Software development with continuous integration

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FESG

A critical view on scientific software

- Tendency to become complex and unstructured
- Highly specialized for dedicated purposes (e.g. PhD-thesis)
- Undocumented, unreadable, not maintainable code
- Error-prone, not well tested, not optimized realizations
- Written in different computer languages

- *A survey of nearly 2000 researchers showed how coding has become important part of researchers toolkit:*
  - *38 % spend at least one fifth of their time developing software*
  - *But only 47 % have a good understanding of software testing*

Information taken from: Nature 467, 775-777 (2010) | doi:10.1038/467775a

General rules to improve quality

Tips to make scientific software more robust:

- Use a software version-control system (cvs, svn, git, …)
  - Put source code, raw data files, parameters and other primary material into it to record what you did, and when.
- Write testable software:
  - Build large code from smaller, easily testable modules.
- Test the software:
  - Collect tests and automate the testing.
- Encourage sharing the software:
  - Others will use your software on different machines for maybe different purpose. This normally reveals hidden bugs.

Information taken from: Nature 467, 775-777 (2010) | doi:10.1038/467775a

Scientific software

SLR VLBI SysMon

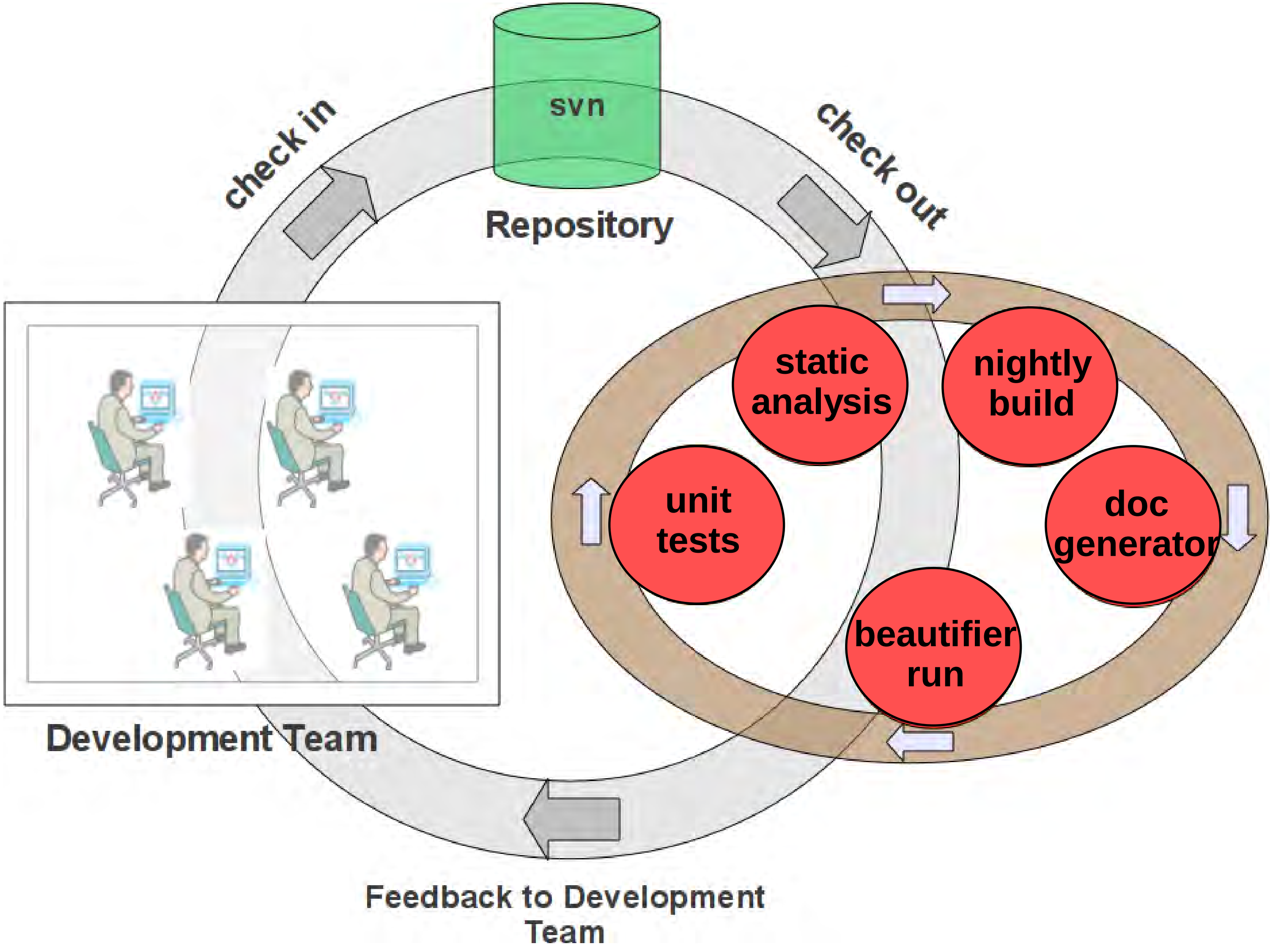
The principles we follow in software development:

- Reduction to a few software languages (C/C++,Perl)
- Style guide with coding layout and coding policies
- Usage of automated code formatting tool
- Use of documentation generation
- Automated code tests and inspections (standardized Makefiles)
- Write a unit-test for each change
- Test on several platforms and architectures with multiple compilers
- Activate all possible compiler -W flags and reduce warnings
- Version controlled software development
- Update and commit changes every day to version control system
- Offering of tested, open source toolboxes (e-RemoteCtrl, SysMon)

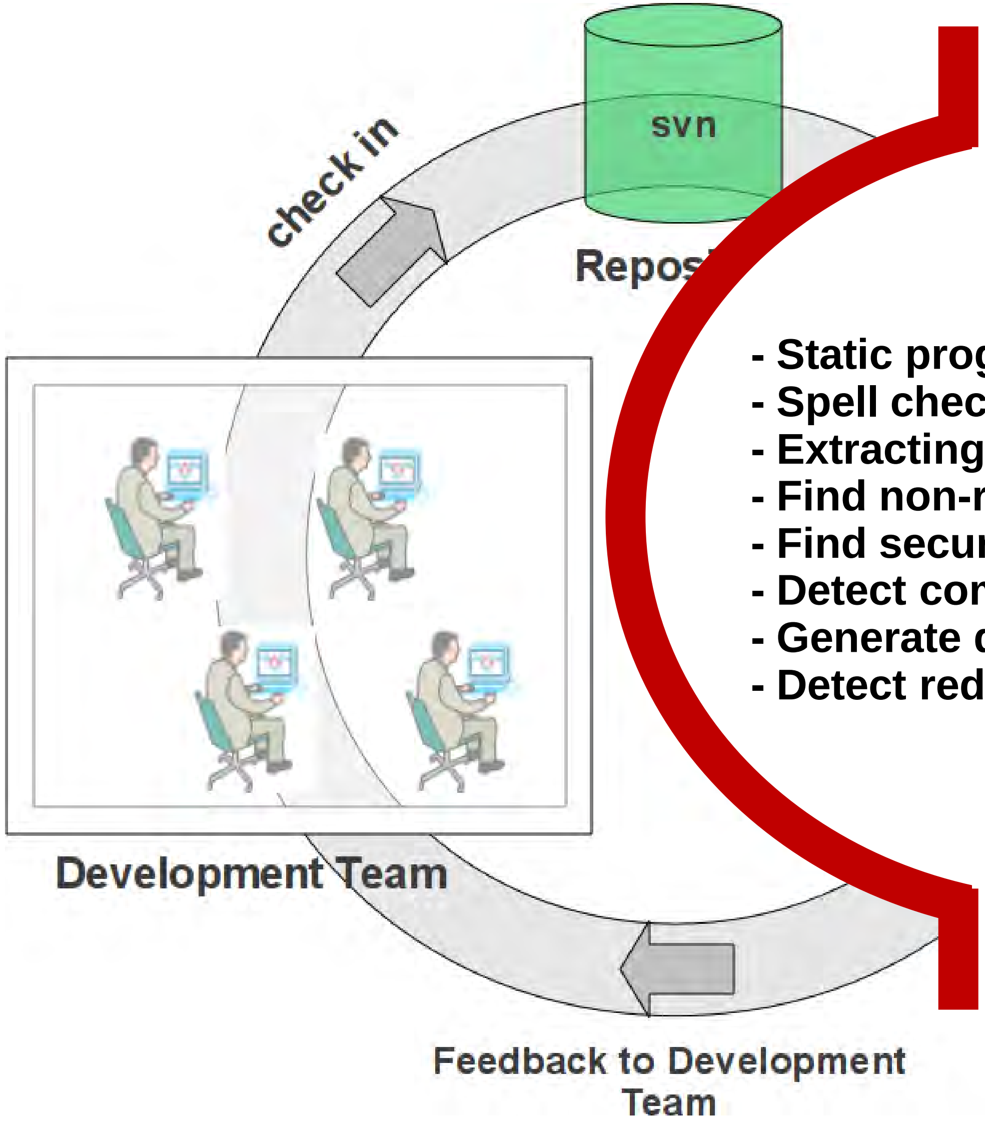
Scientific Software

The Continuous Integration software development method

The Continuous Integration software development principle



The Continuous Integration software development method



Usage of open-source tools:

