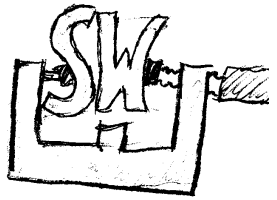
Pattern-Based Quality Assessment of TTCN-3 Test Suites

Helmut Neukirchen

Software Engineering for Distributed Systems Group
Institute for Informatics
Georg-August-University Göttingen
Germany



http://www.swe.informatik.uni-goettingen.de

Outline

1. Introduction
2. TTCN-3 Code Smells
3. TRex Tool
4. Summary / Outlook

1. Introduction

- Testing and Test Control Notation version 3:
  - Language for specifying and implementing distributed tests.
  - Standardised by
    European Telecommunications Standards Institute (ETSI).

- Huge TTCN-3 test suites (>40000 LOC), e.g. for:
  - Session Initiation Protocol (SIP),
  - Internet Protocol Version 6 (IPv6).

  - Suffer from quality problems like any larger software!

Motivation

- Excerpt from standardised SIP test suite:

```
function ptc_CC_PR_TR_CL_TI_015(CSeq loc_CSeq_s )
         runs on SipComponent
{
    var Request v_BYE_Request;

    initPTC(loc_CSeq_s);
    v_Default := activate(defaultCCPRPTC());

    tryingPTCBYE();

    waitForTimeout(65.0*PX_T1);

    notRepeatBYE(PX_TACK);

} //end ptc_CC_PR_TR_CL_TI_015
```

Variable is never used!

Default for alternatives activated, but never deactivated.

Hard coded "magic" values.

⇒ Quality assessment and improvement required!

Quality Assurance for TTCN-3 Test Suites

- Initial approach:
  - Assess test suites,
  - Detect issues,

  } → **Metrics**

  - Restructure test suites. → **Refactoring**

TTCN-3 Metrics (Example)

- Goal: Improve readability of TTCN-3 source code.
- Question: "Are any definitions unused or used only once?"
  - Count number of references to definitions.

$\Rightarrow$ Metric: Number of References to definitions

Zeiss, Neukirchen, Grabowski, Evans, Baker:
Refactoring and Metrics for TTCN-3 Test Suites.
SAM'06, LNCS 4320, Springer, 2006.

Zeiss, Neukirchen, Grabowski, Evans, Baker:
TRex – An Open-Source Tool for Quality Assurance of TTCN-3 Test Suites.
CONQUEST '06, dpunkt, 2006.

Refactoring

„A change made to the internal structure of software to make it easier to understand and cheaper to modify without changing its observable behavior.”

Fowler: Refactoring – Improving the Design of Existing Code. Addison-Wesley, 1999

- TTCN-3 refactoring catalogue:
  - More than 50 refactorings for improving TTCN-3 test suites:
    - Test behaviour, test data description, overall test suite structure.

TTCN-3 Refactoring (Example): Inline Template

- **TTCN-3 example (unrefactored):**

```
module ExampleModule {

  template ExampleType exampleTemplate:={
    ipv6:=false,
    ipAddress:="127.0.0.1"
  }

  testcase exampleTestCase() runs on ExampleComponent {
    portA.send(exampleTemplate);
  }

}
```

TTCN-3 Refactoring (Example): Inline Template

- **TTCN-3 example (refactored):**

```
module ExampleModule {

  testcase exampleTestCase() runs on ExampleComponent {
    portA.send(ExampleType:{false, "127.0.0.1"});
  }

}
```

Zeiss, Neukirchen, Grabowski, Evans, Baker:
Refactoring and Metrics for TTCN-3 Test Suites.
SAM'06, LNCS 4320, Springer, 2006.

Rule-Based Quality Assessment & Improvement

- Example:
  - Number of references to a template = 0
    $\Rightarrow$ Remove template.
  - Number of references to a template = 1
    $\Rightarrow$ Inline template.

Outline

1. Introduction
2. **TTCN-3 Code Smells**
3. TRex Tool
4. Summary / Outlook

2. Code Smells

- Metrics sometimes not powerful enough, e.g.:
  - Goal: Improve changeability of TTCN-3 source code.
  - Question:
    "Do local changes require further non-local changes?"
    - Find duplicated code.

