	42

Direction  
Variable  
Test case

# Unit Testing With Tessy

## ■ Tessy creates the test application

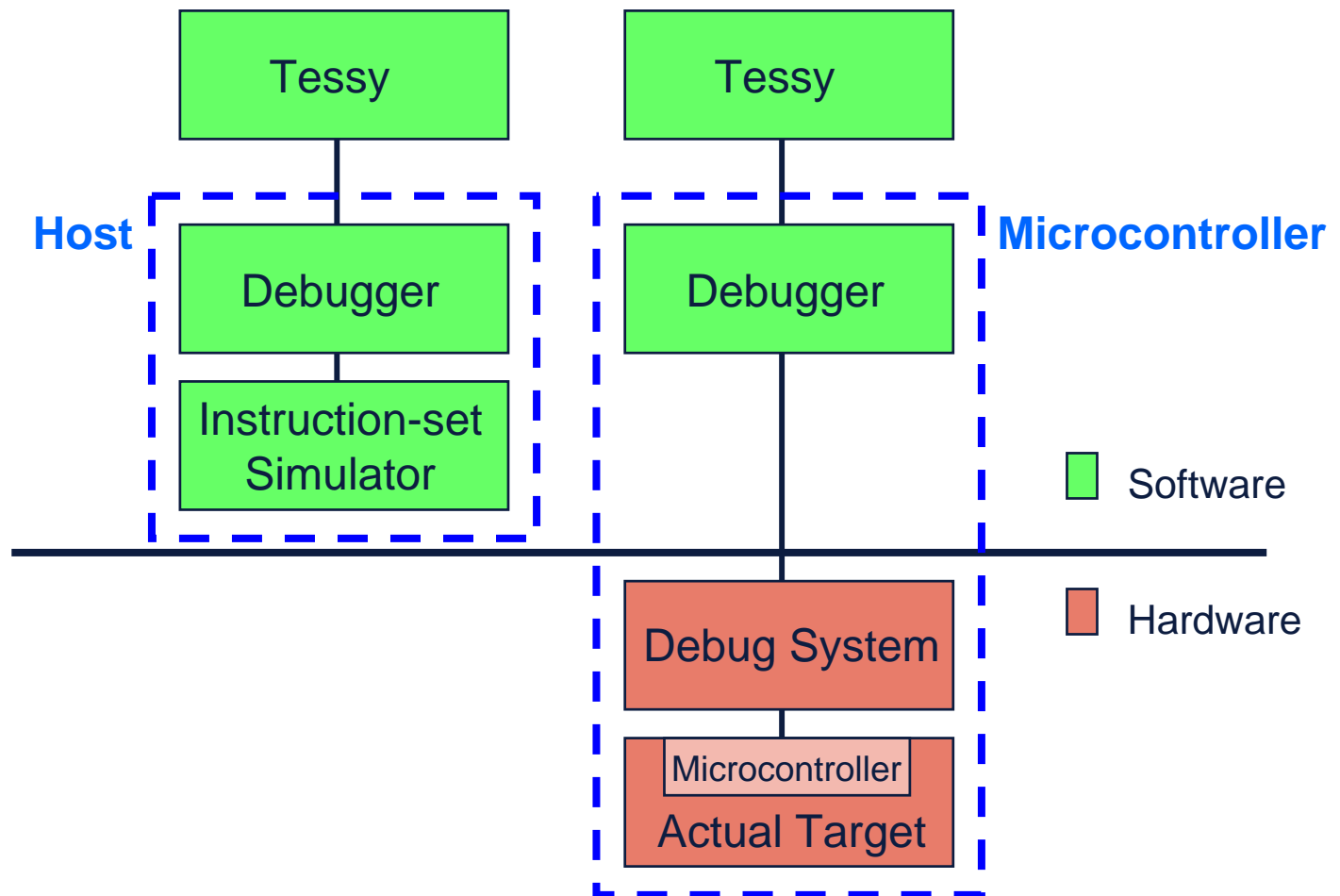
- Test driver (= test harness) + test object = **test application**



