Developing Correct C++ @ Scale

Mark Isaacson

Note: This talk is meant to be heard, not read. The slides aren't useful by themselves.

Fundamental Developer Concerns

- How do you prevent code from breaking?
- How do you define “broken”?
- How do you know if something broke?
- How do you figure out why something broke?
- Who do you talk to when something breaks?

Perspective

Facebook

- Thousands of developers
- 1 repo = most C++ projects
- Hundreds of thousands of files
- Broken code can lead to a broken product
- Continued development/release

Setting the Scene

```
void enforceIsFive(int x) {
  EXPECT_EQ(x, 5);
}

TEST(MySillyTest, BasicTest) {
  enforceIsFive(5);
  enforceIsFive(3); // Oops
}
```

Setting the Scene

```
[==========] Running 1 test from 1 test case.
SillyTest.cpp:31: void enforceIsFive(int): Expect `x == 5' failed.
```

Setting the Scene

```
[==========] Running 1 test from 1 test case.
SillyTest.cpp:31: void enforceIsFive(int): Expect `x == 5' failed.
*** Signal 6 (SIGABRT) stack trace: ***
    @ folly::symbolizer::signalHandler(int, siginfo_t*, void*)
    @ google::LogMessage::Fail() glog/logging.cc:1405
    @ enforceIsFive(int)
    @ SillyTest_BasicTest_Test::TestBody()
    @ testing::internal::UnitTestImpl::RunAllTests() gtest.cc:4602
    @ RUN_ALL_TESTS()
    @ main
```

A default test main function

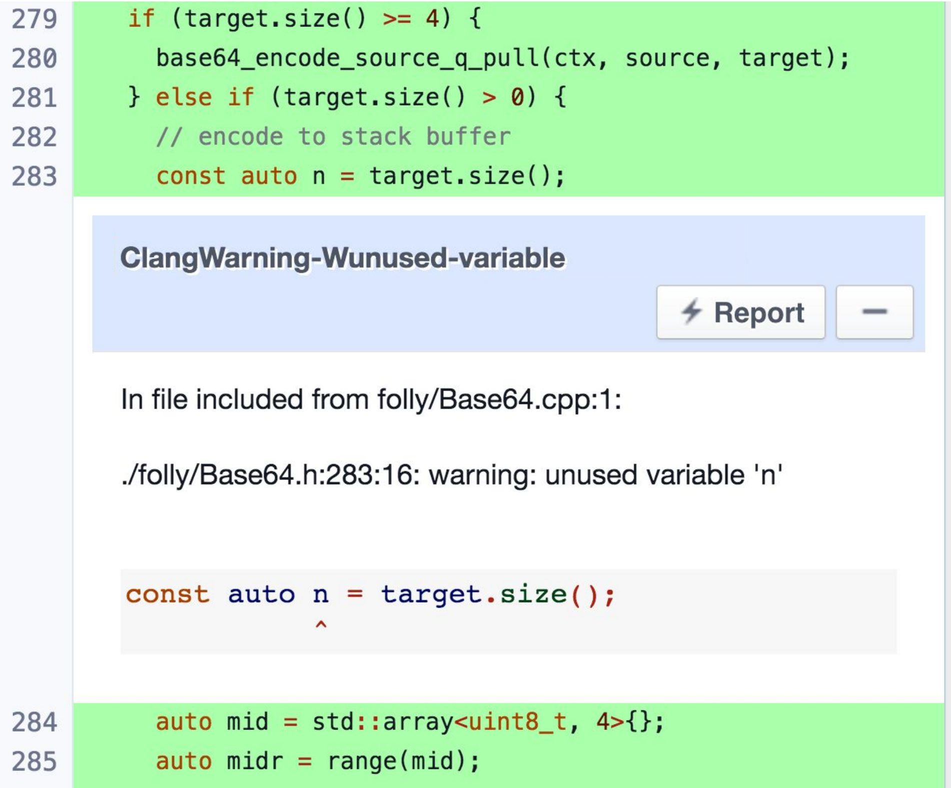
```
int main(int argc, char** argv) __attribute__((__weak__));

int main(int argc, char** argv) {
  ::testing::InitGoogleTest(&argc, argv);
  folly::symbolizer::installFatalSignalHandler();
  /* Stuff */
  folly::symbolizer::installFatalSignalCallbacks();
  return RUN_ALL_TESTS();
}
```

Code Review

How do you know that nothing broke?

