PA193 - Secure coding principles and practices

LABS: Static analysis of source code

Petr Švenda svenda@fi.muni.cz

CROCS
Centre for Research on Cryptography and Security

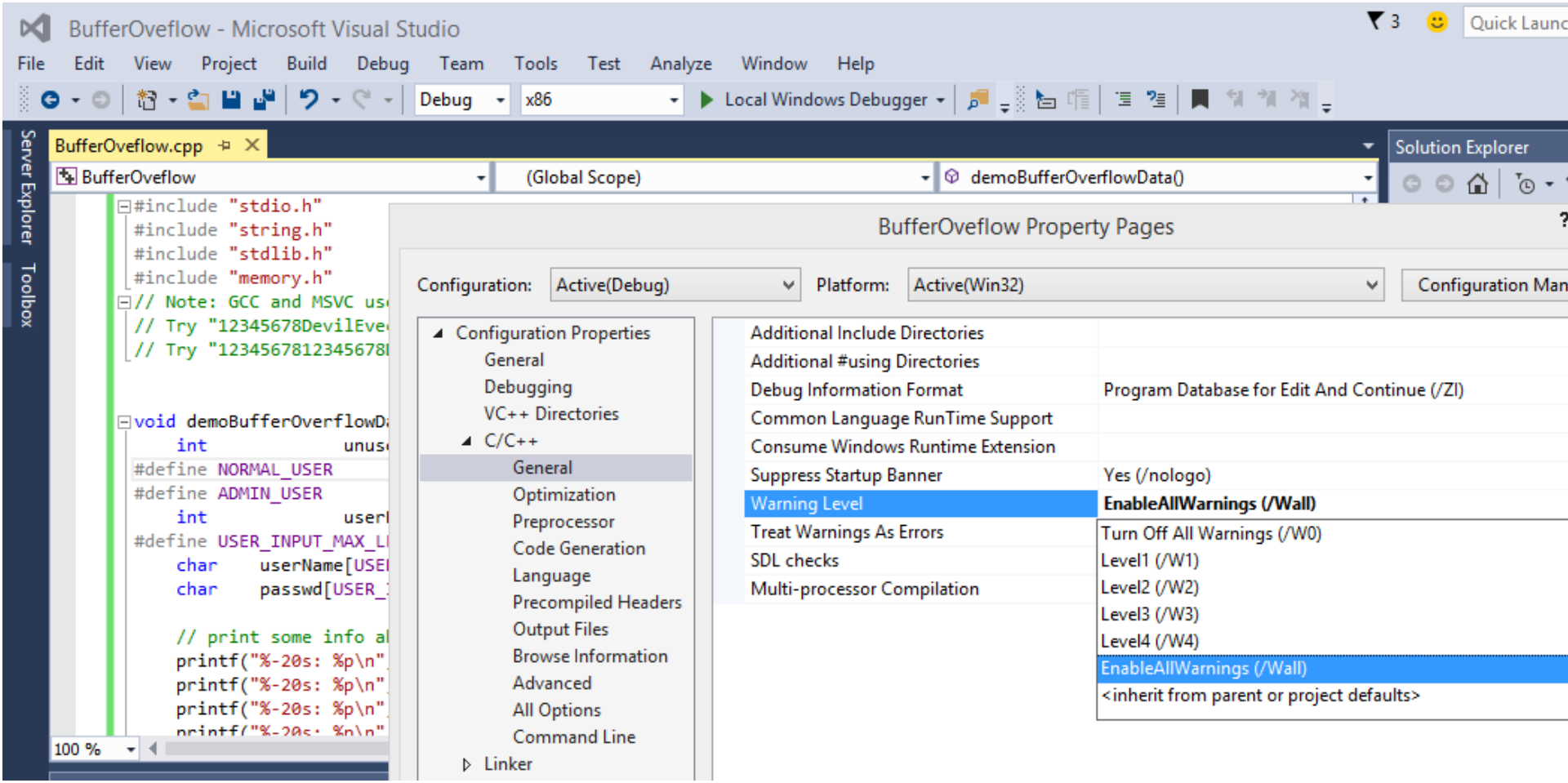
Overview - Lab

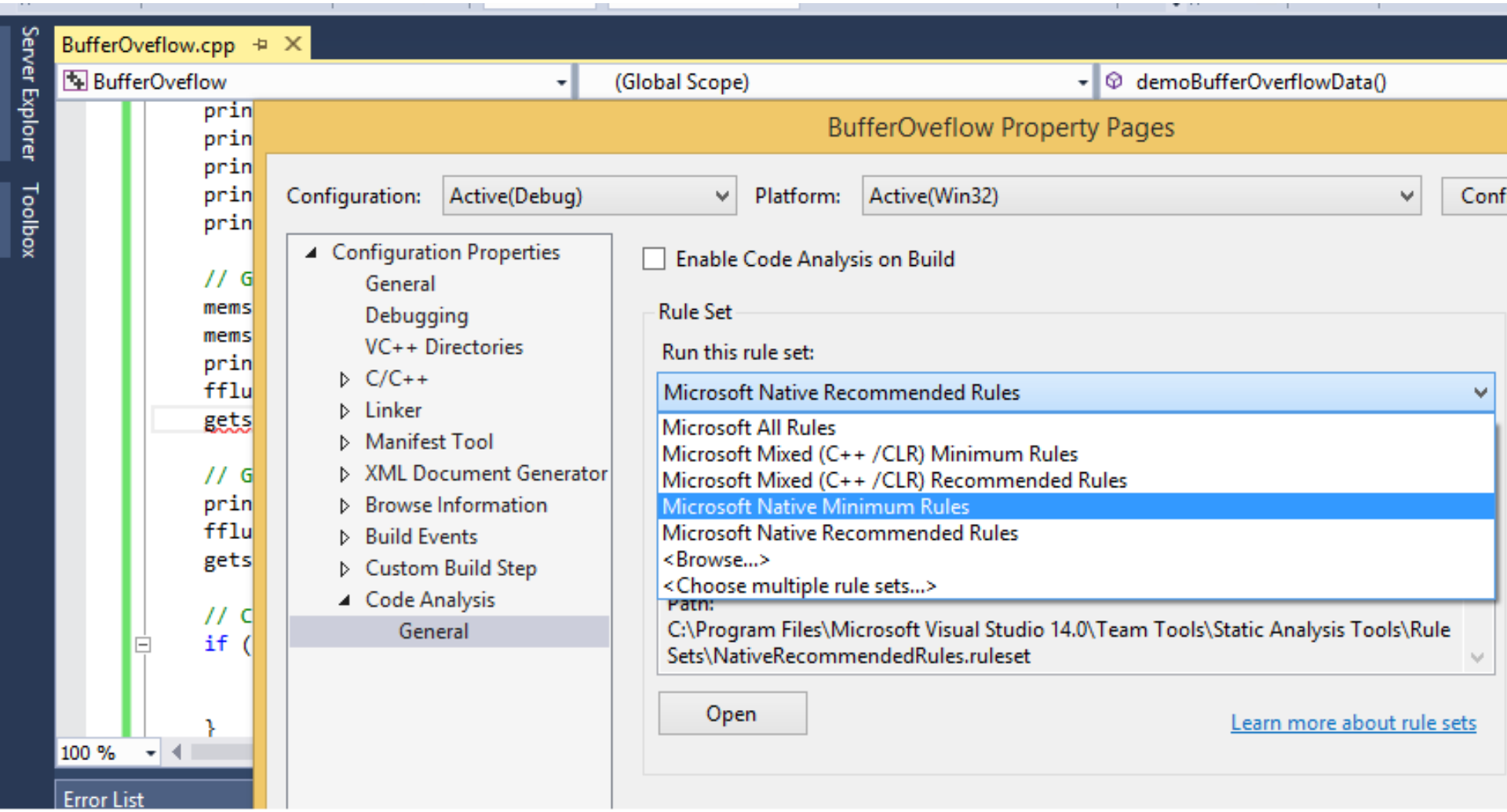
- Goal: Learn how to use basic tools
- Discuss false positives / false negatives

