# QuickCheck Evolution

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# Why is testing hard?

n features

O(n) test cases

O($n^2$) test cases

O($n^3$) test cases

O($n^4$) test cases

3—4 tests per feature

pairs of features

triples of features

Don’t write tests!

# Generate them

# QuickCheck

1999—invented by Koen Claessen and myself, for Haskell

2006—Quviq founded marketing Erlang version

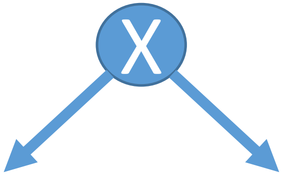
Many extensions

Finding deep bugs for Ericsson, Volvo Cars, Basho, etc…

# Example—binary trees

`leaf`

`{node,L,X,R}`



```
to_list(leaf) -> [];
to_list({node,L,X,R}) ->
  to_list(L) ++ [X] ++ to_list(R).

member(_,leaf) ->
  false;
member(X,{node,L,Y,R}) ->
  if X==Y -> true;
     X<Y  -> member(X,R);
     X>Y  -> member(X,L)
  end.
```

# A property of member

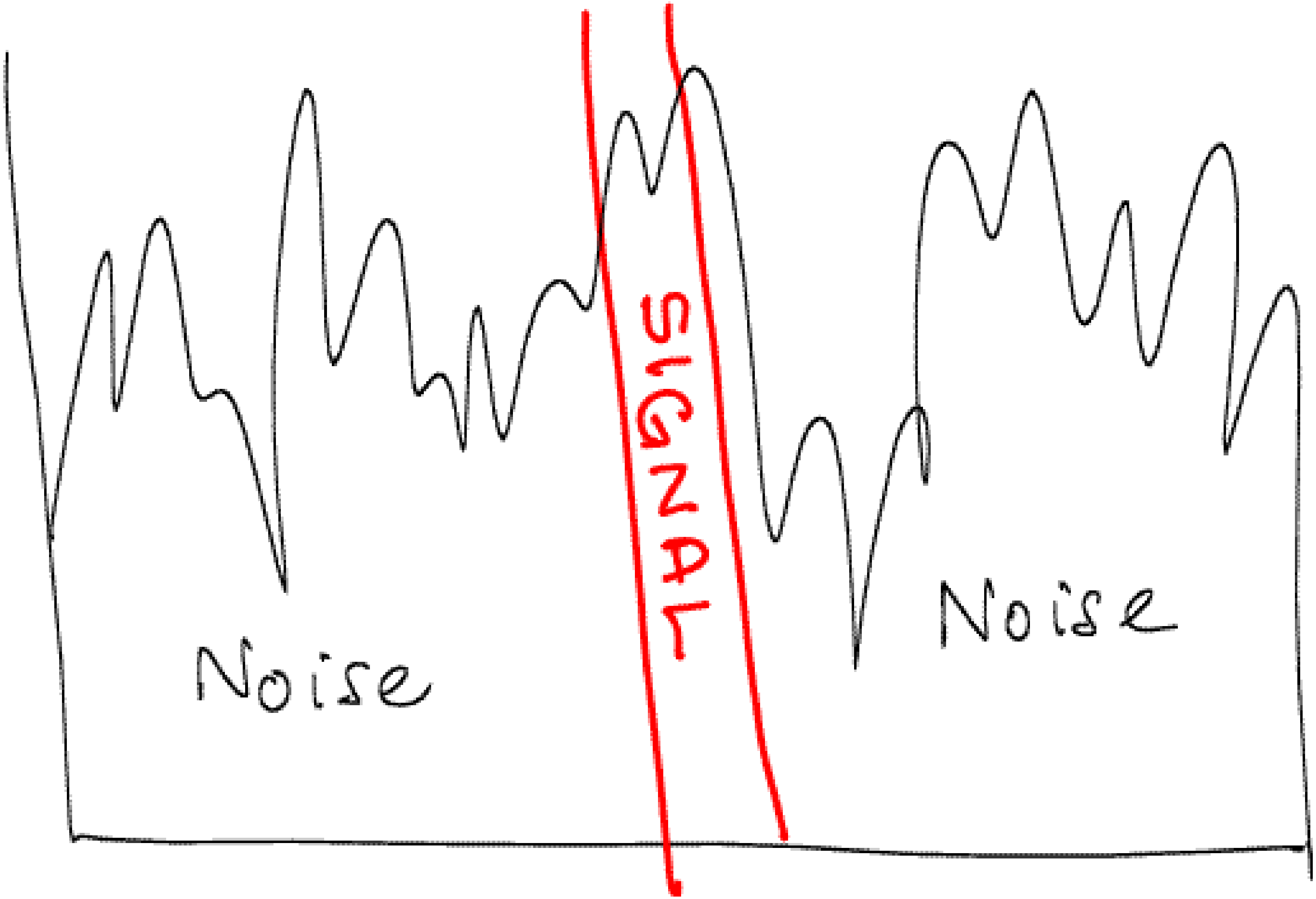
For all X and T…

…generated like this…

```
prop_member() ->
  ?FORALL({X,T},{nat(),tree()},
    member(X,T) == lists:member(X,to_list(T))).
```

…the member function behaves like lists:member

# Let’s run some tests…


Noise
SIGNAL
Noise

# But… what was that example again?

- We may want to *preserve* examples that failed before, as a regression suite

- In reality, a failing case may take a long time to find… we don't want to throw it away!

# Enter… QuickCheck CI

**DEMO**

# QuickCheck CI

- Builds a regression test suite automatically
  - See progress in terms of tests which now pass
  - Save *rare* tests which were hard to find

- Presents coverage information in depth
  - See at a glance what has been tested
  - See the effects of test case *distribution*
  - Helps localize bugs!