Automatic Code Review



```
279     if (target.size() >= 4) {
280       base64_encode_source_q_pull(ctx, source, target);
281     } else if (target.size() > 0) {
282       // encode to stack buffer
283       const auto n = target.size();
```

ClangWarning-Wunused-variable

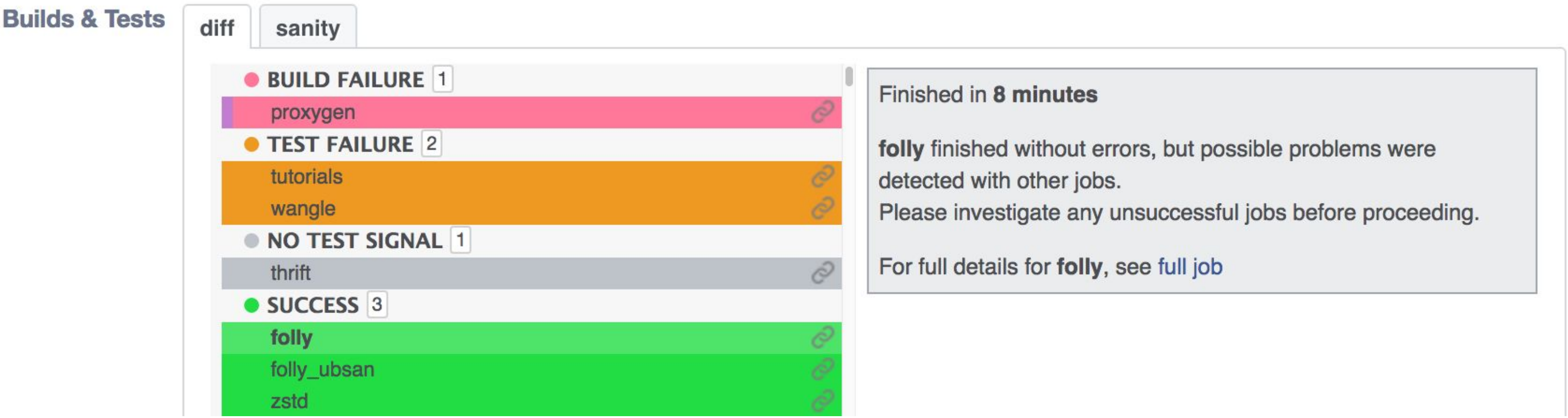
In file included from folly/Base64.cpp:1:

./folly/Base64.h:283:16: warning: unused variable 'n'

```
const auto n = target.size();
           ^
```

```
284       auto mid = std::array<uint8_t, 4>{};
285       auto midr = range(mid);
```

Automatic Code Review



Builds & Tests

● BUILD FAILURE 1
- proxygen

● TEST FAILURE 2
- tutorials
- wangle

● NO TEST SIGNAL 1
- thrift

● SUCCESS 3
- **folly**
- folly_ubsan
- zstd

Finished in **8 minutes**

folly finished without errors, but possible problems were detected with other jobs.
Please investigate any unsuccessful jobs before proceeding.