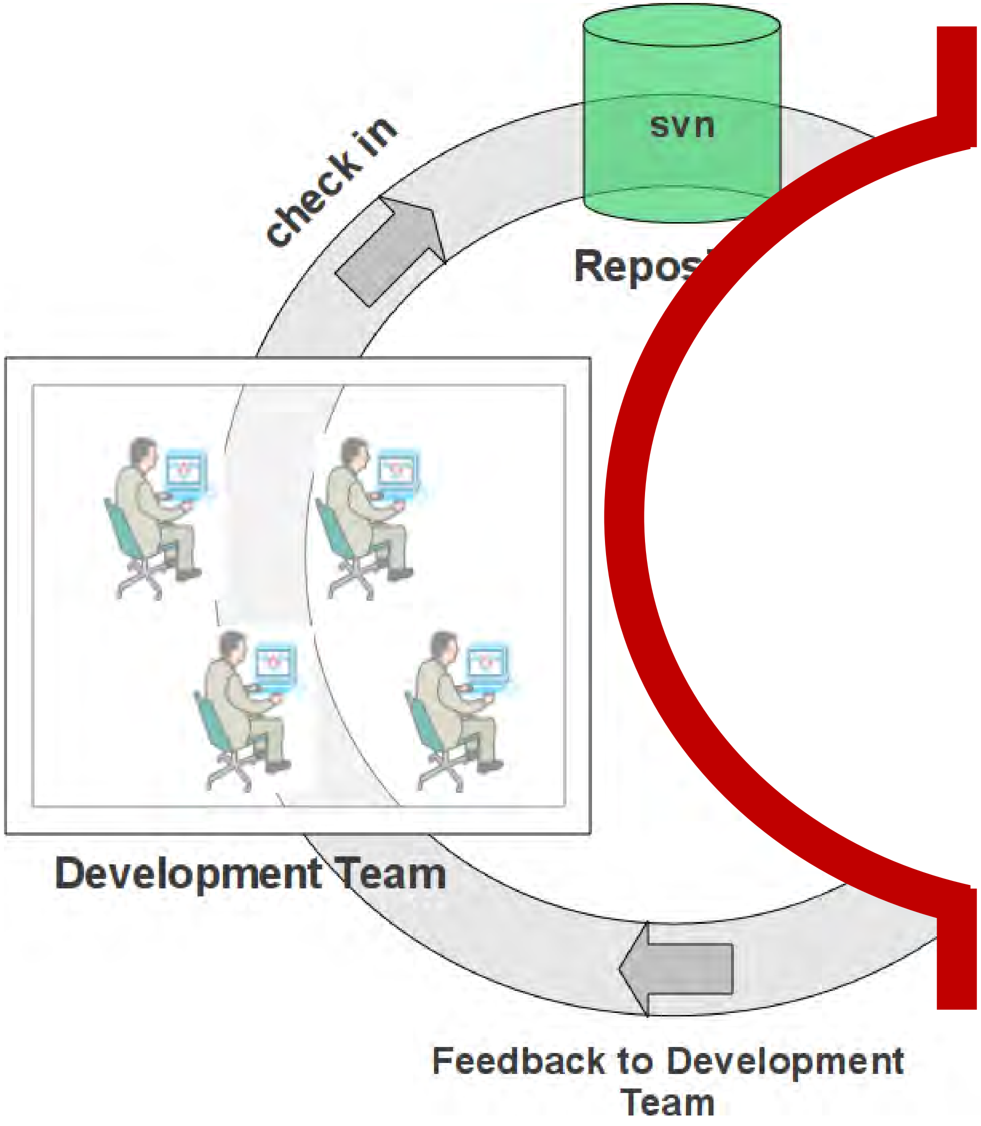
C/C++

- Static program analysis (cppcheck)
- Spell check of program and text files (codespell)
- Extracting of development information (StatSVN)
- Find non-reentrant functions in code (nsiqcppstyle)
- Find security problems (flawfinder)
- Detect common *printf/scanf* format errors (pscan)
- Generate developer documentation (doxygen)
- Detect redundant files in the repository (own development)

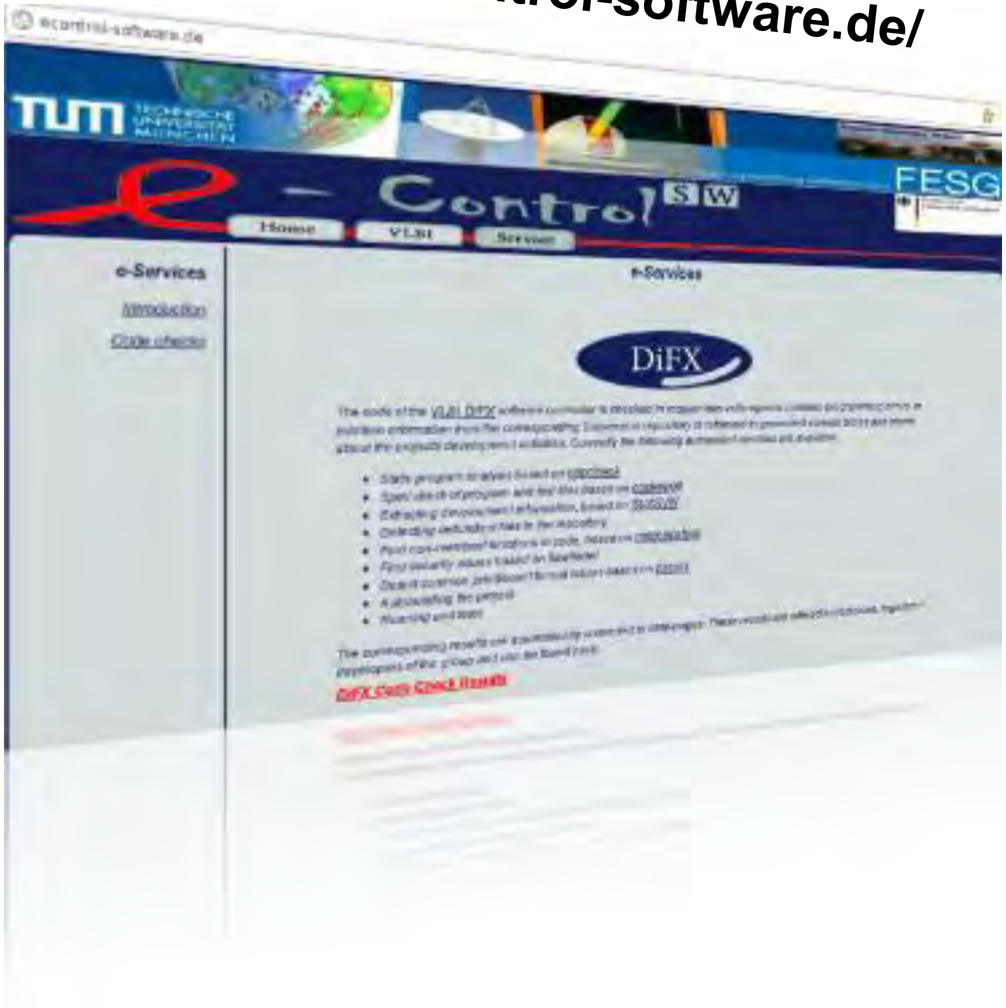
Candidate under evaluation:

- Static analysis: splint,
- Dynamic analysis: clang (address sanity checker)

Continuous Integration as a supporting service



http://econtrol-software.de/



e-Services

Introduction

Code checks

e-Services

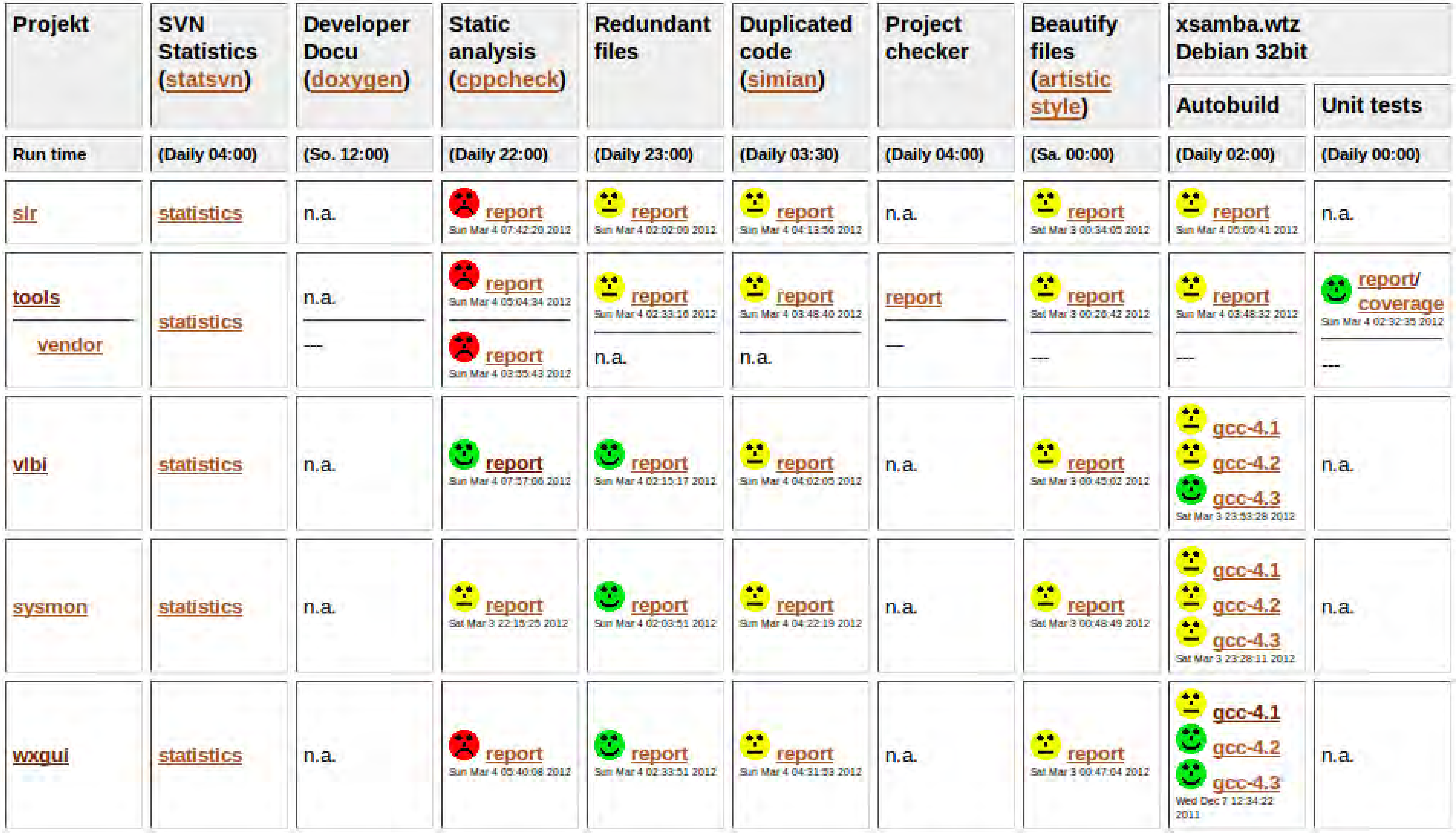
The code of the VLBI DiFX software correlator is checked [illegible]