- Test data is not included in the test application

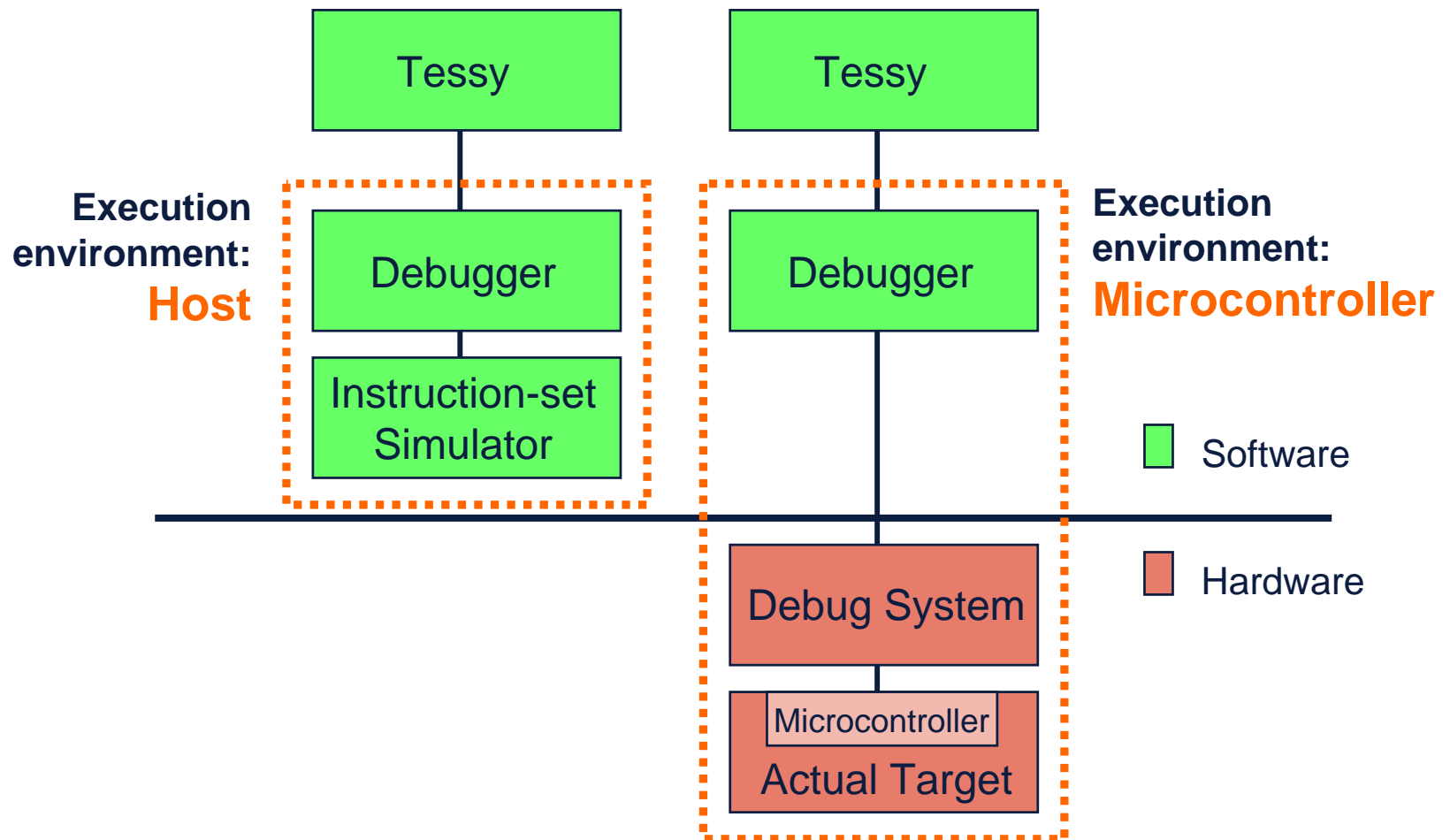
# Unit Testing With Tessy

## ■ Test execution environments



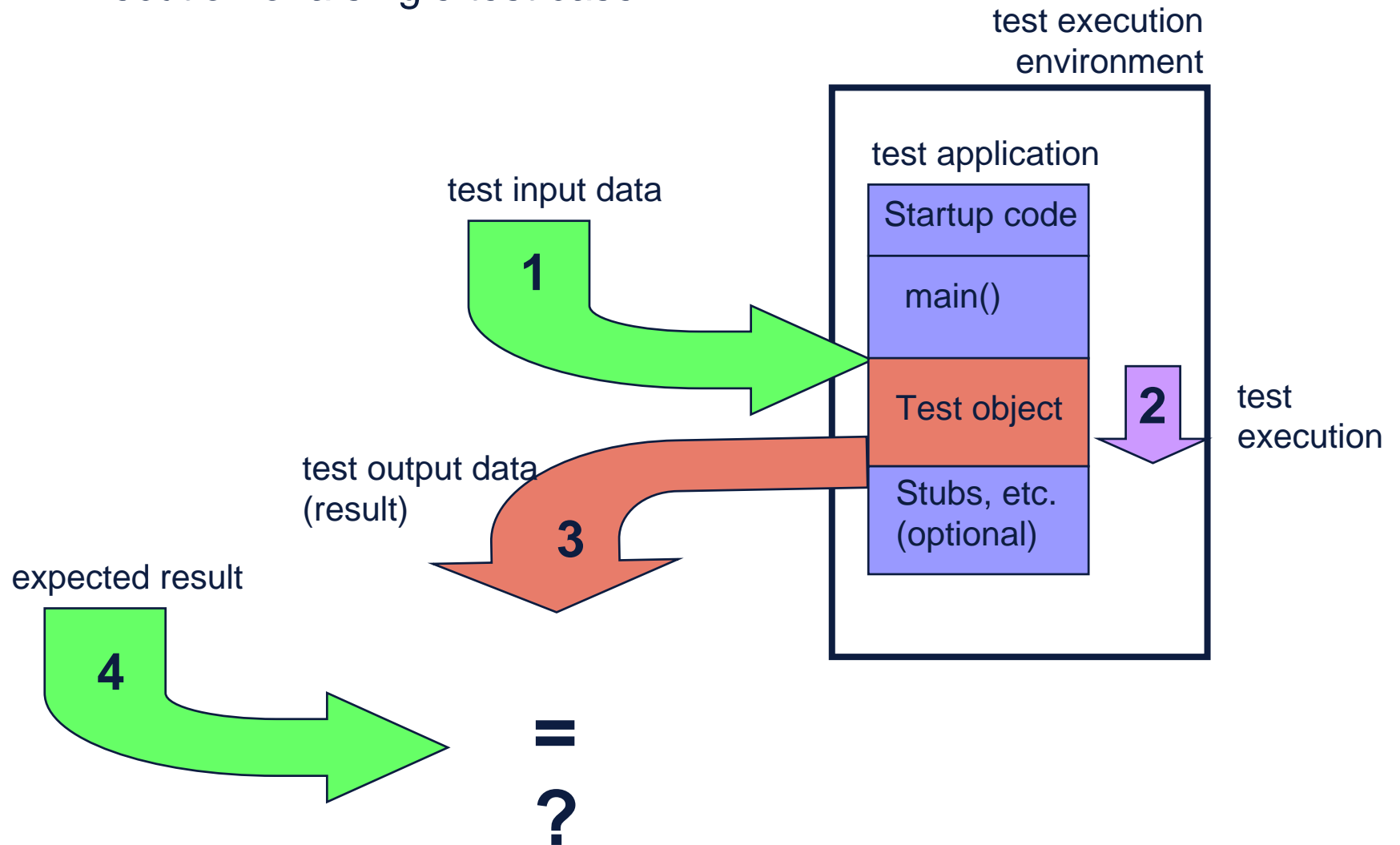
# Unit Testing With Tessy

## ■ Test execution environments



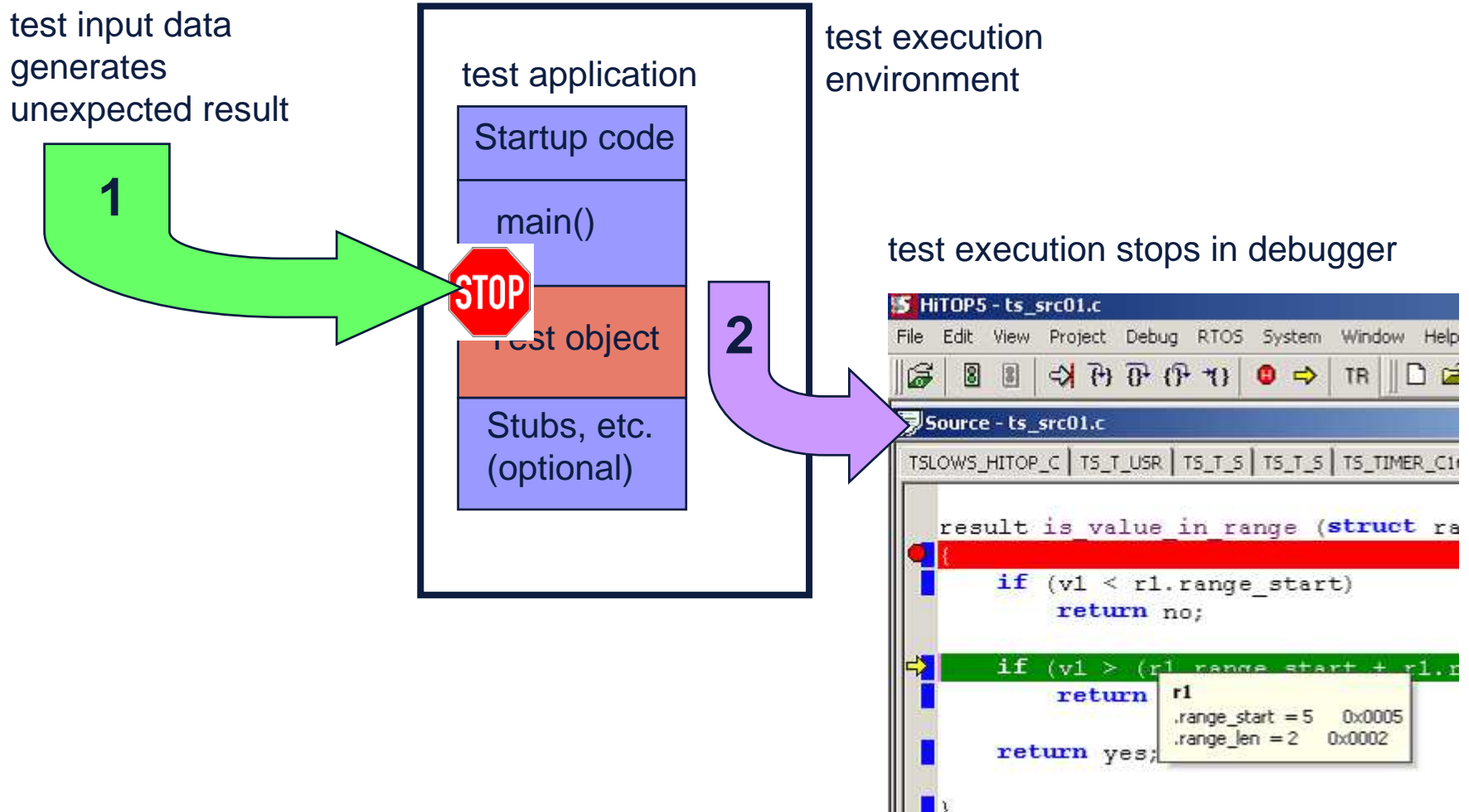
# Unit Testing With Tessy

## ■ Execution of a single test case



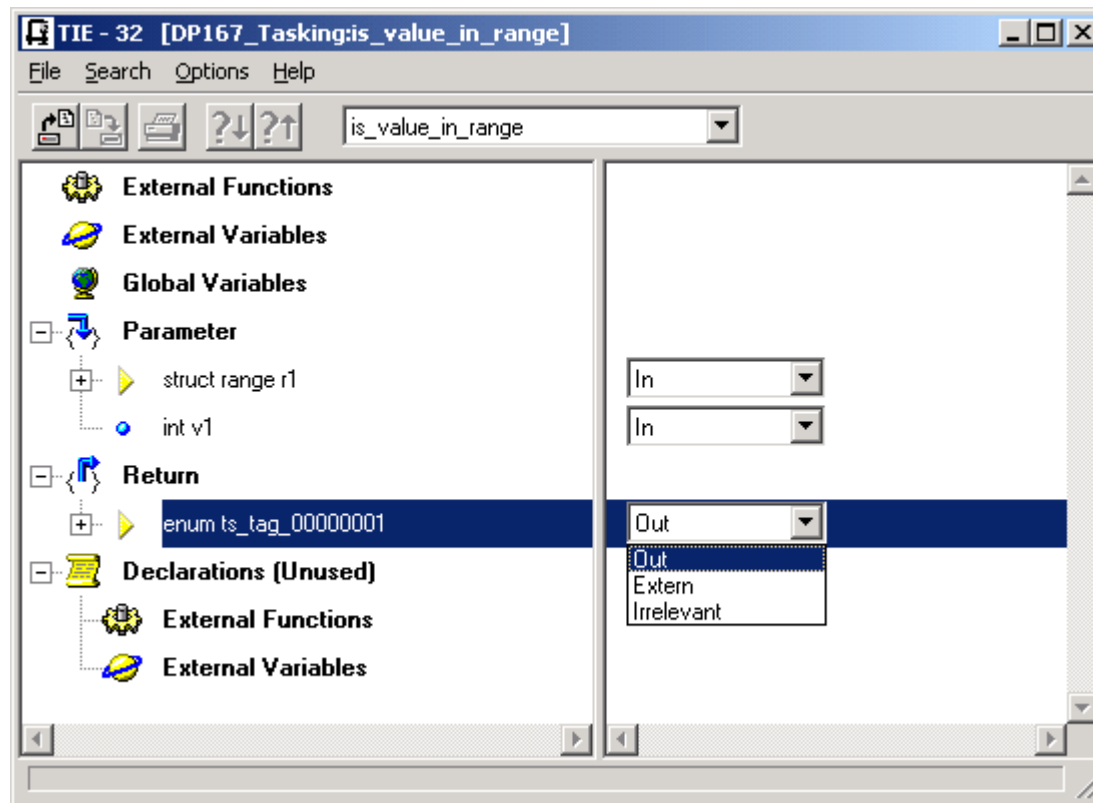
# Unit Testing With Tessy

## ■ Execution of a failed test case



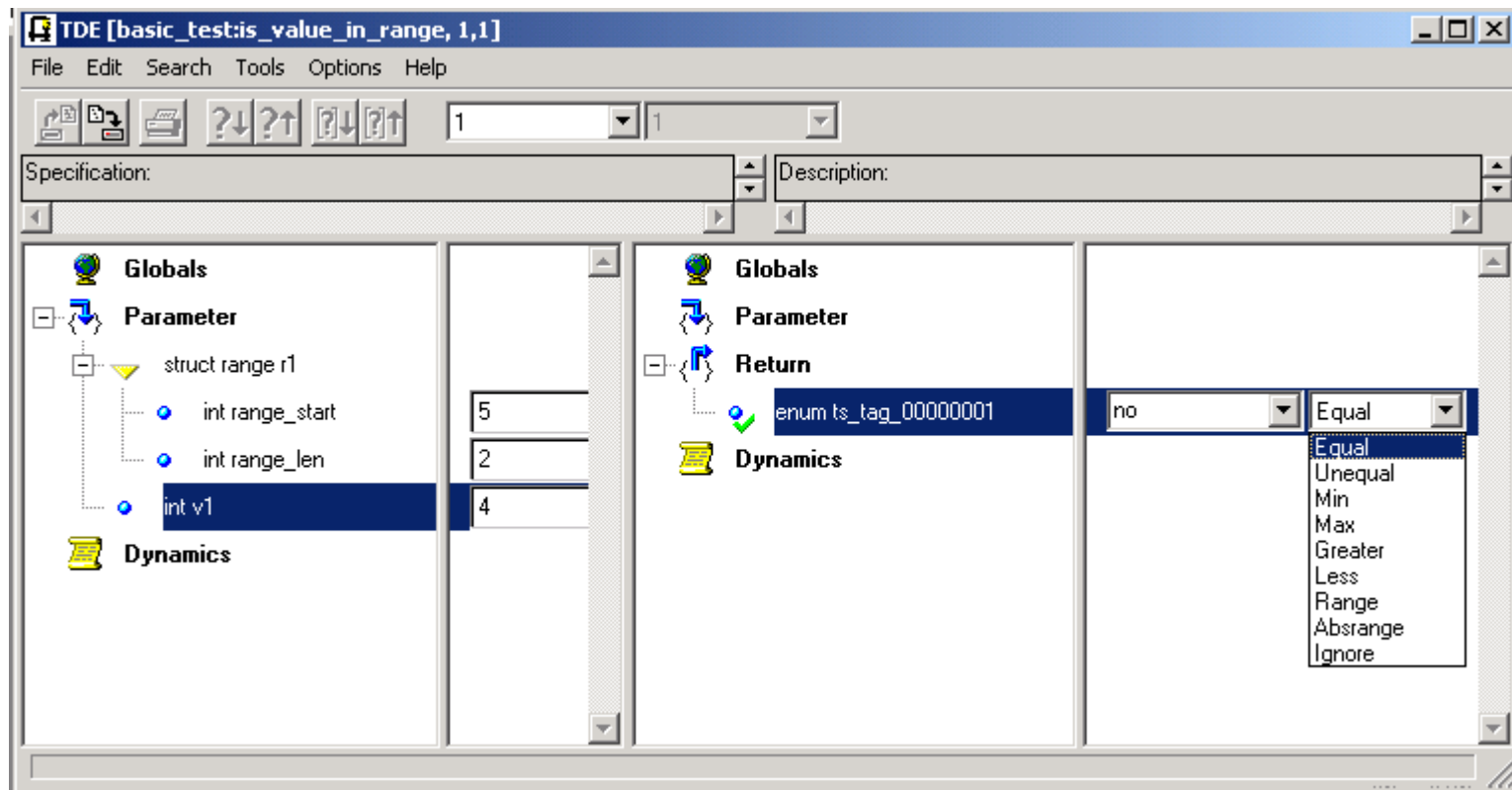
# Tessy

- Test Interface Editor (TIE) -- part of Tessy



# Tessy

## ■ Test Data Editor (TDE) -- part of Tessy



# Tessy - Code Coverage

---

## Tessy features

- C1 coverage
  - Branch coverage = decision coverage
- C2 coverage
  - Modified Condition / Decision Coverage (MC/DC)