For full details for **folly**, see full job

Pass/Fail State is complicated

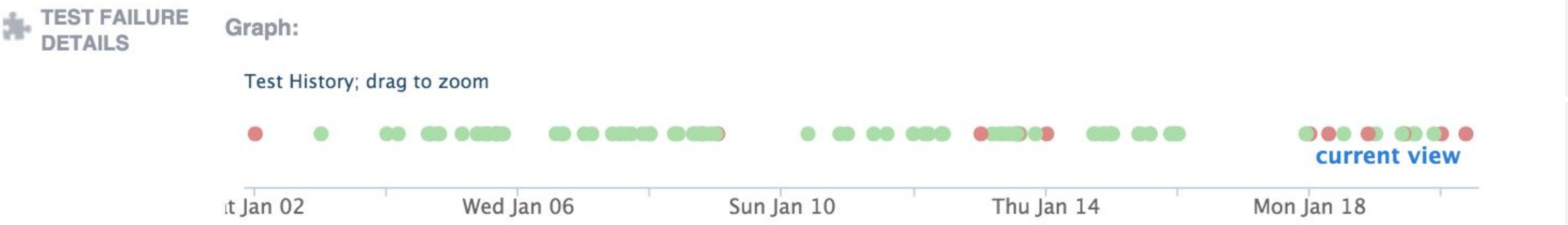
- Green is “nothing new”

● SUCCESS

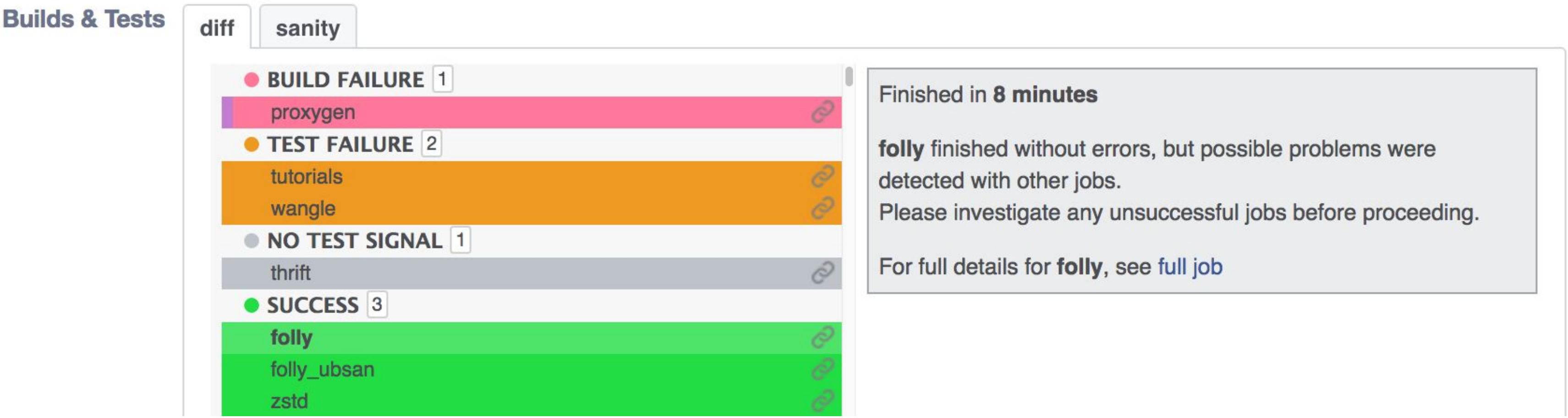
Pass/Fail State is complicated

- Green is “nothing new”
- Wardens keep signal high

● SUCCESS



Automatic Code Review



● BUILD FAILURE 1

proxygen

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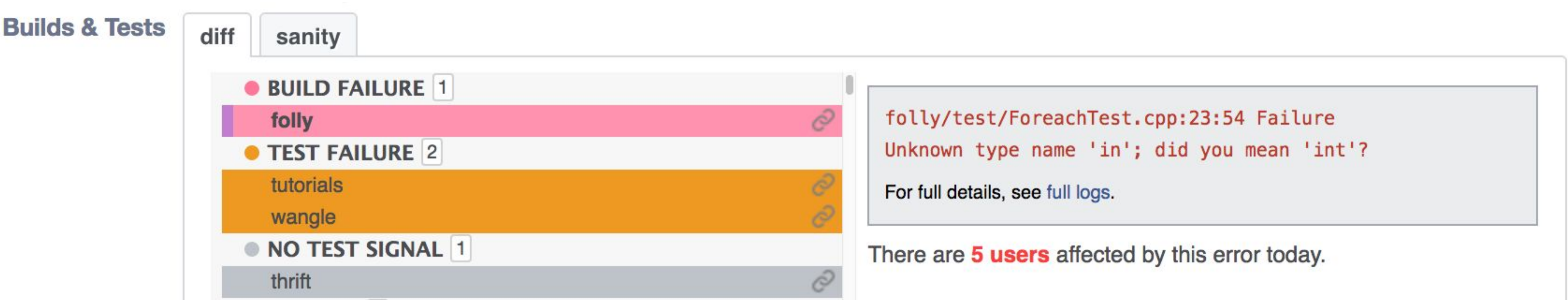
Automatic Code Review