- Static program analysis based on cppcheck
- Spell check of program and text files based on codespell
- Extracting documentation information, based on [illegible]
- Detecting redundant files in the repository
- [illegible] locations in code, based on [illegible]
- Find security issues based on flawfinder
- Detect common [illegible] based on [illegible]
- [illegible]
- Running unit tests

The corresponding results [illegible]

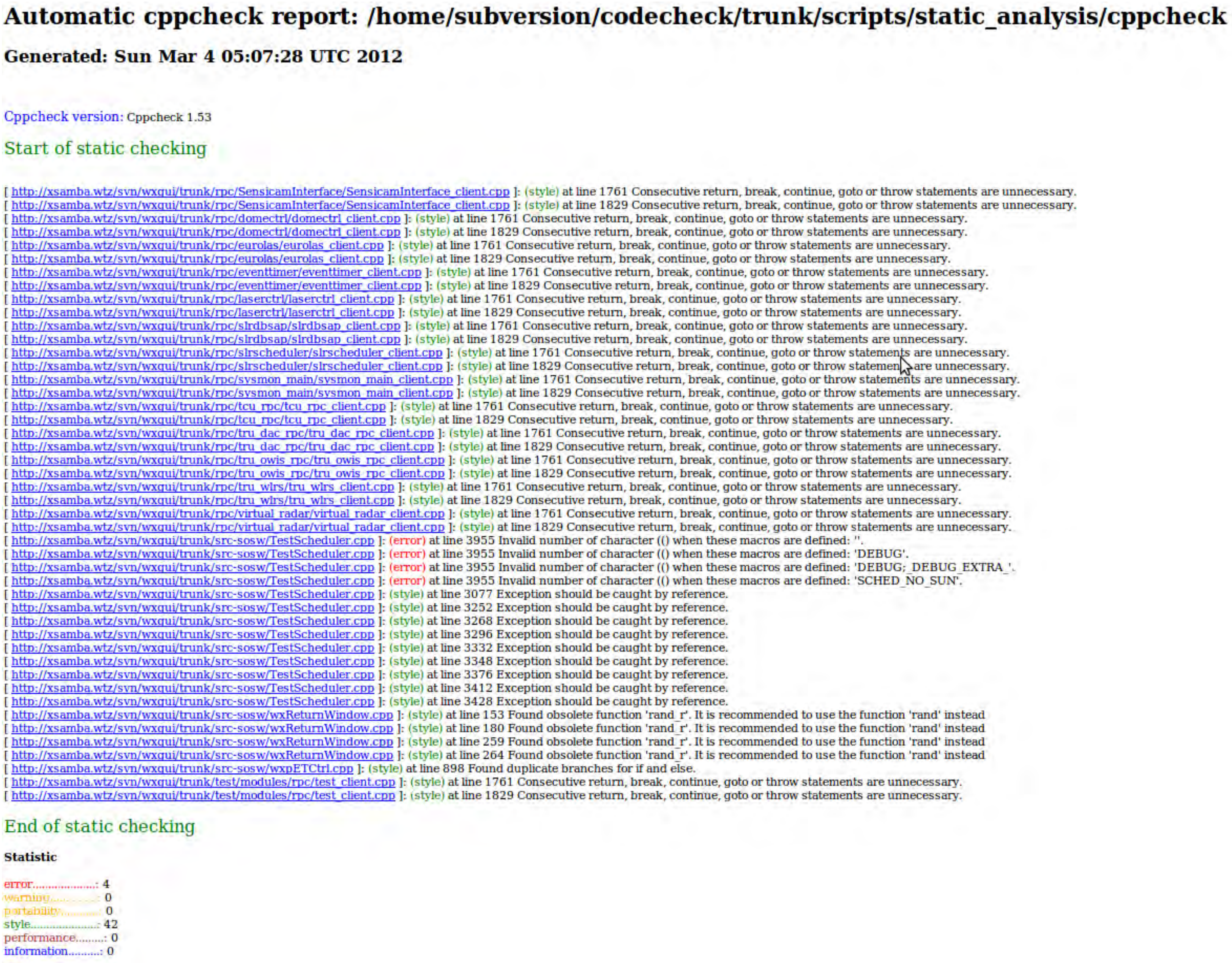
DiFX Code Check Results

The Continuous Integration software development method
- Current project state overview -



Projekt	SVN Statistics (statsvn)	Developer Docu (doxygen)	Static analysis (cppcheck)	Redundant files	Duplicated code (simian)	Project checker	Beautify files (artistic style)	xsamba.wtz Debian 32bit	
								Autobuild	Unit tests
Run time	(Daily 04:00)	(So. 12:00)	(Daily 22:00)	(Daily 23:00)	(Daily 03:30)	(Daily 04:00)	(Sa. 00:00)	(Daily 02:00)	(Daily 00:00)
slr	statistics	n.a.	🔴 report Sun Mar 4 07:42:20 2012	🟡 report Sun Mar 4 02:02:00 2012	🟡 report Sun Mar 4 04:13:56 2012	n.a.	🟡 report Sat Mar 3 00:34:05 2012	🟡 report Sun Mar 4 05:05:41 2012	n.a.
tools	statistics	n.a.	🔴 report Sun Mar 4 05:04:34 2012	🟡 report Sun Mar 4 02:33:16 2012	🟡 report Sun Mar 4 03:48:40 2012	report	🟡 report Sat Mar 3 00:26:42 2012	🟡 report Sun Mar 4 03:48:32 2012	🟢 report/ coverage Sun Mar 4 02:32:35 2012
vendor		---	🔴 report Sun Mar 4 03:35:43 2012	n.a.	n.a.	—	---	---	---
vlbi	statistics	n.a.	🟢 report Sun Mar 4 07:57:06 2012	🟢 report Sun Mar 4 02:15:17 2012	🟡 report Sun Mar 4 04:02:05 2012	n.a.	🟡 report Sat Mar 3 00:45:02 2012	🟡 gcc-4.1 🟡 gcc-4.2 🟢 gcc-4.3 Sat Mar 3 23:53:28 2012	n.a.
sysmon	statistics	n.a.	🟡 report Sat Mar 3 22:15:25 2012	🟢 report Sun Mar 4 02:03:51 2012	🟡 report Sun Mar 4 04:22:19 2012	n.a.	🟡 report Sat Mar 3 00:48:49 2012	🟡 gcc-4.1 🟡 gcc-4.2 🟡 gcc-4.3 Sat Mar 3 23:28:11 2012	n.a.
wxgui	statistics	n.a.	🔴 report Sun Mar 4 05:40:08 2012	🟢 report Sun Mar 4 02:33:51 2012	🟡 report Sun Mar 4 04:31:53 2012	n.a.	🟡 report Sat Mar 3 00:47:04 2012	🟡 gcc-4.1 🟢 gcc-4.2 🟢 gcc-4.3 Wed Dec 7 12:34:22 2011	n.a.

The Continuous Integration software development method



Automatic cppcheck report: /home/subversion/codecheck/trunk/scripts/static_analysis/cppcheck