  - Multiple Condition Coverage (MCC)
  
- MC/DC and MCC are available since Tessy V2.5
- The Tessy Coverage Viewer is available since Tessy V2.6

# Tessy - Code Coverage

- C1 code coverage results
  - Tessy reveals which branches were not taken

The screenshot displays the CV - Tessy Coverage Viewer interface. The main window shows a flowchart for the function `is_value_in_range`. A red box highlights a branch in the flowchart, indicating it was not taken. The coverage summary table shows a total coverage of 75.00%.

Testcase / Teststep	Coverage
1 (1)	25.00 %
2 (1)	50.00 %

```
is_val_in_range_0.c | C1-Report | MCC-Report | MC/DC-Report
Result is_value_in_range (struct Range r1, int v1)
{
    if (v1 < r1.range_start)
        return no;

    if (v1 > (r1.range_start + r1.range_len))
        return no;

    return yes;
}
```

# Tessy - Code Coverage

- Modified Condition / Decision Coverage (MC/DC)
  - If a decision is selected in the tree view, the corresponding source is displayed

The screenshot displays the Tessy Coverage Viewer interface. The main window is titled "CV - Tessy Coverage Viewer" and contains several panes:

- Called Functions:** A list showing the function "abcd".
- Control Flow Graph (CFG):** A diagram showing a decision node (diamond) with three outgoing paths labeled 1, 2, and 3. Path 3 is highlighted in red, indicating it is the selected condition.
- MCC-Coverage:** A table showing coverage for Modified Condition/Decision Coverage. The overall coverage is 60.00%.
- C1-Coverage:** A table showing coverage for Condition/Expression Coverage. The overall coverage is 100.00%.