- Check C/C++ code with compiler warnings
- Check C/C++ code with VS PREFast
- Check C/C++ code with CppCheck
- Check Java code with FindBugs

MS Visual Studio: Warnings and PREfast

- Set project warning level to /W4 (or /Wall)
  - Run and compile bufferOverflowDemo.cpp
  - (don't forget: new project must be created)
  - Fix all warnings for clean compilation in VS /W4
- Run Code analysis on bufferOverflowDemo.cpp
  - Analyze→Run code analysis on …
  - You need have Project selected inside Project explorer (otherwise Run code analysis… option will not appear)
  - Try difference between 'minimum' and 'all rules'
- Try at home: *gcc -Wall -Wextra*


BufferOveflow - Microsoft Visual Studio
File Edit View Project Build Debug Team Tools Test Analyze Window Help
Debug
x86
Local Windows Debugger
BufferOveflow.cpp
BufferOveflow
(Global Scope)
demoBufferOverflowData()
Solution Explorer
Server Explorer
Toolbox
#include "stdio.h"
#include "string.h"
#include "stdlib.h"
#include "memory.h"
// Note: GCC and MSVC us
// Try "12345678DevilEve
// Try "12345678123456781
void demoBufferOverflowD
int unus
#define NORMAL_USER
#define ADMIN_USER
int user
#define USER_INPUT_MAX_LI
char userName[USE
char passwd[USER_
// print some info al
printf("%-20s: %p\n"
printf("%-20s: %p\n"
printf("%-20s: %p\n"
100 %
BufferOveflow Property Pages
Configuration: Active(Debug)
Platform: Active(Win32)
Configuration Man
Configuration Properties
General
Debugging
VC++ Directories
C/C++
General
Optimization
Preprocessor
Code Generation
Language
Precompiled Headers
Output Files
Browse Information
Advanced
All Options
Command Line
Linker
Additional Include Directories
Additional #using Directories
Debug Information Format
Program Database for Edit And Continue (/ZI)
Common Language RunTime Support
Consume Windows Runtime Extension
Suppress Startup Banner
Yes (/nologo)
Warning Level
EnableAllWarnings (/Wall)
Treat Warnings As Errors
SDL checks
Multi-processor Compilation
Turn Off All Warnings (/W0)
Level1 (/W1)
Level2 (/W2)
Level3 (/W3)
Level4 (/W4)
EnableAllWarnings (/Wall)
<inherit from parent or project defaults>