● BUILD FAILURE 1
- folly

● TEST FAILURE 2
- tutorials
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● NO TEST SIGNAL 1
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```
folly/test/ForeachTest.cpp:23:54 Failure
Unknown type name 'in'; did you mean 'int'?
```

For full details, see full logs.

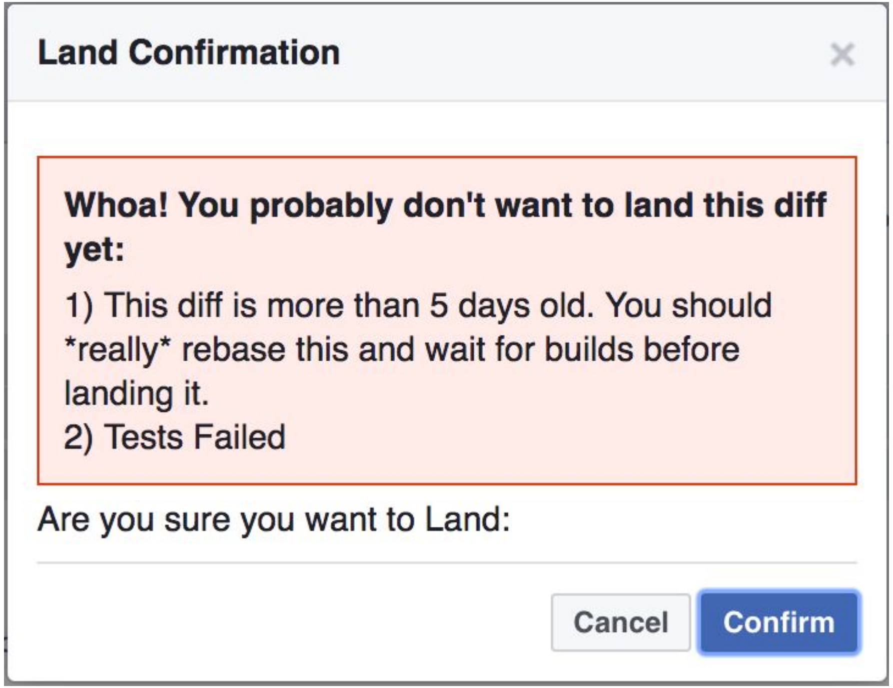
There are **5 users** affected by this error today.

Human Code Review

- Human component
  - Interpreting the automatic information
  - Meta-correctness checks
  - The ultimate decider

Shipping the Code

Shipping the Code



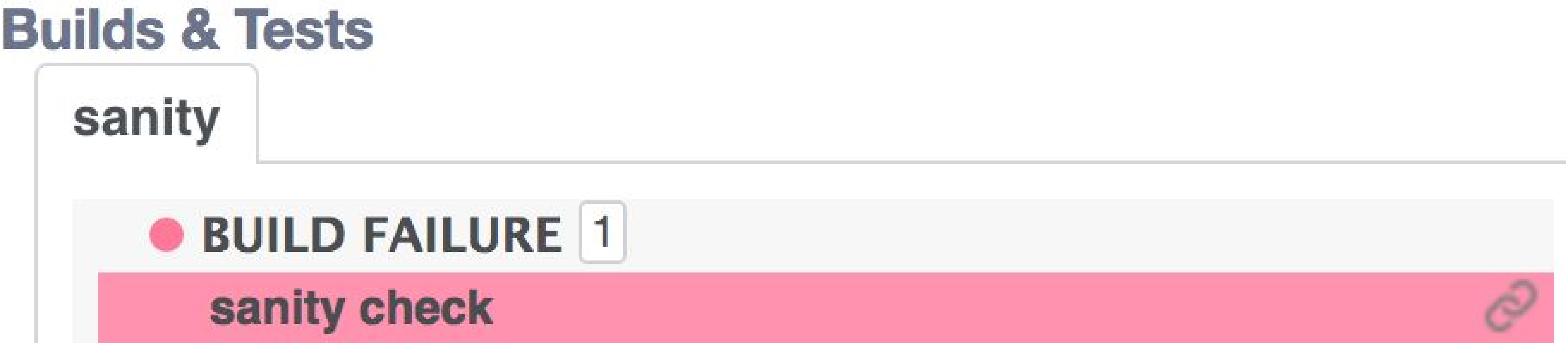
Land Confirmation

Whoa! You probably don't want to land this diff yet:

1) This diff is more than 5 days old. You should *really* rebase this and wait for builds before landing it.
2) Tests Failed

Are you sure you want to Land:

Optimizing Turnaround



Builds & Tests

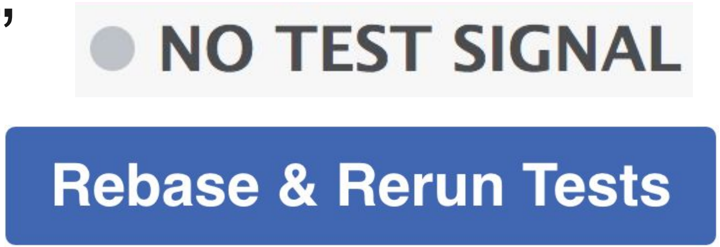
sanity

● BUILD FAILURE 1

sanity check

What gets through?

- Undefined behavior
- The “already broken”



ASAN