Generated: Sun Mar 4 05:07:28 UTC 2012

Cppcheck version: Cppcheck 1.53

Start of static checking

```
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[ http://xsamba.wtz/svn/wxgui/trunk/src-sosw/TestScheduler.cpp ]: (error) at line 3955 Invalid number of character (() when these macros are defined: ''.
[ http://xsamba.wtz/svn/wxgui/trunk/src-sosw/TestScheduler.cpp ]: (error) at line 3955 Invalid number of character (() when these macros are defined: 'DEBUG'.
[ http://xsamba.wtz/svn/wxgui/trunk/src-sosw/TestScheduler.cpp ]: (error) at line 3955 Invalid number of character (() when these macros are defined: 'DEBUG;_DEBUG_EXTRA_'.
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[ http://xsamba.wtz/svn/wxgui/trunk/src-sosw/TestScheduler.cpp ]: (style) at line 3077 Exception should be caught by reference.
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[ http://xsamba.wtz/svn/wxgui/trunk/src-sosw/TestScheduler.cpp ]: (style) at line 3412 Exception should be caught by reference.
[ http://xsamba.wtz/svn/wxgui/trunk/src-sosw/TestScheduler.cpp ]: (style) at line 3428 Exception should be caught by reference.
[ http://xsamba.wtz/svn/wxgui/trunk/src-sosw/wxReturnWindow.cpp ]: (style) at line 153 Found obsolete function 'rand_r'. It is recommended to use the function 'rand' instead
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```
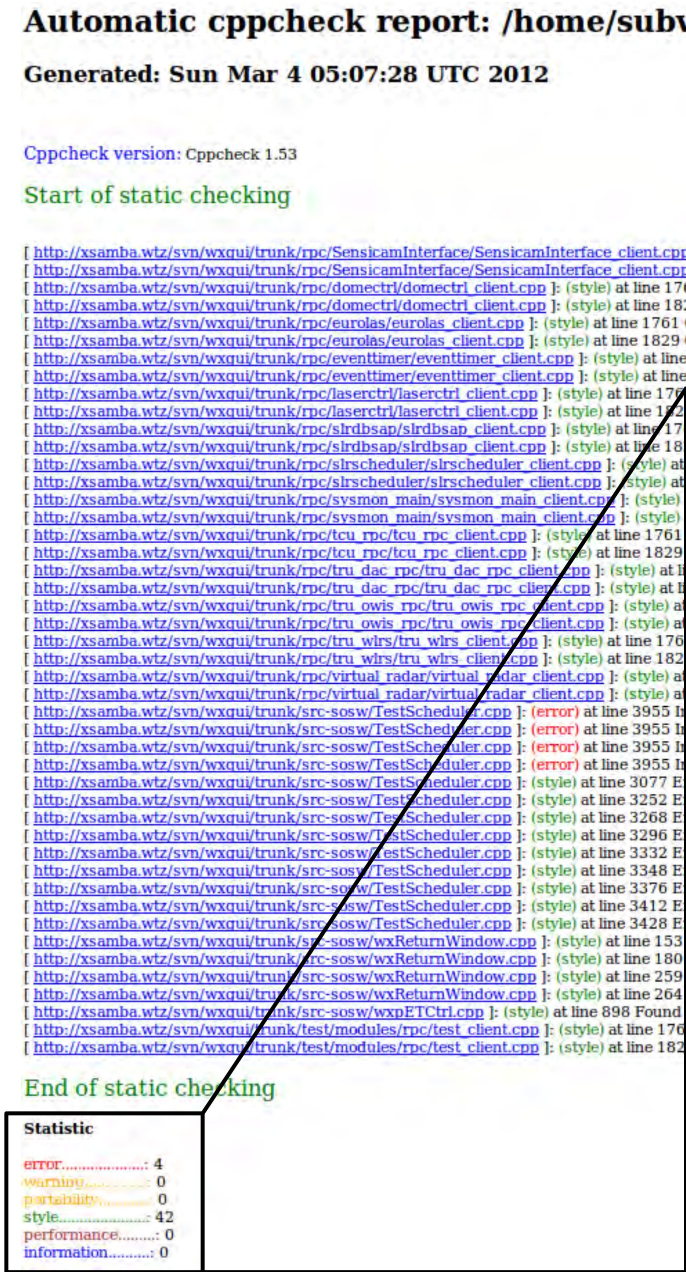

End of static checking

Statistic