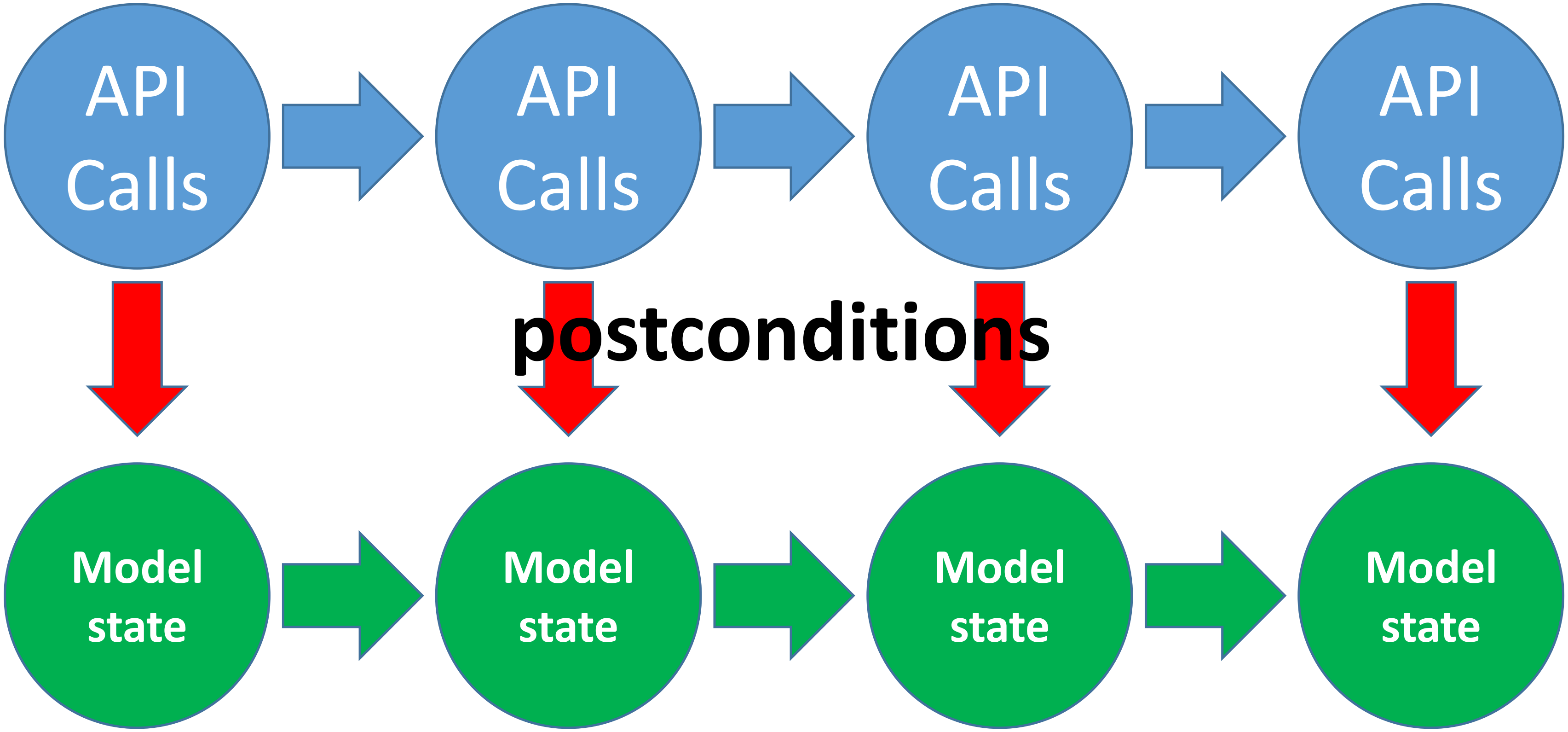
# State machine testing—example

- Let’s test the process registry
  - register(Name,Pid)
  - unregister(Name)