```
int main() {
  auto x = new int(5);
  delete x;
  *x = 3;
  return 0;
}
```

ASAN

```
ERROR: AddressSanitizer: heap-use-after-free
WRITE of size 4 at 0xf0 thread T0
     #0 my_binary.cpp:9  main
0xf0 is located 0 bytes inside of 4-byte region [0xf0,0xf4)
freed by thread T0 here:
     #0 my_binary+0x70   operator delete(void*)
     #1 my_binary.cpp:8  main
previously allocated by thread T0 here:
     #0 my_binary+0x30   operator new(unsigned long)
     #1 my_binary.cpp:7  main
```

ASAN (Raw-ish Output)

```
ERROR: AddressSanitizer: heap-use-after-free on address 0xf0
at pc 0x19 bp 0xa0 sp 0x98

WRITE of size 4 at 0xf0 thread T0

    #0 0x18 in main my_binary.cpp:9

    #1 0xf5 in __libc_start_main (lib/libc.so.6+0xf5)

    #2 0x25 in _start sysdeps/x86_64/start.S:12

0xf0 is located 0 bytes inside of 4-byte region [0xf0,0xf4)
```

ASAN (Raw-ish Output)

```
freed by thread T0 here:
    #0 0x70 in operator delete(void*) (my_binary+0x40)
    #1 0xd5 in main my_binary.cpp:8
    #2 0xf5 in __libc_start_main (lib/libc.so.6+0xf5)
    #3 0x25 in _start sysdeps/x86_64/start.S:12
previously allocated by thread T0 here:
    #0 0x30 in operator new(unsigned long) (my_binary+30)
    #1 0x6a in main my_binary.cpp:7
    #2 0xf5 in __libc_start_main (lib/libc.so.6+0xf5)
    #3 0x25 in _start sysdeps/x86_64/start.S:12
```

ASAN (Reduced Output)