```
error....................: 4
warning.............: 0
portability............: 0
style.....................: 42
performance.........: 0
information..........: 0
```

The Continuous Integration software development method



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[ http://xsamba.wtz/svn/wxgui/trunk/src-sosw/TestScheduler.cpp ]: (style) at line 3376 E
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End of static checking

Statistic

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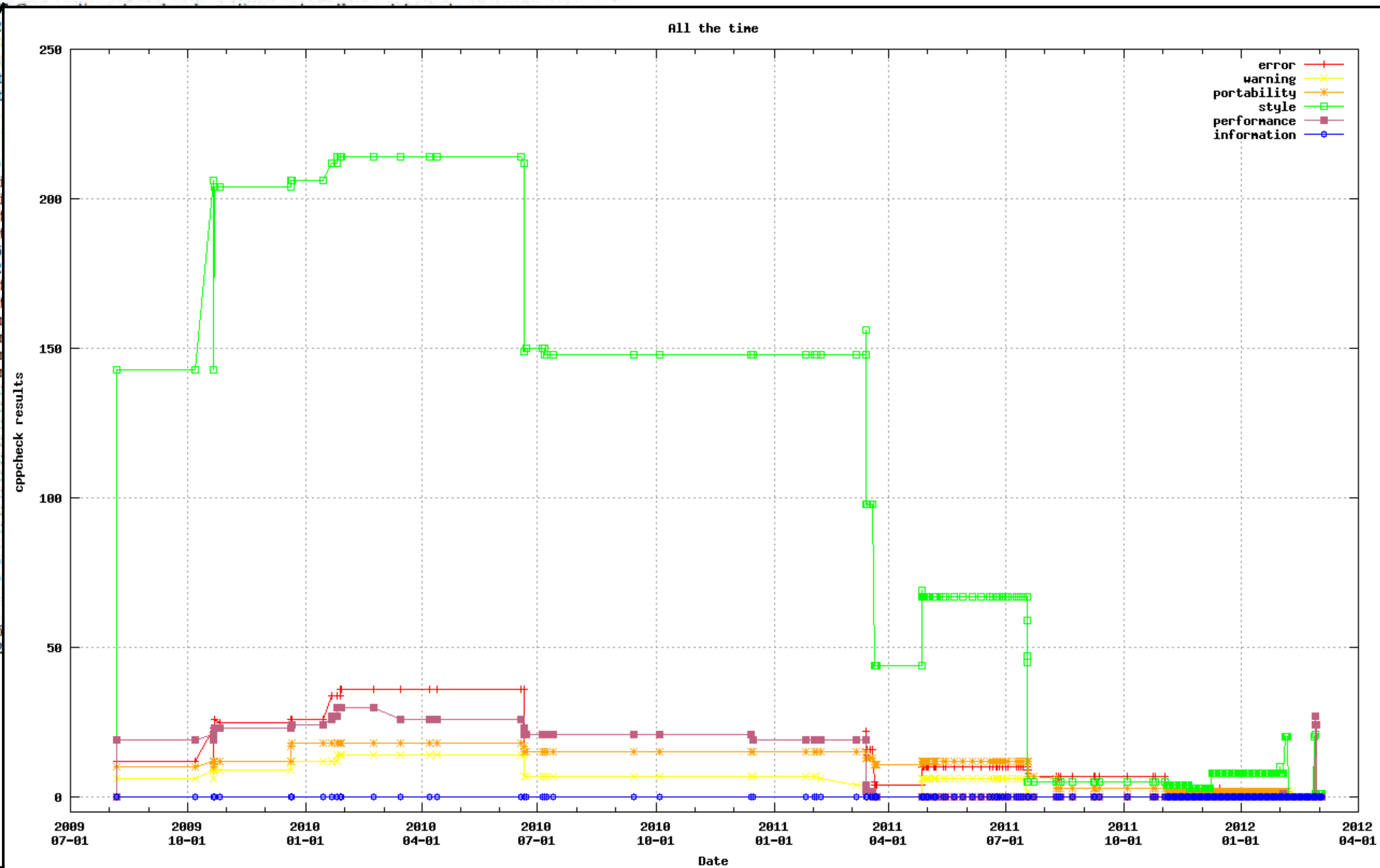
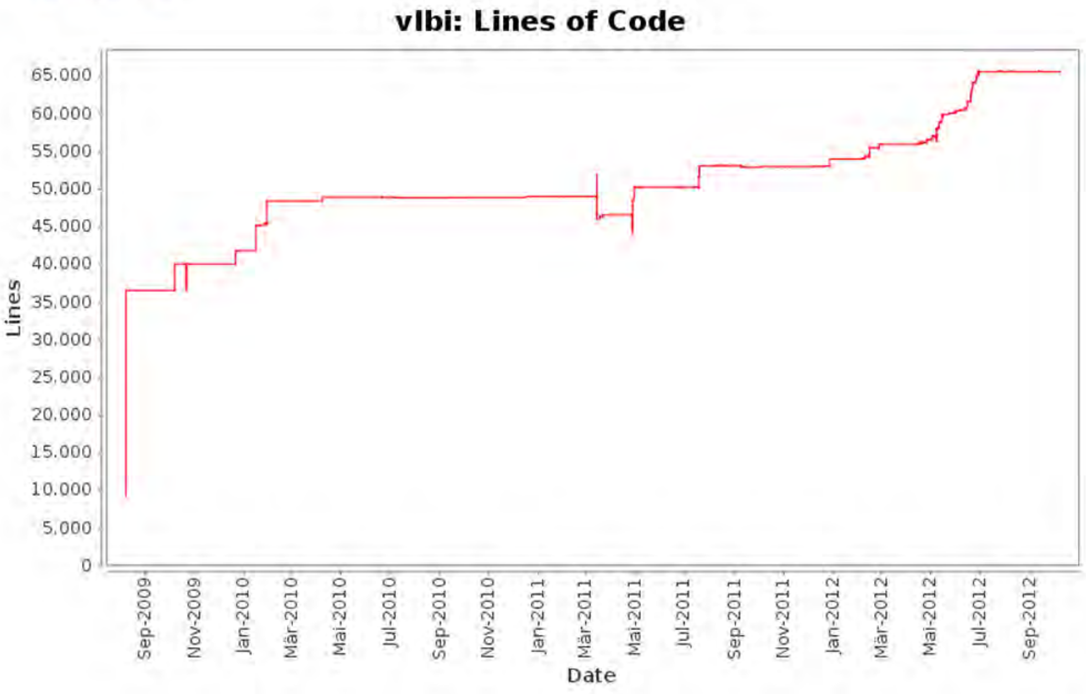


The Continuous Integration software development method

Total Lines of Code:
31349
Most Recent Commit:
2012-10-08 12:22



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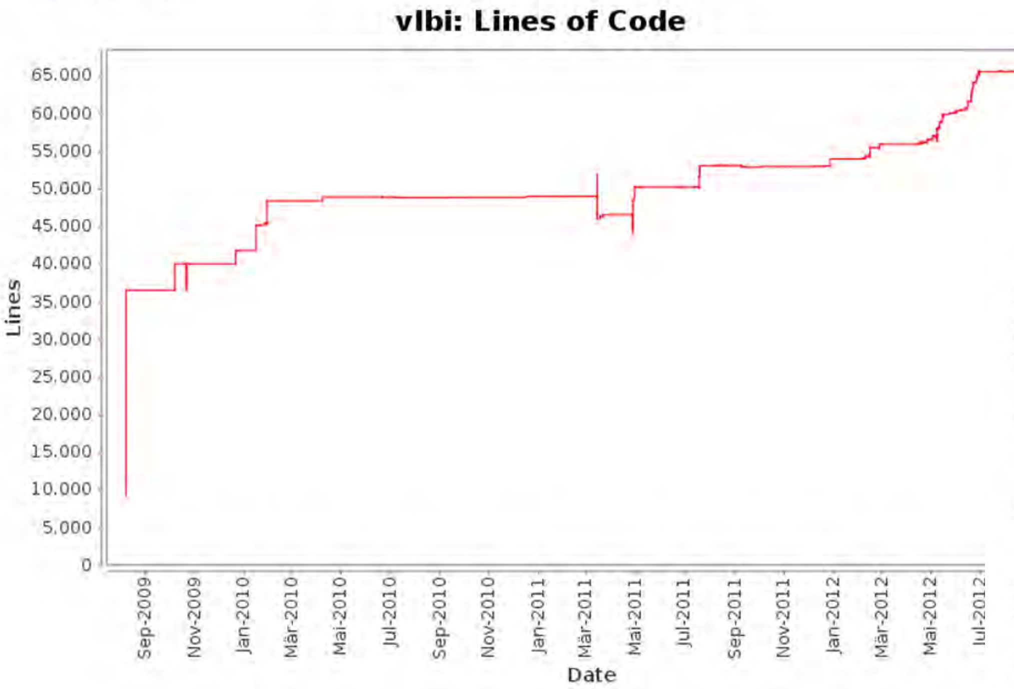
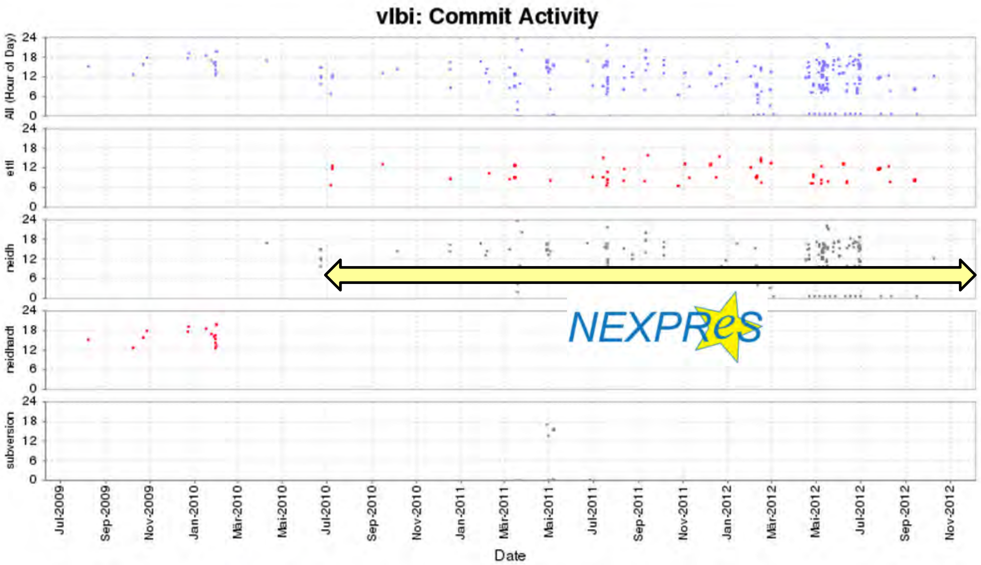
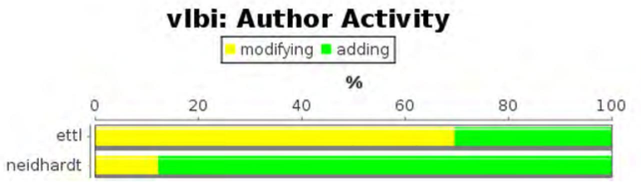
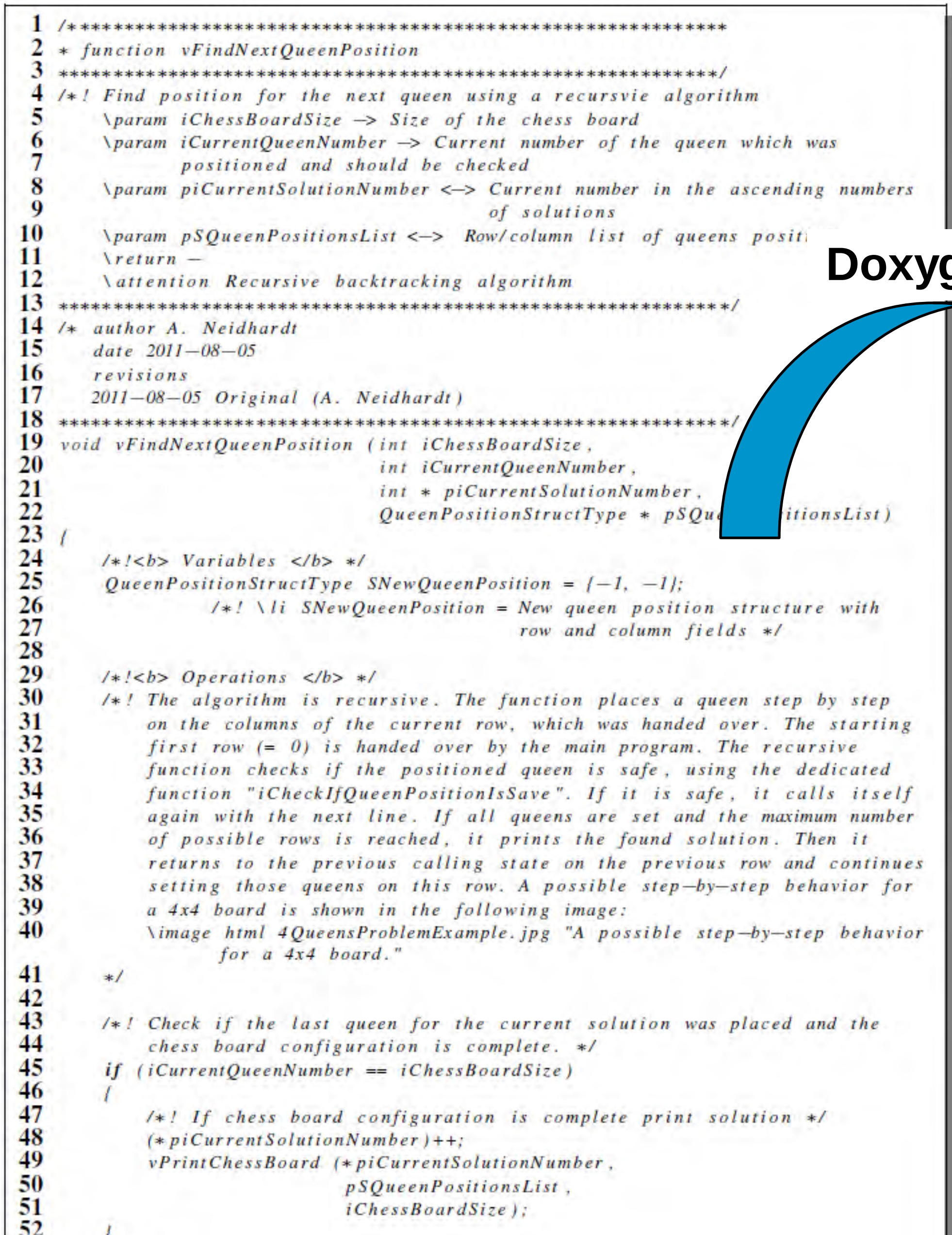






The Continuous Integration software development method

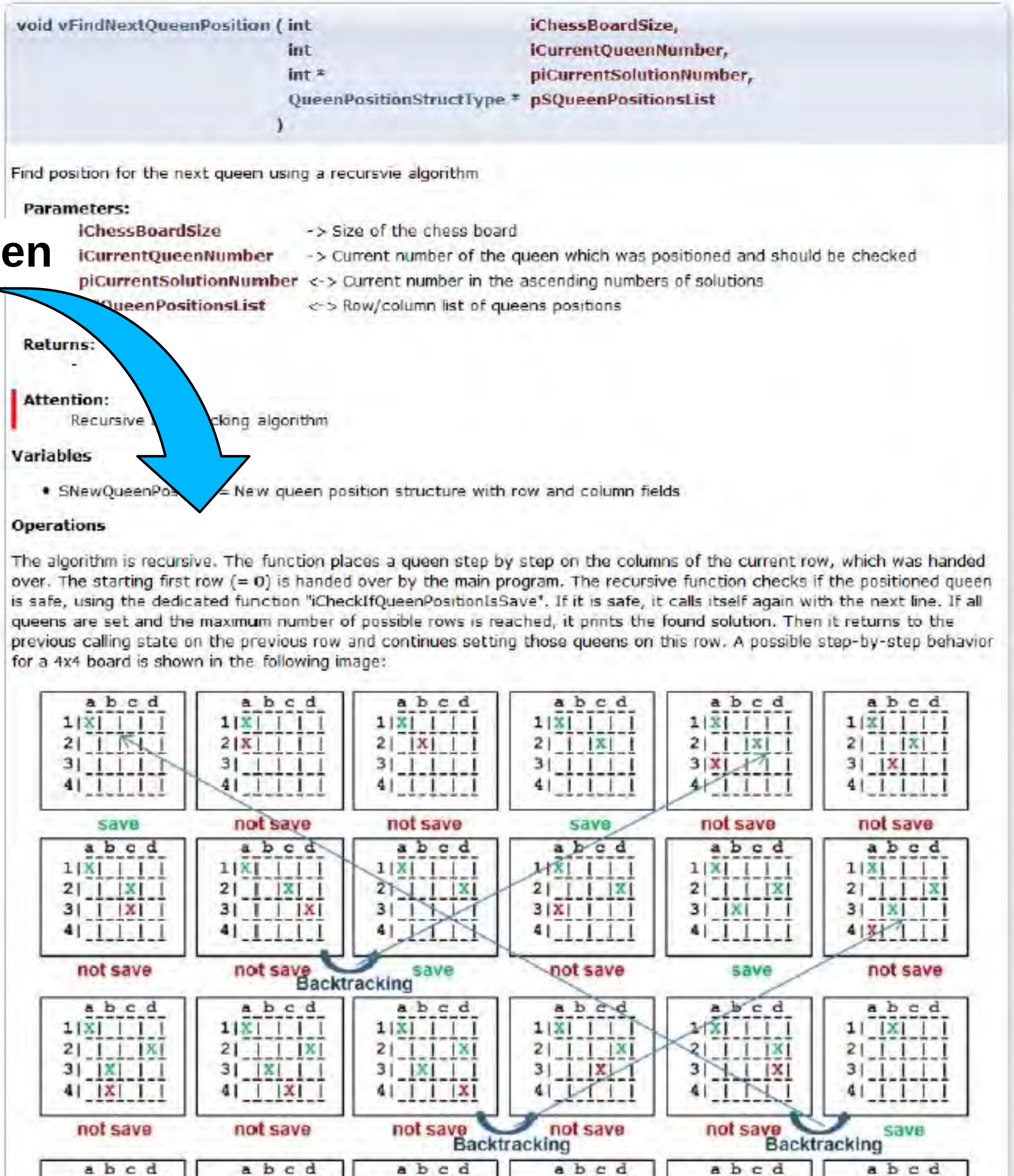