⇒ Pattern-based approach required: code smells.

- **"certain structures in the code that suggest (sometimes they scream for) the possibility of refactoring"**

Fowler: Refactoring – Improving the Design of Existing Code.
Addison-Wesley, 1999

TTCN-3 Code Smells

- TTCN-3 code smells:
  patterns of inappropriate usage of TTCN-3.
  - Not considered as TTCN-3 code smell:
    - Syntax errors,
    - Violation of static semantics,
    - Defects in test case logic.
- Notion of metrics and code smells not disjoint:
  - Code smell $\rightarrow$ Metric: count occurrences of code smell.
  - Metric $\rightarrow$ Code smell: metric violates boundary.

TTCN-3 Code Smell Catalogue

- Collected TTCN-3 code smells in a structured catalogue.
- So far identified 38 TTCN-3 code smells with respect to
  - Duplicated Code, e.g. Duplicate Alt Branches
  - References, e.g. Singular Component Variable/Const./Timer
  - Parameters, e.g. Constant Actual Parameter Value
  - Complexity, e.g. Complex Conditional
  - Default Anomalies, e.g. Activation Asymmetry
  - Test Behaviour, e.g. Missing Verdict
  - Test Configuration, e.g. Idle Parallel Test Component
  - Coding Standards, e.g. Magic Values
  - Data Flow Anomalies, e.g. Unused Variable Definition
  - Miscellaneous, e.g. Over-specific Runs On

TTCN-3 Code Smell Description

- Fixed format:
  - Name,
  - Description,
  - Motivation,
  - Options,
  - Related Action(s),
  - Example.

TTCN-3 Code Smell (Example): Activation Asymmetry

- **Description:**
  - Default activation and deactivation are in different statement blocks.
- **Motivation:**
  - Improve analysability with respect to active defaults.
  - Enable static analysis of matching default activation and deactivation.
- **Options:**
  - A missing deactivate may not be considered as code smell inside TTCN-3 testcase constructs, since defaults are implicitly deactivated at the end of a testcase.
- **Related Action(s):**
  - Add default deactivation (or activation) if missing.
  - Move matching default activation and deactivation into same statement block.

TTCN-3 Code Smell (Example): Activation Asymmetry

- **TTCN-3 Example:**

```
module ExampleModule {

  function exampleFunction() return default {
    return activate(exampleAltstep());
  }
  testcase exampleTestcase() runs on ExampleComponent {
    var default myDefaultVar := null;
    myDefaultVar := exampleFunction();
    alt {
      [] portA.receive(messageOne) { portB.send(messageTwo); }
    }
    deactivate(myDefaultVar);
  }

}
```