- Source Code:** The source code for the function "abcd" is displayed, with the condition in the if statement highlighted in red to match the selected path in the CFG.

Coverage: 60.00%				
A	B	C	D	Test...
0	0	-	-	1.1
0	1	0	0	
0	1	0	1	3.1
0	1	1	-	4.1
1	-	0	1	

Total Coverage: 100.00%	
Testcase / Teststep	Coverage
+ 1 (1)	50.00 %
+ 3 (1)	50.00 %
+ 4 (1)	50.00 %

```
int A, B, C, D;
int r;

void abcd(void)
{
    if ((A || B) && (C || D))
        r = 1;
    else
        r = 0;
}
```

# Tessy - Code Coverage

- Multiple Condition Coverage (MCC)
  - If a decision is selected in the tree view, the corresponding source is displayed

The screenshot displays the Tessy Coverage Viewer interface. The main window is titled "CV - Tessy Coverage Viewer" and contains several panes:

- Called Functions:** A list showing the function "abcd".
- Flowchart:** A control flow graph for the function "abcd". It starts with a node labeled "5", leading to a decision diamond. The diamond has two outgoing paths labeled "2" and "3", which lead to two separate processing blocks. Both paths then merge and lead to a final node.
- MCC-Coverage Table:** A table showing the results of Multiple Condition Coverage analysis. The table has columns for conditions A, B, C, D, and a "Reached" column. The overall coverage is 71.43%.
- C1-Coverage Table:** A table showing the results of Condition 1 Coverage analysis. The overall coverage is 100.00%.
- Source Code:** The source code for the function "abcd" is displayed at the bottom, with the decision condition highlighted.