```
/*************************************************************
* function vFindNextQueenPosition
*************************************************************/
/*! Find position for the next queen using a recursvie algorithm
    \param iChessBoardSize -> Size of the chess board
    \param iCurrentQueenNumber -> Current number of the queen which was
            positioned and should be checked
    \param piCurrentSolutionNumber <-> Current number in the ascending numbers
                                       of solutions
    \param pSQueenPositionsList <->  Row/column list of queens posit
    \return -
    \attention Recursive backtracking algorithm
*************************************************************/
/* author A. Neidhardt
   date 2011-08-05
   revisions
   2011-08-05 Original (A. Neidhardt)
*************************************************************/
void vFindNextQueenPosition (int iChessBoardSize,
                             int iCurrentQueenNumber,
                             int * piCurrentSolutionNumber,
                             QueenPositionStructType * pSQue        itionsList)
{
    /*!<b> Variables </b> */
    QueenPositionStructType SNewQueenPosition = {-1, -1};
            /*! \li SNewQueenPosition = New queen position structure with
                                        row and column fields */

    /*!<b> Operations </b> */
    /*! The algorithm is recursive. The function places a queen step by step
        on the columns of the current row, which was handed over. The starting
        first row (= 0) is handed over by the main program. The recursive
        function checks if the positioned queen is safe, using the dedicated
        function "iCheckIfQueenPositionIsSave". If it is safe, it calls itself
        again with the next line. If all queens are set and the maximum number
        of possible rows is reached, it prints the found solution. Then it
        returns to the previous calling state on the previous row and continues
        setting those queens on this row. A possible step-by-step behavior for
        a 4x4 board is shown in the following image:
        \image html 4QueensProblemExample.jpg "A possible step-by-step behavior
             for a 4x4 board."
    */

    /*! Check if the last queen for the current solution was placed and the
        chess board configuration is complete. */
    if (iCurrentQueenNumber == iChessBoardSize)
    {
        /*! If chess board configuration is complete print solution */
        (*piCurrentSolutionNumber)++;
        vPrintChessBoard (*piCurrentSolutionNumber,
                          pSQueenPositionsList,
                          iChessBoardSize);
    }
```

Doxygen



```
void vFindNextQueenPosition ( int                         iChessBoardSize,
                              int                         iCurrentQueenNumber,
                              int *                       piCurrentSolutionNumber,
                              QueenPositionStructType *   pSQueenPositionsList
                            )
```

Find position for the next queen using a recursvie algorithm

Parameters:

iChessBoardSize	->	Size of the chess board
iCurrentQueenNumber	->	Current number of the queen which was positioned and should be checked
piCurrentSolutionNumber	<->	Current number in the ascending numbers of solutions
QueenPositionsList	<->	Row/column list of queens positions

Returns:
-

Attention:
Recursive cking algorithm

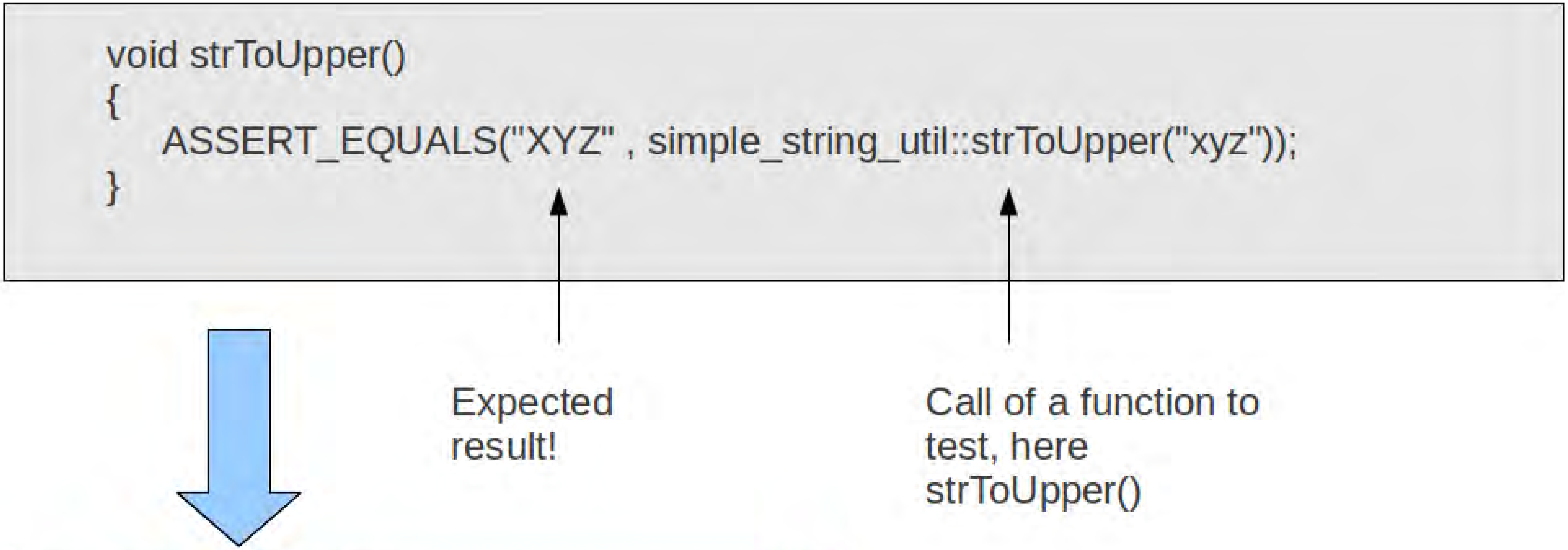
Variables

- SNewQueenPos = New queen position structure with row and column fields

Operations

The algorithm is recursive. The function places a queen step by step on the columns of the current row, which was handed over. The starting first row (= 0) is handed over by the main program. The recursive function checks if the positioned queen is safe, using the dedicated function "iCheckIfQueenPositionIsSave". If it is safe, it calls itself again with the next line. If all queens are set and the maximum number of possible rows is reached, it prints the found solution. Then it returns to the previous calling state on the previous row and continues setting those queens on this row. A possible step-by-step behavior for a 4x4 board is shown in the following image:

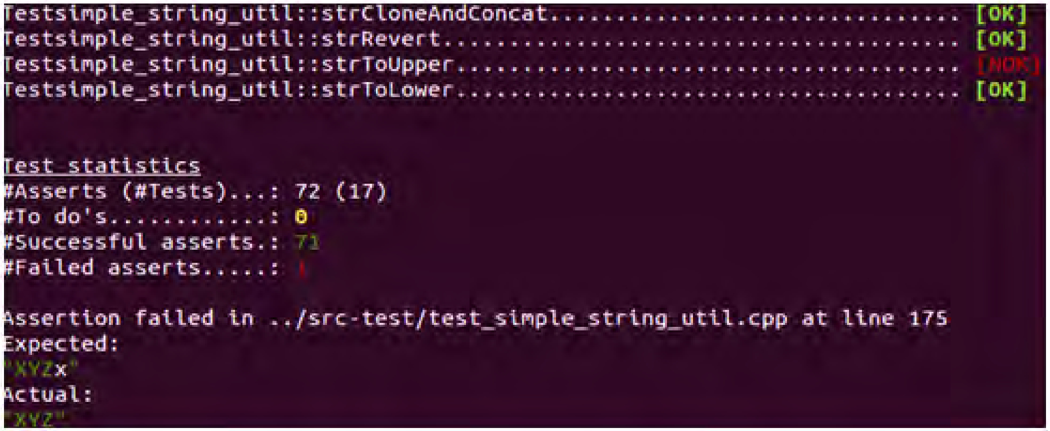
The Continuous Integration software development method
- unit-testing -