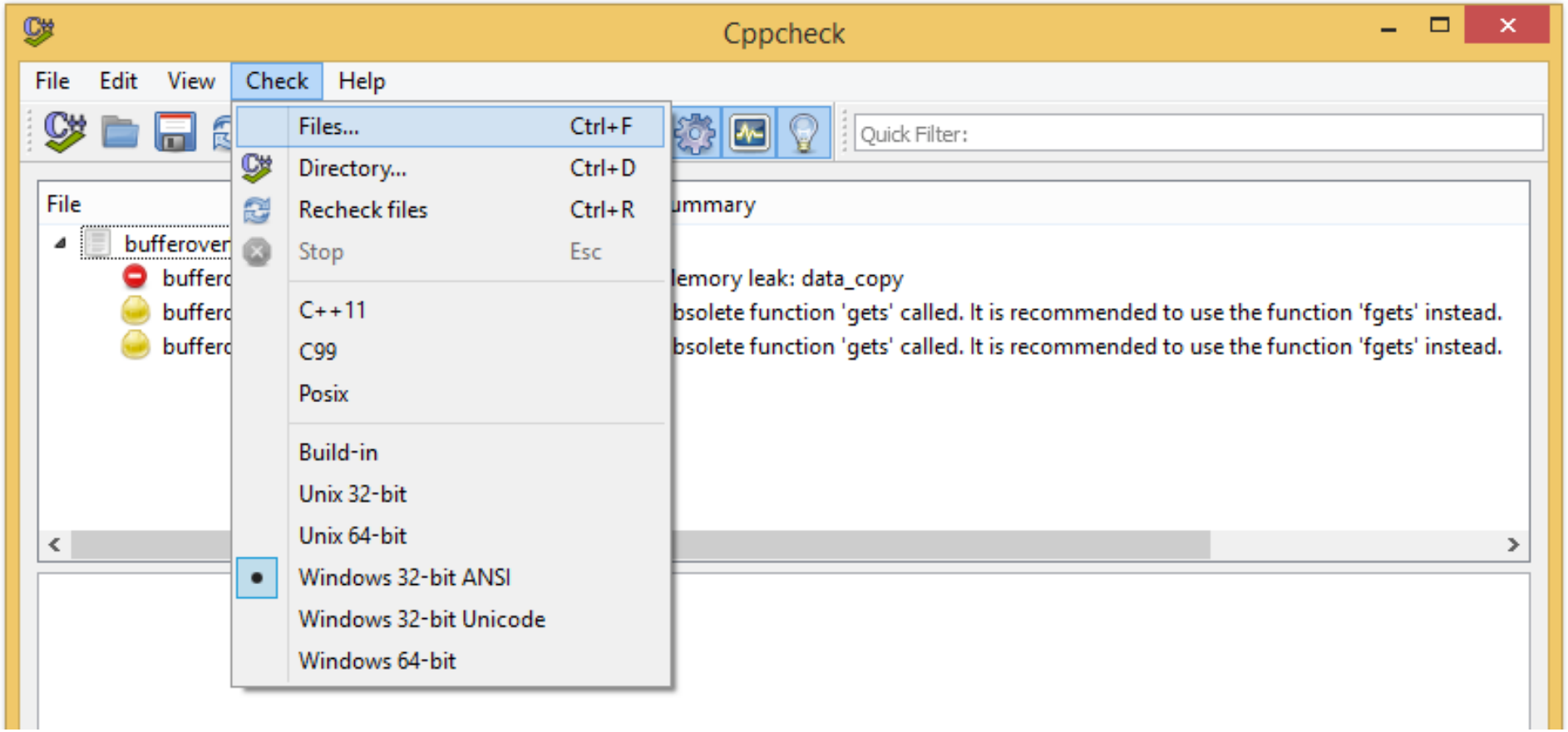

Server Explorer
Toolbox
BufferOveflow.cpp
BufferOveflow
(Global Scope)
demoBufferOverflowData()
BufferOveflow Property Pages
Configuration: Active(Debug)
Platform: Active(Win32)
Configuration Properties
General
Debugging
VC++ Directories
C/C++
Linker
Manifest Tool
XML Document Generator
Browse Information
Build Events
Custom Build Step
Code Analysis
General
Enable Code Analysis on Build
Rule Set
Run this rule set:
Microsoft Native Recommended Rules
Microsoft All Rules
Microsoft Mixed (C++ /CLR) Minimum Rules
Microsoft Mixed (C++ /CLR) Recommended Rules
Microsoft Native Minimum Rules
Microsoft Native Recommended Rules
<Browse...>
<Choose multiple rule sets...>
Path:
C:\Program Files\Microsoft Visual Studio 14.0\Team Tools\Static Analysis Tools\Rule Sets\NativeRecommendedRules.ruleset
Open
Learn more about rule sets
100 %
Error List

Questions (inspect whole BODemo.cpp)

- What is the difference between /W3 and PREFast analysis?
- Why you should compile without warning?
- Are all bugs caught by static analysis?
- Which bugs are not caught?