  - spawn()—to create pids for test data

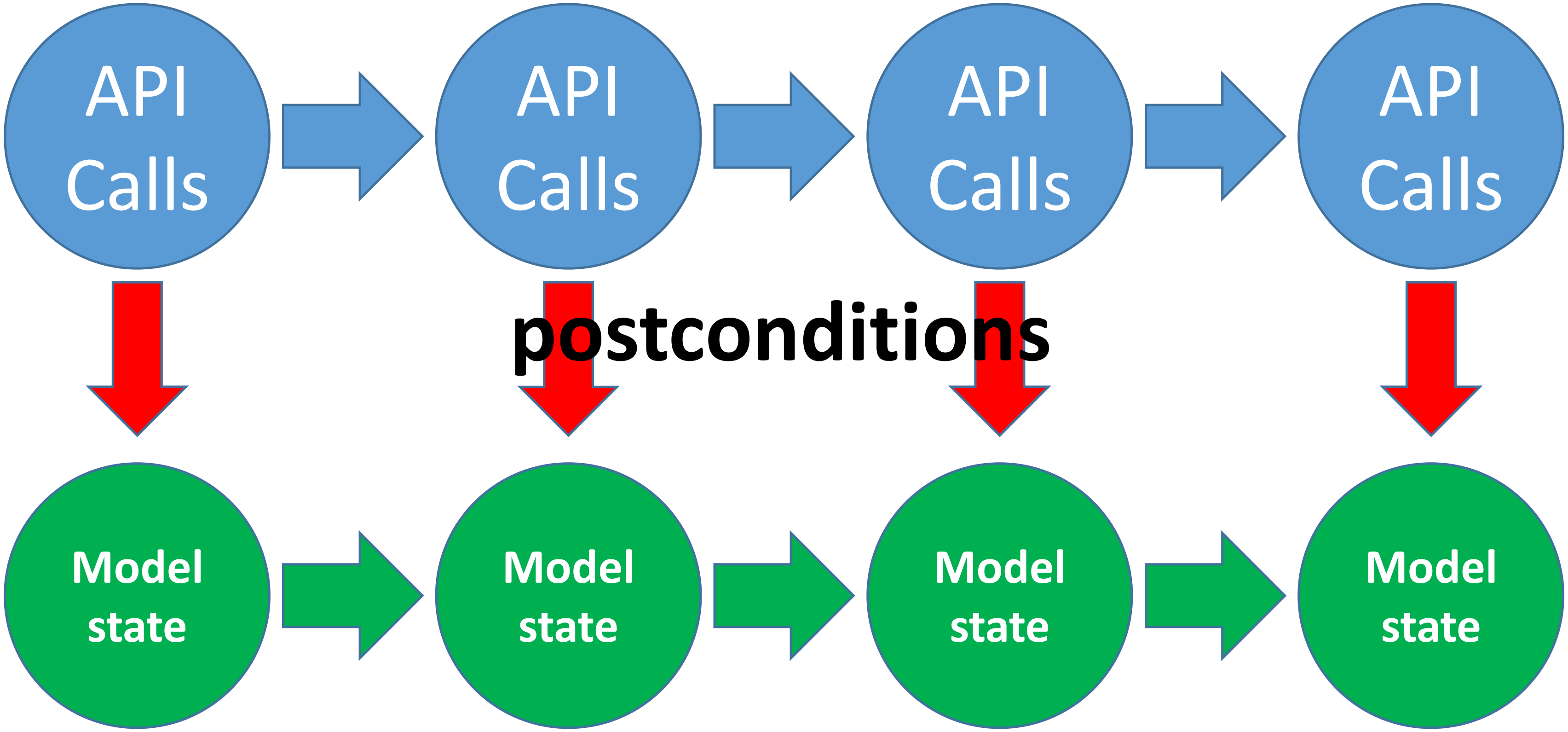
- What’s different now?
  - These functions change the state of the registry