```
void strToUpper()
{
    ASSERT_EQUALS("XYZ" , simple_string_util::strToUpper("xyz"));
}
```

Expected result!

Call of a function to test, here strToUpper()

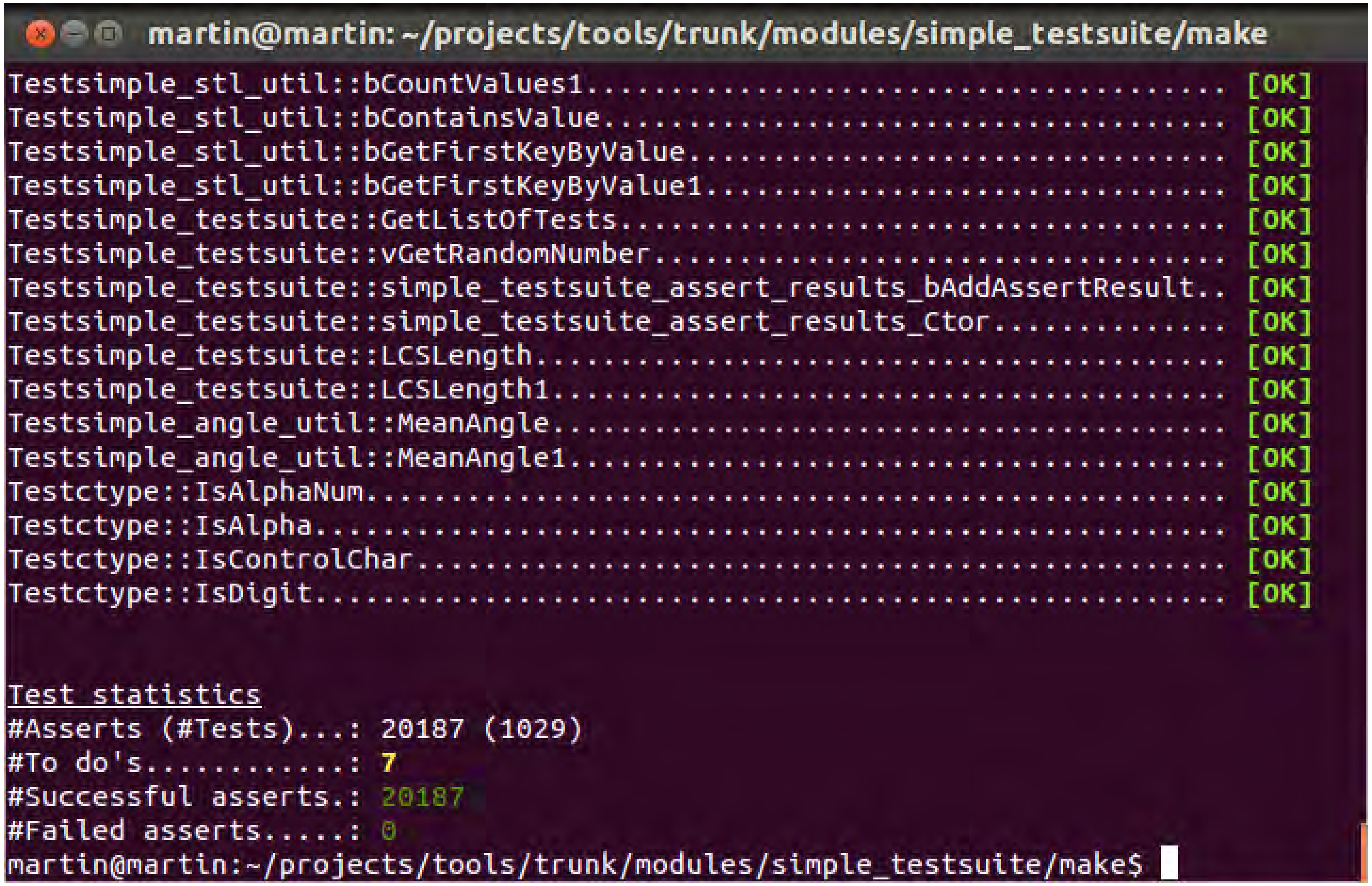


```
Testsimple_string_util::strCloneAndConcat................................ [OK]
Testsimple_string_util::strRevert........................................ [OK]
Testsimple_string_util::strToUpper....................................... [NOK]
Testsimple_string_util::strToLower....................................... [OK]


Test statistics
#Asserts (#Tests)...: 72 (17)
#To do's............: 0
#Successful asserts.: 71
#Failed asserts.....: 1

Assertion failed in ../src-test/test_simple_string_util.cpp at line 175
Expected:
"XYZx"
Actual:
"XYZ"
```

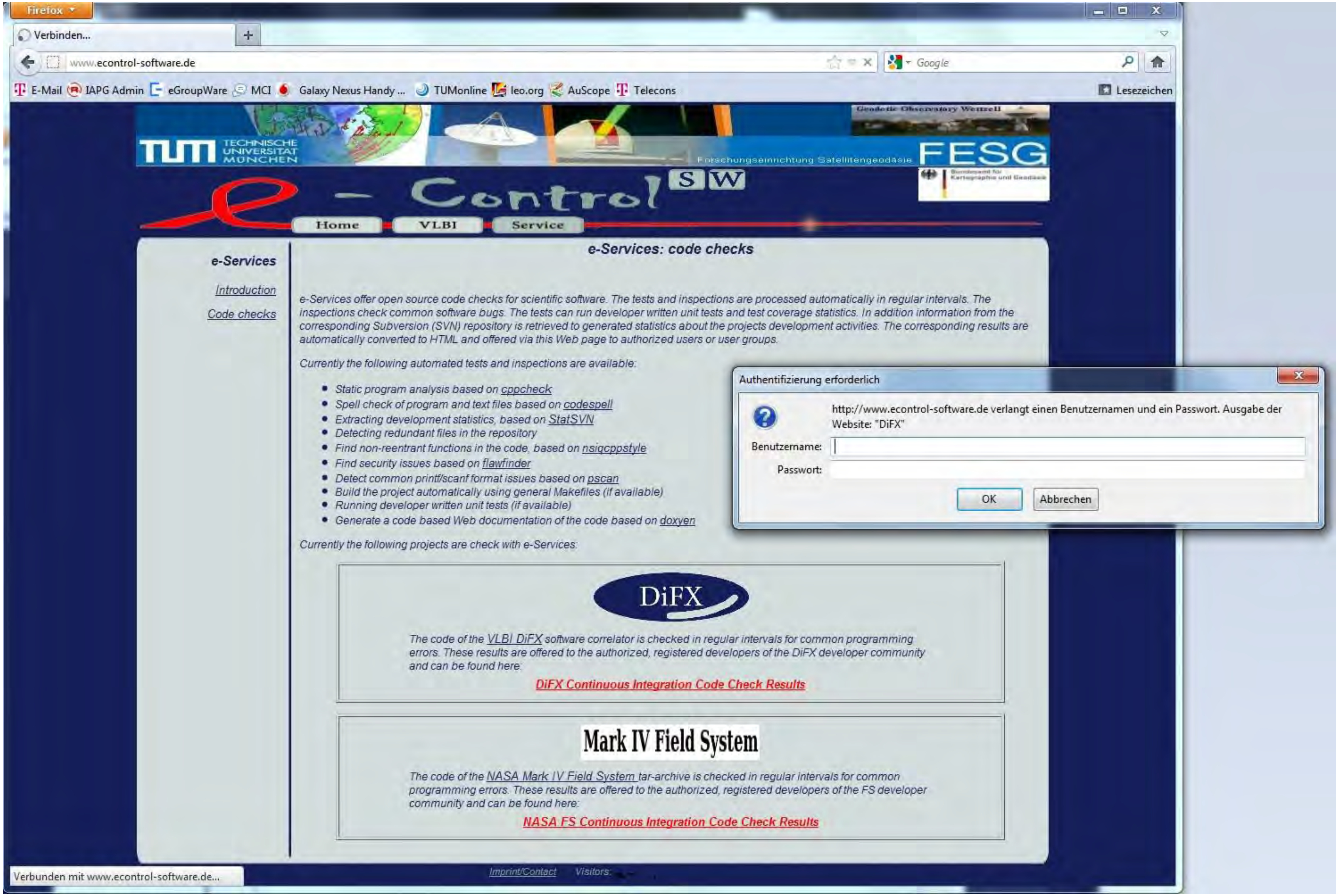
The Continuous Integration software development method
- unit-testing -


martin@martin: ~/projects/tools/trunk/modules/simple_testsuite/make

```
Testsimple_stl_util::bCountValues1...................................... [OK]
Testsimple_stl_util::bContainsValue..................................... [OK]
Testsimple_stl_util::bGetFirstKeyByValue................................ [OK]
Testsimple_stl_util::bGetFirstKeyByValue1............................... [OK]
Testsimple_testsuite::GetListOfTests.................................... [OK]
Testsimple_testsuite::vGetRandomNumber.................................. [OK]
Testsimple_testsuite::simple_testsuite_assert_results_bAddAssertResult.. [OK]
Testsimple_testsuite::simple_testsuite_assert_results_Ctor.............. [OK]
Testsimple_testsuite::LCSLength......................................... [OK]
Testsimple_testsuite::LCSLength1........................................ [OK]
Testsimple_angle_util::MeanAngle........................................ [OK]
Testsimple_angle_util::MeanAngle1....................................... [OK]
Testctype::IsAlphaNum................................................... [OK]
Testctype::IsAlpha...................................................... [OK]
Testctype::IsControlChar................................................ [OK]
Testctype::IsDigit...................................................... [OK]