Cppcheck

1. Download Cppcheck and unpack (or install)
2. Use Cppchcek against bufferOverflow.cpp
   - run command line, cppcheck bufferOverflow.cpp
   - cppcheck --enable=all bufferOverflow.cpp
3. Setup Cppcheck GUI viewer for Cppcheck
   - (Notepad++ is already predistributed on lab computers or download at http://sourceforge.net/projects/notepadpp-usb/)
   - Edit → Preferences → Applications → Add
     - Executable: "C:\Program Files\Notepad++\notepad++.exe“
     - Parameters: -n(line) (file)
4. Run Cppcheck GUI and analyze files or directories

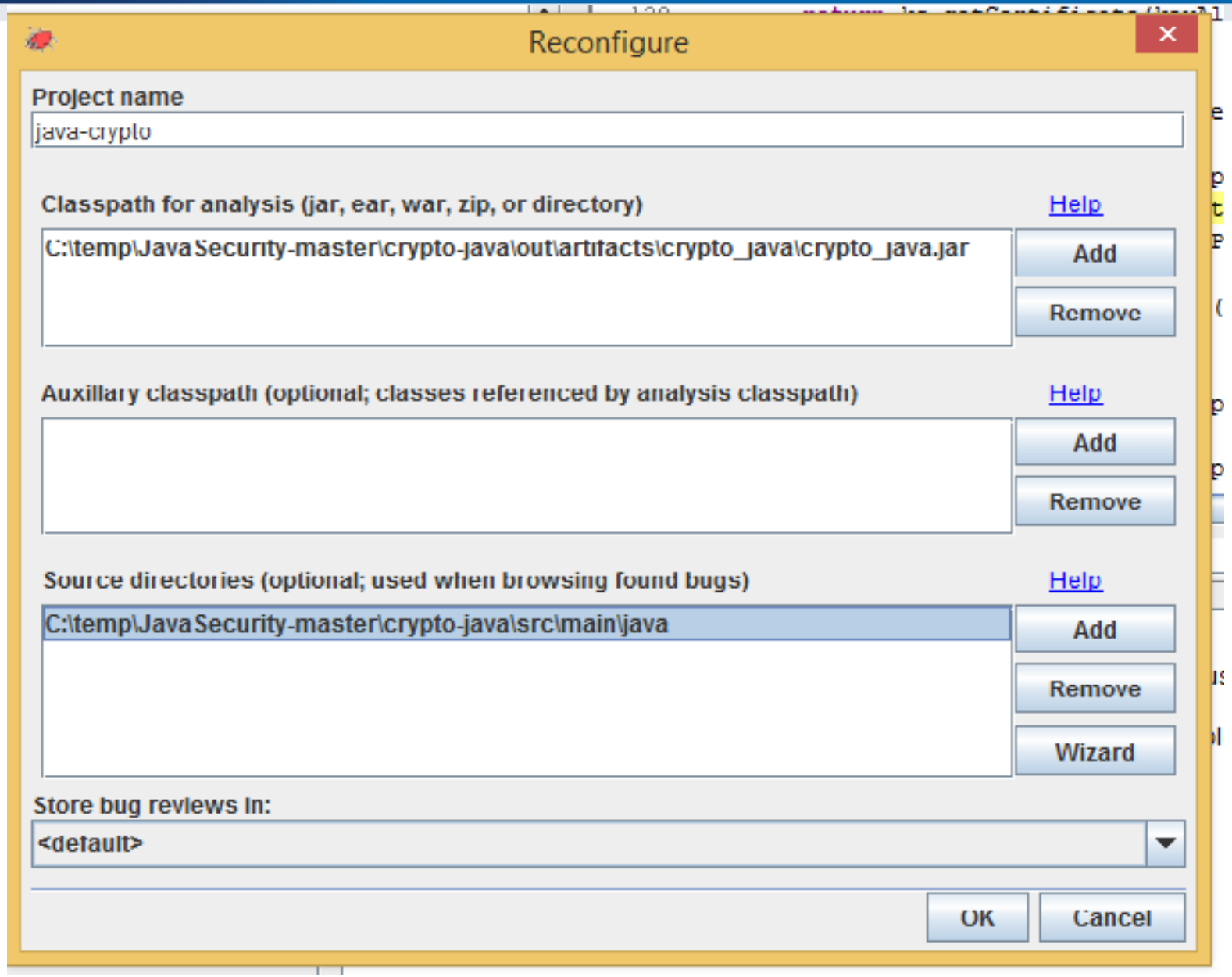

Cppcheck
File
Edit
View
Check
Help
Files... Ctrl+F
Directory... Ctrl+D
Recheck files Ctrl+R
Stop Esc
C++11
C99
Posix
Build-in
Unix 32-bit
Unix 64-bit
Windows 32-bit ANSI
Windows 32-bit Unicode
Windows 64-bit
Quick Filter:
File
ummary
bufferover
emory leak: data_copy
bsolete function 'gets' called. It is recommended to use the function 'fgets' instead.
bsolete function 'gets' called. It is recommended to use the function 'fgets' instead.