```
ERROR: AddressSanitizer: heap-use-after-free
WRITE of size 4 at 0xf0 thread T0
     #0 my_binary.cpp:9  main
0xf0 is located 0 bytes inside of 4-byte region [0xf0,0xf4)
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```

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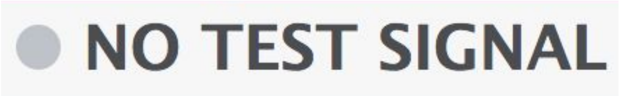

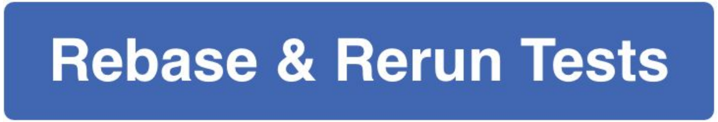

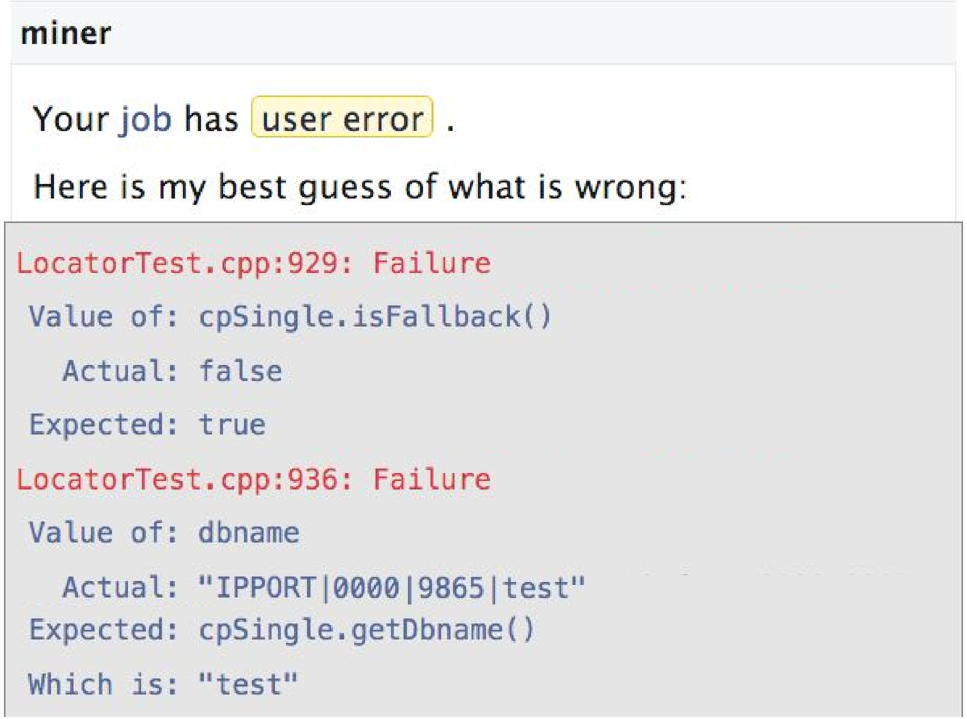

miner

Your job has user error .

Here is my best guess of what is wrong:

```
LocatorTest.cpp:929: Failure
 Value of: cpSingle.isFallback()
   Actual: false
 Expected: true
LocatorTest.cpp:936: Failure
 Value of: dbname
   Actual: "IPPORT|0000|9865|test"
 Expected: cpSingle.getDbname()
 Which is: "test"
```

* This code/test output is fictitious.

Mining Error Messages

Informing Developers

- Repro command
- Error message
- Test configuration
- History
- # of breakages

1 problem, 1 task

Task Aggregation

- By configuration
- By binary
- By "fail rev"

Who knows about X?

Credits

- Developer Infrastructure
  - Product Stability
  - Signal Infrastructure
  - fbcode Foundation
- Security Infrastructure
- + More

Fundamental Developer Concerns

- How do you prevent code from breaking?
- How do you define “broken”?
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- Who do you talk to when something breaks?

return 0;