Test statistics
#Asserts (#Tests)...: 20187 (1029)
#To do's............: 7
#Successful asserts.: 20187
#Failed asserts.....: 0
martin@martin:~/projects/tools/trunk/modules/simple_testsuite/make$ 
```

Experience



e-Services

Introduction

Code checks

e-Services: code checks

e-Services offer open source code checks for scientific software. The tests and inspections are processed automatically in regular intervals. The inspections check common software bugs. The tests can run developer written unit tests and test coverage statistics. In addition information from the corresponding Subversion (SVN) repository is retrieved to generated statistics about the projects development activities. The corresponding results are automatically converted to HTML and offered via this Web page to authorized users or user groups.

Currently the following automated tests and inspections are available:

- Static program analysis based on cppcheck
- Spell check of program and text files based on codespell
- Extracting development statistics, based on StatSVN
- Detecting redundant files in the repository
- Find non-reentrant functions in the code, based on nsiqcppstyle
- Find security issues based on flawfinder
- Detect common printf/scanf format issues based on pscan
- Build the project automatically using general Makefiles (if available)
- Running developer written unit tests (if available)
- Generate a code based Web documentation of the code based on doxyen

Currently the following projects are check with e-Services:

DiFX

The code of the VLBI DiFX software correlator is checked in regular intervals for common programming errors. These results are offered to the authorized, registered developers of the DiFX developer community and can be found here:

DiFX Continuous Integration Code Check Results

Mark IV Field System

The code of the NASA Mark IV Field System tar-archive is checked in regular intervals for common programming errors. These results are offered to the authorized, registered developers of the FS developer community and can be found here:

NASA FS Continuous Integration Code Check Results

Imprint/Contact Visitors:

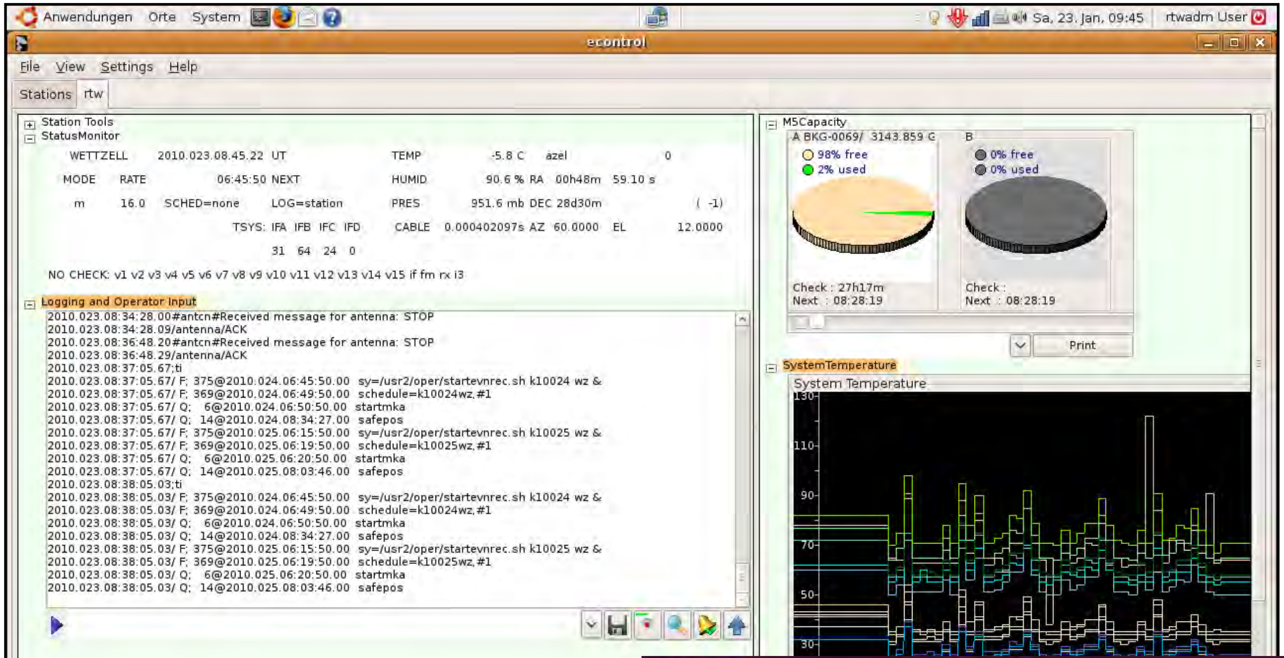
Authentifizierung erforderlich

http://www.econtrol-software.de verlangt einen Benutzernamen und ein Passwort. Ausgabe der Website: "DiFX"

Benutzername:

Passwort:

Experience



```
   WETTZELL     2010.023.08.45.22  UT            TEMP          -5.8 C    azel              0
  MODE     RATE          06:45:50  NEXT          HUMID         90.6 %  RA   00h48m   59.10 s
   m       16.0    SCHED=none      LOG=station   PRES          951.6 mb  DEC 28d30m           (  -1)
                         TSYS:  IFA  IFB  IFC  IFD    CABLE  0.000402097s  AZ  60.0000   EL    12.0000
                                31   64   24   0
 NO CHECK: v1 v2 v3 v4 v5 v6 v7 v8 v9 v10 v11 v12 v13 v14 v15 if fm rx i3
```

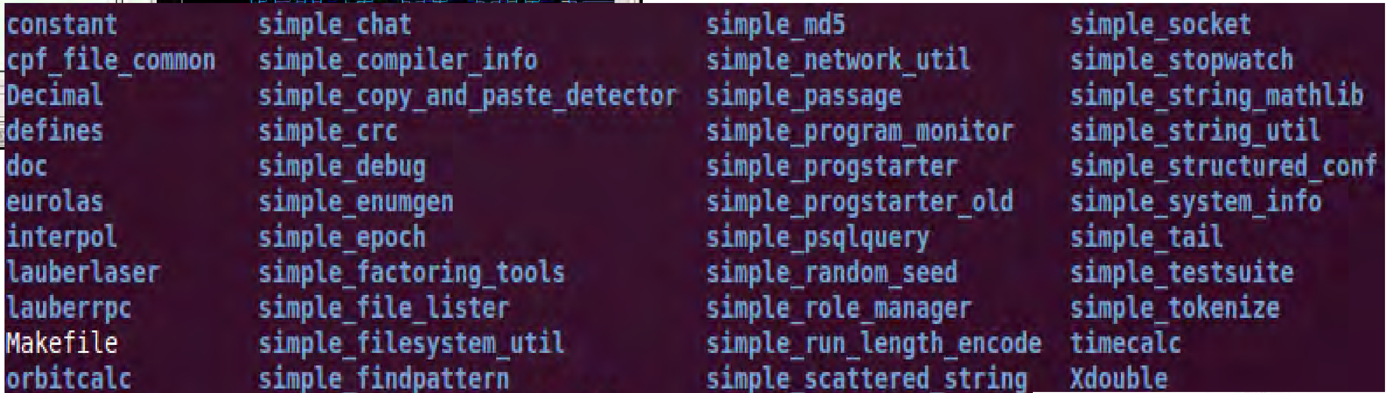
Logging and Operator Input

```
2010.023.08:34:28.00#antcn#Received message for antenna: STOP
2010.023.08:34:28.09/antenna/ACK
2010.023.08:36:48.20#antcn#Received message for antenna: STOP
2010.023.08:36:48.29/antenna/ACK
2010.023.08:37:05.67;ti
2010.023.08:37:05.67/ F; 375@2010.024.06:45:50.00  sy=/usr2/oper/startevnrec.sh k10024 wz &
2010.023.08:37:05.67/ F; 369@2010.024.06:49:50.00  schedule=k10024wz,#1
2010.023.08:37:05.67/ Q;   6@2010.024.06:50:50.00  startmka
2010.023.08:37:05.67/ Q;  14@2010.024.08:34:27.00  safepos
2010.023.08:37:05.67/ F; 375@2010.025.06:15:50.00  sy=/usr2/oper/startevnrec.sh k10025 wz &
2010.023.08:37:05.67/ F; 369@2010.025.06:19:50.00  schedule=k10025wz,#1
2010.023.08:37:05.67/ Q;   6@2010.025.06:20:50.00  startmka
2010.023.08:37:05.67/ Q;  14@2010.025.08:03:46.00  safepos
2010.023.08:38:05.03;ti
2010.023.08:38:05.03/ F; 375@2010.024.06:45:50.00  sy=/usr2/oper/startevnrec.sh k10024 wz &
2010.023.08:38:05.03/ F; 369@2010.024.06:49:50.00  schedule=k10024wz,#1
2010.023.08:38:05.03/ Q;   6@2010.024.06:50:50.00  startmka
2010.023.08:38:05.03/ Q;  14@2010.024.08:34:27.00  safepos
2010.023.08:38:05.03/ F; 375@2010.025.06:15:50.00  sy=/usr2/oper/startevnrec.sh k10025 wz &
2010.023.08:38:05.03/ F; 369@2010.025.06:19:50.00  schedule=k10025wz,#1
2010.023.08:38:05.03/ Q;   6@2010.025.06:20:50.00  startmka
2010.023.08:38:05.03/ Q;  14@2010.025.08:03:46.00  safepos
```

e-RemoteCtrl

Do not miss our e-RemoteCtrl demonstration at lunchtime today!

Wettzell Toolbox



```
constant          simple_chat                        simple_md5                 simple_socket
cpf_file_common   simple_compiler_info               simple_network_util        simple_stopwatch
Decimal           simple_copy_and_paste_detector     simple_passage             simple_string_mathlib
defines           simple_crc                         simple_program_monitor     simple_string_util
doc               simple_debug                       simple_progstarter         simple_structured_conf
eurolas           simple_enumgen                     simple_progstarter_old     simple_system_info
interpol          simple_epoch                       simple_psqlquery           simple_tail
lauberlaser       simple_factoring_tools             simple_random_seed         simple_testsuite
lauberrpc         simple_file_lister                 simple_role_manager        simple_tokenize
Makefile          simple_filesystem_util             simple_run_length_encode   timecalc
orbitcalc         simple_findpattern                 simple_scattered_string    Xdouble
progstarter       simple_floating_point_util         simple_sem
simple_aes        simple_input_fuzzer                simple_serial
simple_benchmark  simple_mathlib_verify              simple_shell_macros
```

Thank you

The service is also available for your software.
http://www.econtrol-software.de