A	B	C	D	Reached
0	0	-	-	X
0	1	0	0	X
0	1	0	1	X
0	1	1	-	X
1	-	0	0	X
1	-	0	1	X
1	-	1	-	X

```
int A, B, C, D;
int r;

void abcd(void)
{
    if ((A || B) && (C || D))
        r = 1;
    else
        r = 0;
}
```

## Tessy – Customer List (A – K)

*(Excerpt)*

---

<b>ABB</b>	<b>Daimler</b>	<b>Helbako</b>
<b>Airbus Deutschland</b>	<b>Delphi</b>	<b>Hella</b>
<b>ANS Medical</b>	<b>Delphi Grundig</b>	<b>Huf Hülsbeck Fürst</b>
<b>Baxter Healthcare</b>	<b>Demag Cranes</b>	<b>Husco</b>
<b>Becker Mining</b>	<b>Diehl Ako</b>	<b>IAV</b>
<b>Behr-Hella</b>	<b>EADS Astrium</b>	<b>IEE</b>
<b>Bertrandt</b>	<b>Electrolux</b>	<b>Infineon</b>
<b>Beru</b>	<b>Eliop</b>	<b>JCB</b>
<b>BMW</b>	<b>Endress &amp; Hauser</b>	<b>John Deere</b>
<b>Bosch</b>	<b>Festo</b>	<b>Kiekert</b>
<b>Bosch Rexroth</b>	<b>GE Aviation</b>	<b>Knick</b>
<b>Bosch Siemens Hausg.</b>	<b>Getrag</b>	<b>Knorr-Bremse</b>
<b>Bose</b>	<b>Gigatronik</b>	<b>Kostal</b>
<b>Brose</b>	<b>GKN Driveline</b>	<b>Krauss-Maffei Wegmann</b>
<b>Cherry</b>	<b>Hanning &amp; Kahl</b>	<b>Krohne</b>
<b>Continental Temic</b>	<b>Harman-Becker</b>	<b>Küster</b>

## Tessy – Customer List (L – Z)

*(Excerpt)*

---

<b>Lamtec</b>	<b>Rafi</b>	<b>Trumpf Med</b>
<b>Lear</b>	<b>SAB Wabco</b>	<b>TRW</b>
<b>Liebherr-Aerospace</b>	<b>Samson</b>	<b>Va Tech Sat</b>
<b>Magna Steyr</b>	<b>Servomex</b>	<b>Valeo</b>
<b>Marquardt</b>	<b>SEW Eurodrive</b>	<b>Viessmann</b>
<b>Mentor</b>	<b>Shanghai Shen Hang</b>	<b>Wabco</b>
<b>Nidec Motors</b>	<b>Siemens A&amp;D</b>	<b>Wago</b>
<b>Palfinger</b>	<b>Siemens MED</b>	<b>Wago</b>
<b><u>Pegaso</u></b>	<b>Siemens VDO</b>	<b>Wartsilä</b>
<b>Pepperl&amp;Fuchs</b>	<b>Sona</b>	<b>Whirlpool</b>
<b>Phoenix Internat.</b>	<b>Stago</b>	<b>Wipro</b>
<b>PhoenixContact</b>	<b>Takata</b>	<b>ZF Friedrichshafen</b>
<b>Pierburg</b>	<b>Tata Elxsi</b>	<b>ZF Sachs</b>
<b>Preh</b>	<b>TechniSAT</b>	<b>ZKW Zizala</b>
<b>Pressac</b>	<b>Thielert Aircraft</b>	<b>Zollner</b>
<b>Prognost</b>	<b>TietoEnator</b>	



# Tessy

---

■ Thank you for your attention!

■ <http://www.hitex.com/perm/tessy.html>