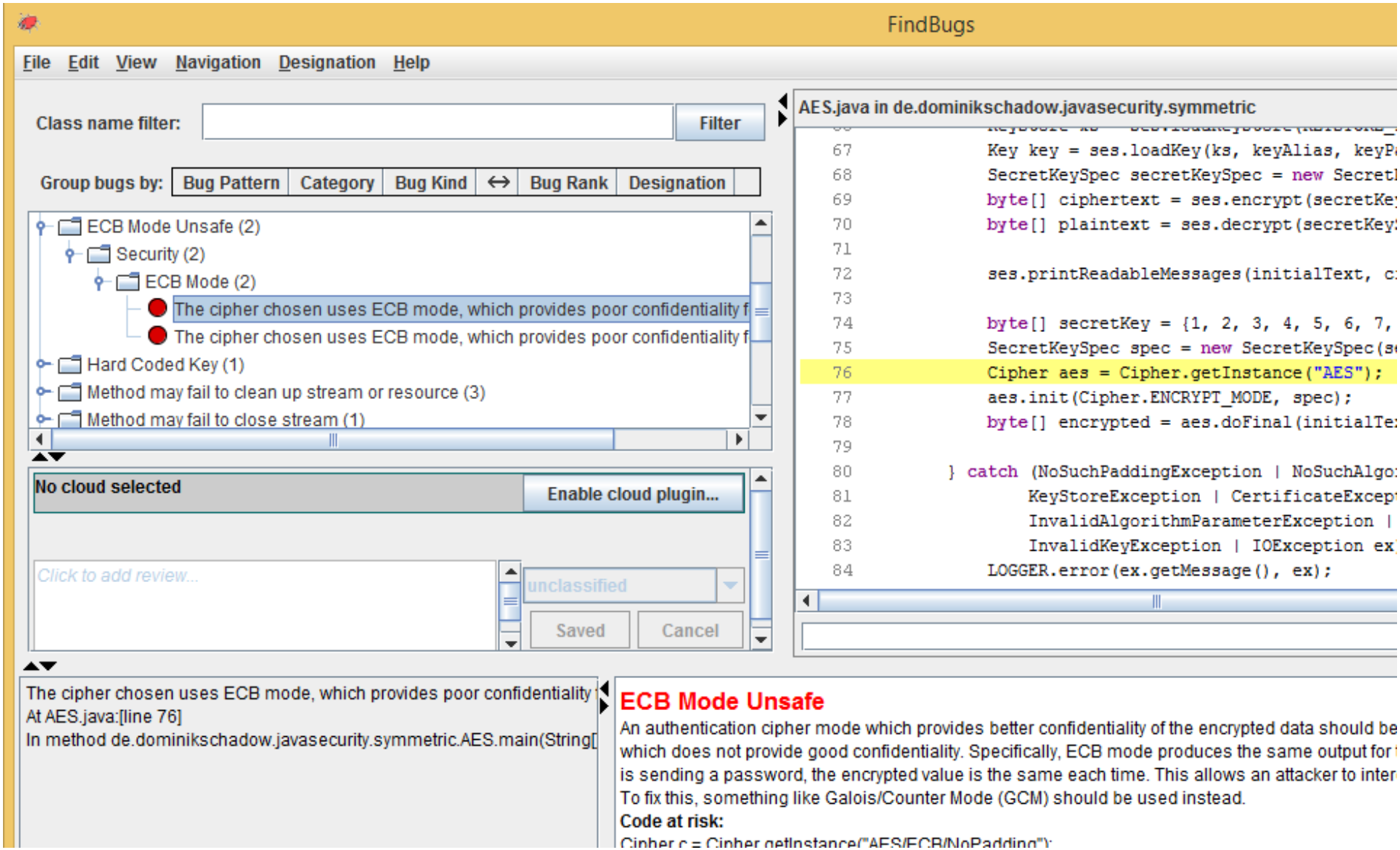
FindBugs/FindSecurityBugs - Java

- Download FindBugs http://findbugs.sourceforge.net/
- Download FindSecurityBugs (plugin)
  - https://h3xstream.github.io/find-sec-bugs/download.htm
  - copy findsecbugs-plugin-1.5.0.jar into FindBugs\plugin\ directory
  - List of patterns: https://h3xstream.github.io/find-sec-bugs/bugs.htm
- Run FindBugs\bin\findbugs.bat (on Windows)
  - Or directly FindBugs\lib\findbugs.jar
  - Enable plugin in Edit → Preferences → Plugins

FindBugs/FindSecurityBugs - Java

- Note: you need compiled *.jar for analysis
  - And source code for quick display of problems ☺
- Extract content of crypto-java.zip
- Run FindBugs
- Start analysis
  - File → New project
  - Classpath for analysis: select target *.jar file (crypto_java.jar)
  - Source directories: select parent dir of target package
    - crypto-java\src\main\java\ in our case


Reconfigure
Project name
java-crypto
Classpath for analysis (jar, ear, war, zip, or directory)
Help
C:\temp\JavaSecurity-master\crypto-java\out\artifacts\crypto_java\crypto_java.jar
Add
Remove
Auxiliary classpath (optional; classes referenced by analysis classpath)
Help
Add
Remove
Source directories (optional; used when browsing found bugs)
Help
C:\temp\JavaSecurity-master\crypto-java\src\main\java
Add
Remove
Wizard
Store bug reviews in:
<default>
OK
Cancel


FindBugs
File Edit View Navigation Designation Help
Class name filter:
Filter
Group bugs by: Bug Pattern Category Bug Kind ↔ Bug Rank Designation
ECB Mode Unsafe (2)
Security (2)
ECB Mode (2)
The cipher chosen uses ECB mode, which provides poor confidentiality f