Utilising TTCN-3 Code Smells for Advanced Test Suite Quality Assurance

- Advanced approach:
  - Assess test suites,
  - Detect issues,

  } → **Metrics, TTCN-3 Code Smells**

  - Restructure test suites. → **Refactoring**

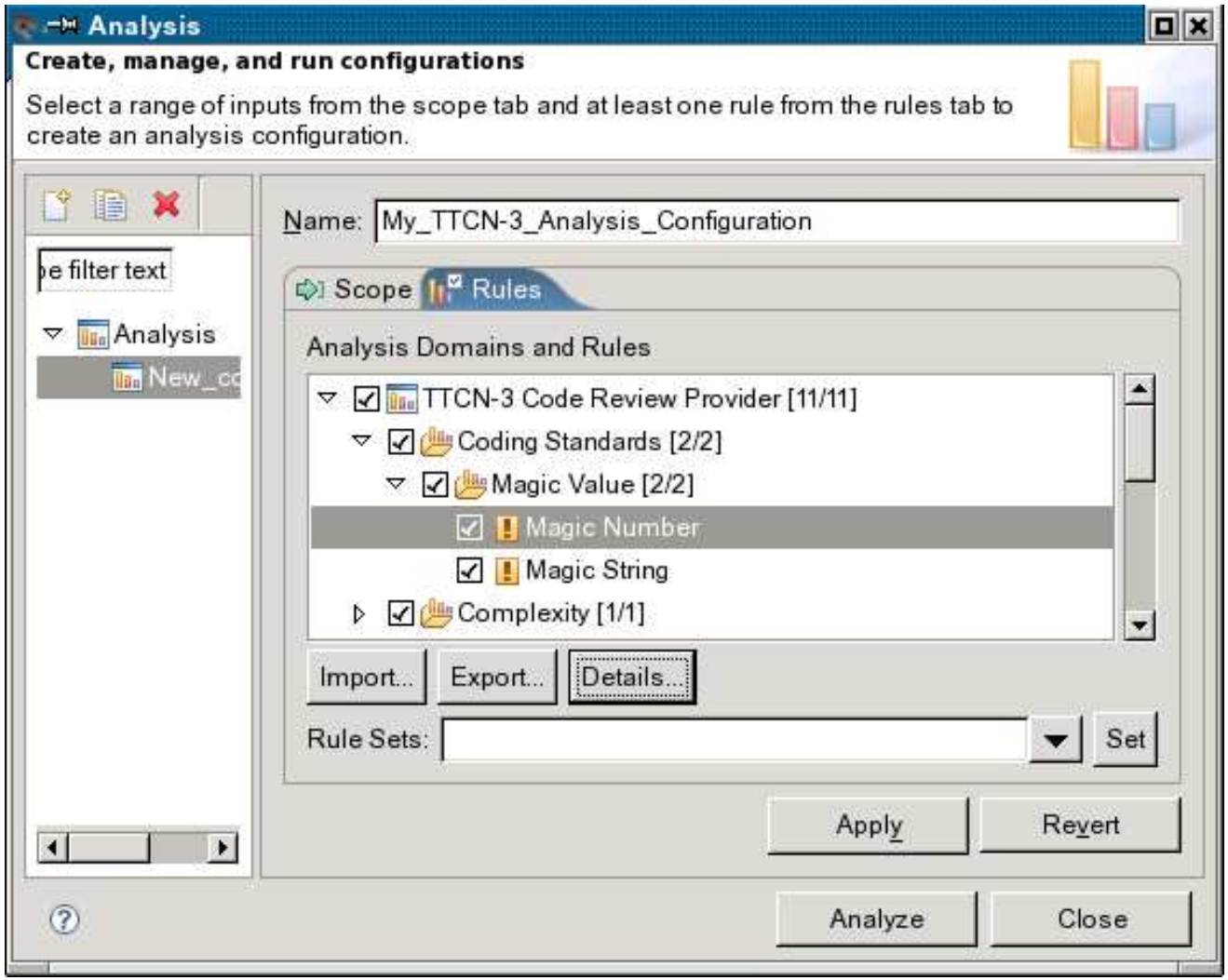
Outline

1. Introduction
2. TTCN-3 Code Smells
3. **TRex Tool**
4. Summary / Outlook

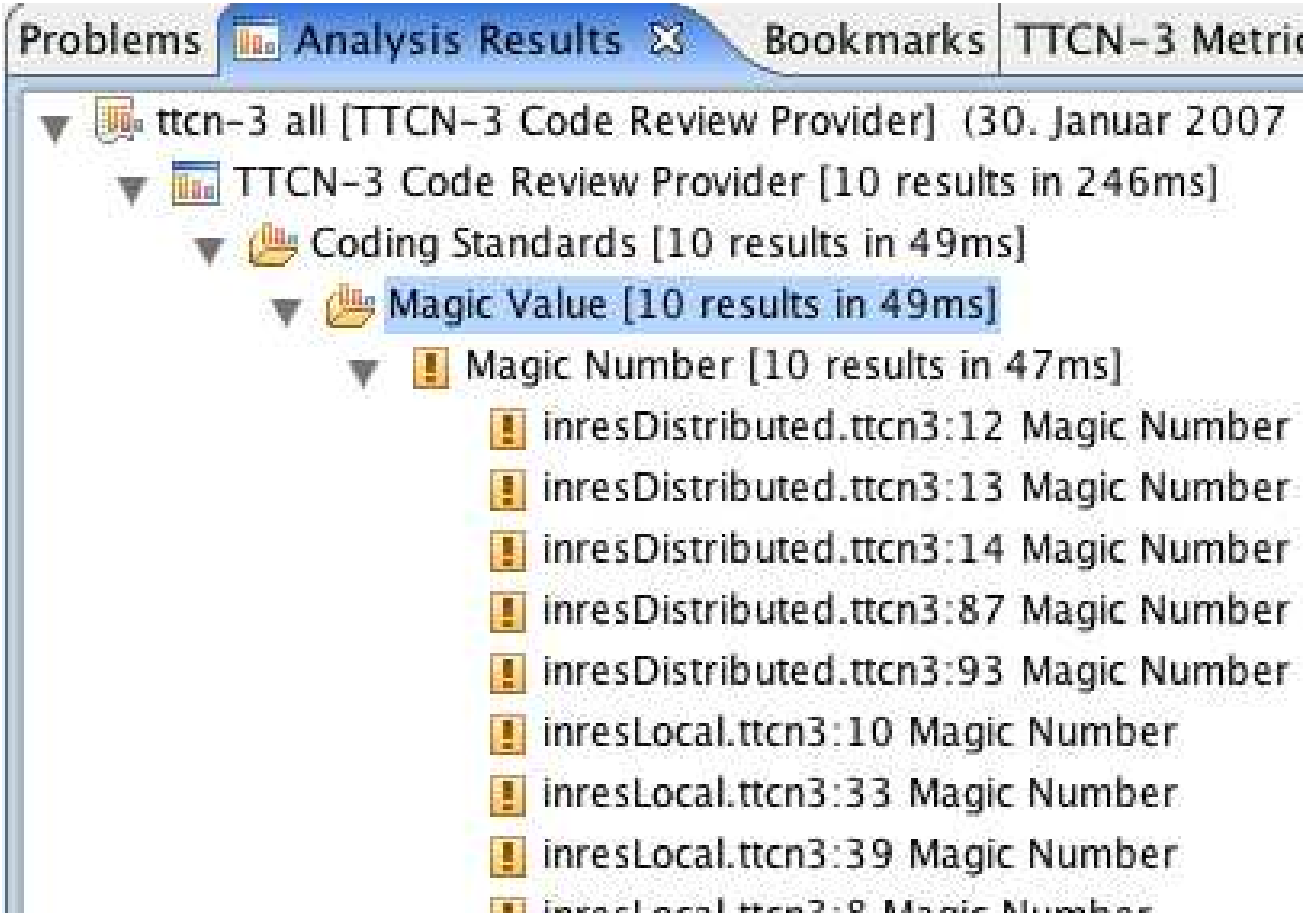
3. TRex

- TTCN-3 Refactoring and Metrics tool:
  - Open source plug-ins for Eclipse platform,
  - Integrated TTCN-3 development environment,
  - Automated calculation of TTCN-3 metrics,
  - Automated detection of TTCN-3 code smells,
    - Based on Eclipse Test & Performance Tools Platform (TPTP).
  - Tool supported TTCN-3 refactoring,
  - Rule-based quality assessment & improvement.
    - Refactorings associated to code smells as a “Quick Fix”.