The cipher chosen uses ECB mode, which provides poor confidentiality f
Hard Coded Key (1)
Method may fail to clean up stream or resource (3)
Method may fail to close stream (1)
No cloud selected
Enable cloud plugin...
Click to add review...
unclassified
Saved
Cancel
AES.java in de.dominikschadow.javasecurity.symmetric
67 Key key = ses.loadKey(ks, keyAlias, keyP
68 SecretKeySpec secretKeySpec = new Secret
69 byte[] ciphertext = ses.encrypt(secretKe
70 byte[] plaintext = ses.decrypt(secretKey
71
72 ses.printReadableMessages(initialText, c
73
74 byte[] secretKey = {1, 2, 3, 4, 5, 6, 7,
75 SecretKeySpec spec = new SecretKeySpec(s
76 Cipher aes = Cipher.getInstance("AES");
77 aes.init(Cipher.ENCRYPT_MODE, spec);
78 byte[] encrypted = aes.doFinal(initialTe
79
80 } catch (NoSuchPaddingException | NoSuchAlgo
81 KeyStoreException | CertificateExcep
82 InvalidAlgorithmParameterException |
83 InvalidKeyException | IOException ex
84 LOGGER.error(ex.getMessage(), ex);
The cipher chosen uses ECB mode, which provides poor confidentiality
At AES.java:[line 76]
In method de.dominikschadow.javasecurity.symmetric.AES.main(String[
ECB Mode Unsafe
An authentication cipher mode which provides better confidentiality of the encrypted data should be
which does not provide good confidentiality. Specifically, ECB mode produces the same output for
is sending a password, the encrypted value is the same each time. This allows an attacker to inter
To fix this, something like Galois/Counter Mode (GCM) should be used instead.
Code at risk:
Cipher c = Cipher.getInstance("AES/ECB/NoPadding");

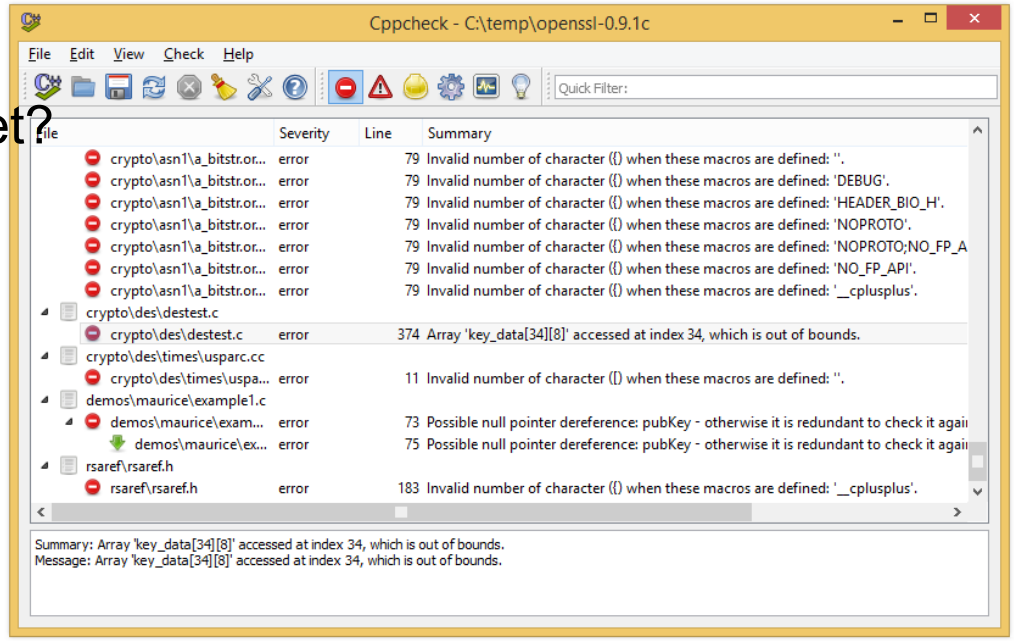
Questions: FindBugs & FindSecurityBugs

- Which issues were found?
- Are all reported issues from project source code?
- How you would rate severity of different issues?
- How can you use FindBugs in team collaboration?

- Is FindBugs working on source code or compiled code? Compare to CppCheck.

CPPCheck + OpenSSL

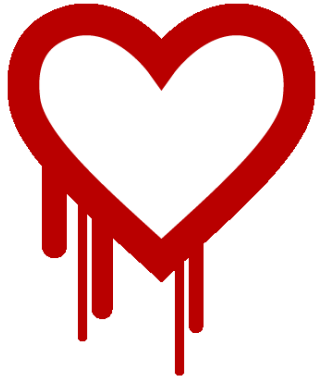
- Run against OpenSSL0.9.1c (1998)
  - https://www.openssl.org/source/old/0.9.x/openssl-0.9.1c.tar.gz
  - what are the bugs?
- Run against newest OpenSSL
  - ftp://ftp.openssl.org/source/
  - Why not completely clean yet?



Questions

- Which bugs are found in bufferOverflowDemo.cpp? Compare to PREFast in Visual Studio.
- Which bugs are found in old OpenSSL?
- Are style warnings important?

Hearthbleed bug



- OpenSSL 1.0.1 through 1.0.1f
- Download https://www.openssl.org/source/openssl-1.0.1e.tar.gz
- Locate function dtls1_process_heartbeat(SSL *s)
  - Ssl\t1_lib.c
- Will your static analyzers find anything?
  - Don’t be sad, even Coverity didn’t before bug was exposed
  - http://security.coverity.com/blog/2014/Apr/on-detecting-heartbleed-with-static-analysis.html

Homework

- Nothing this week ☺