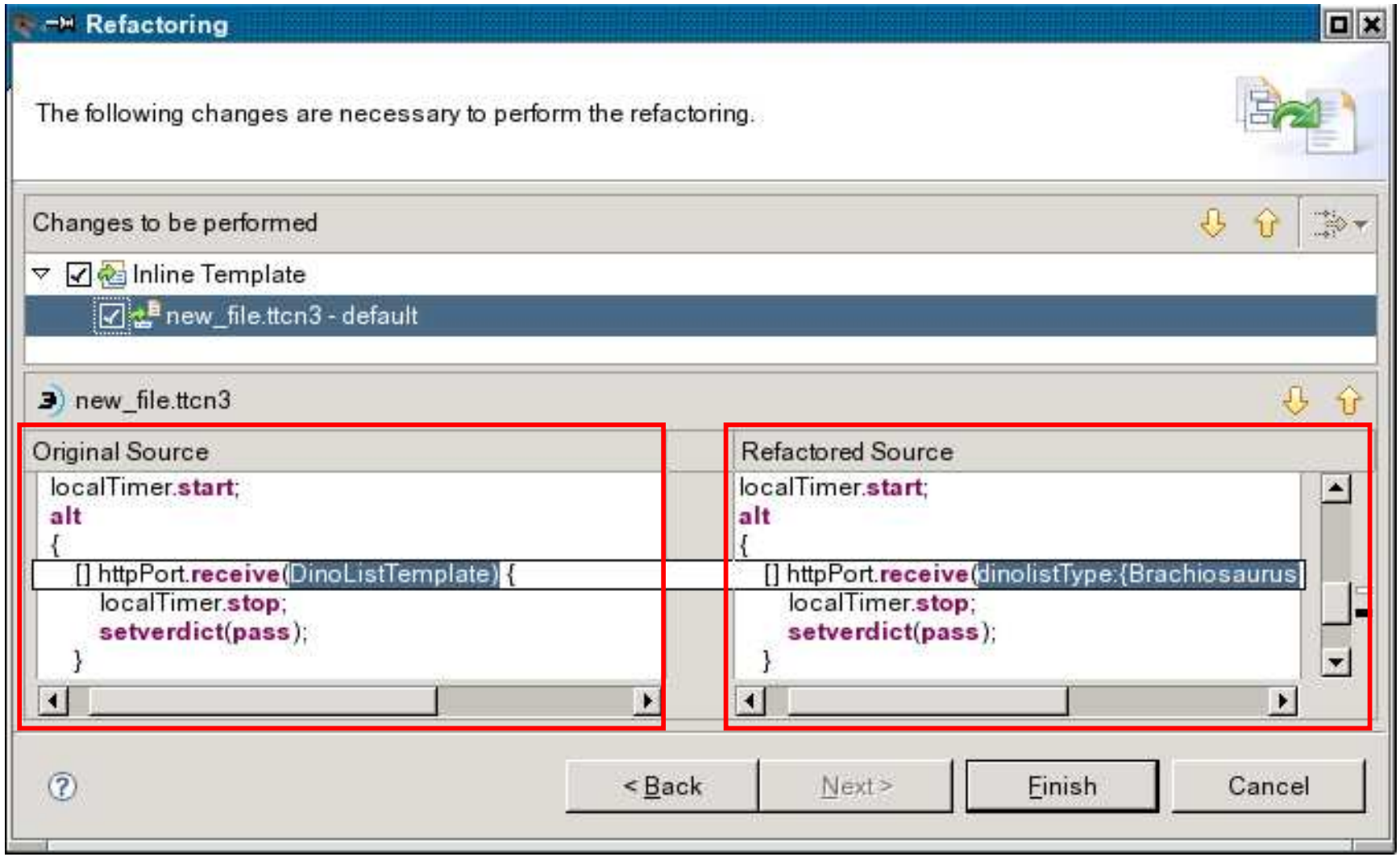
TTCN-3 Code Smell Detection Configuration



TTCN-3 Code Smell Detection Results



TTCN-3 Code Smell Removal



Application of TRex

Metric / TTCN-3 Code Smell	SIP	IPv6
Lines of code	42397	46163
Number of testcases	528	295
Number of functions	785	643
Number of altsteps	10	11
Number of components	2	10
Duplicate Alt Branches (inside same module only)	938	224
Activation Asymmetries (testcase included)	602	801
Activation Asymmetries (testcase excluded)	73	317
Magic Values (Magic numbers only, 0 and 1 excluded)	543	368
Unused Definitions (local definitions only)	50	156
Singular Component Variables/Constants/Timers	2	15

Outline

1. Introduction
2. TTCN-3 Code Smells
3. TRex Tool
4. **Summary / Outlook**

4. Summary and Outlook

- Summary:
  - Quality assurance for TTCN-3 test suites based on metrics, pattern-based code smells, refactoring for TTCN-3.
  - Catalogue of 38 TTCN-3 code smells.
  - TRex tool for automated quality assurance of TTCN-3 test suites.
- Outlook:
  - Make TTCN-3 code smell catalogue available as Wiki.
  - Instead of imperative implementation of TTCN-3 code smell pattern detection: Declarative description of TTCN-3 code smell patterns.

- Thank you for your attention!
- Any Questions?

http://www.trex.informatik.uni-goettingen.de