- Not looking for bugs!
  - We’ll reverse engineer *preconditions* instead

# State Machine Models



# State Machine Models



# Modelling the registry state

Added by spawn

```
#state{
   pids = […<0.32.0>…],
   regs = [{a,<0.32.0>},…]
}
```

Added by register, removed by unregister

# Specification of register

```
register_pre(S) ->
  S#state.pids /= [].
```

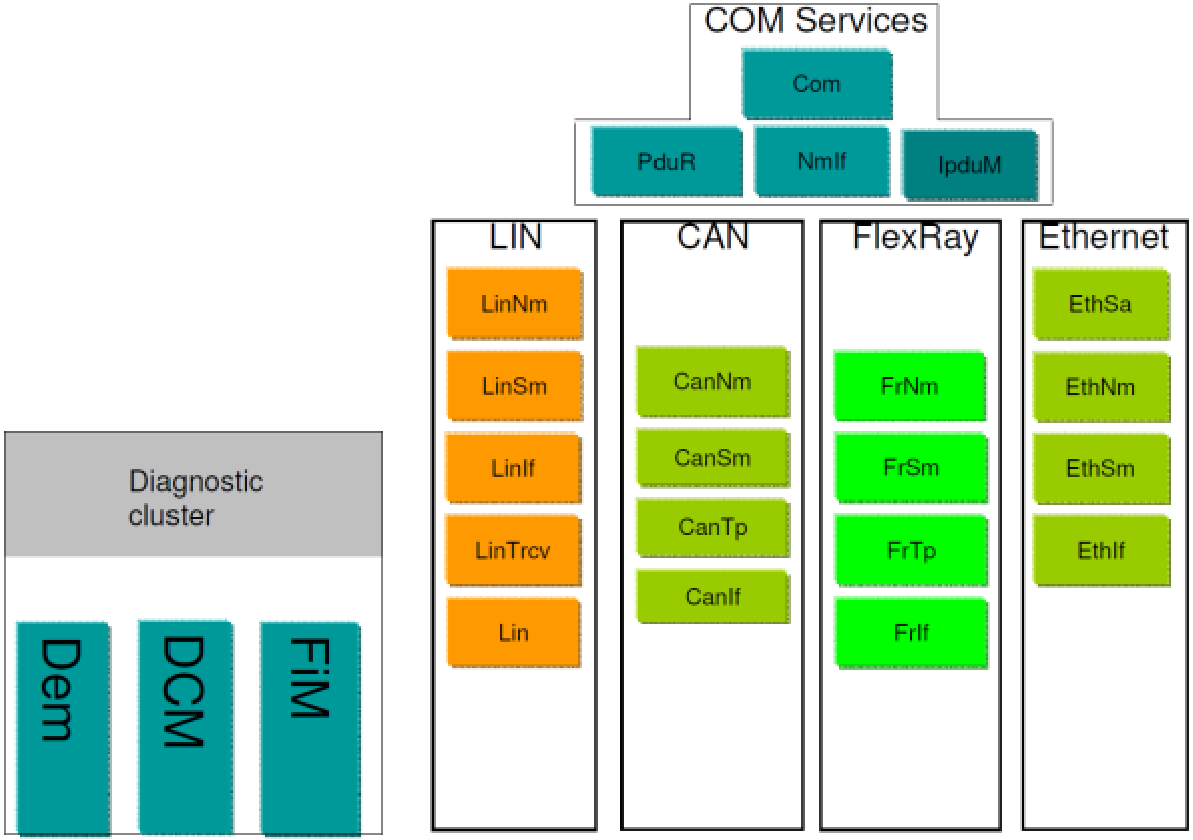
```
register_args(S) ->
  [name(),elements(S#state.pids)].

register(Name,Pid) ->
  erlang:register(Name,Pid).

register_next(S,_,[Name,Pid]) ->
  S#state{regs=S#state.regs++[{Name,Pid}]}.
```

# DEMO

# State machine models

- Conveniently specify the intended behaviour of stateful systems
- QuickCheck CI reports a variety of interesting test cases, and groups them sensibly
- Testing in practice involves
  - Reverse engineering of specifications (yes, really!)
  - Finding and correcting bugs in the code

# Doing it for real…



COM Services

Com

PduR

NmIf

IpduM

LIN

LinNm

LinSm

LinIf

LinTrcv

Lin

CAN

CanNm

CanSm

CanTp

CanIf

FlexRay

FrNm

FrSm

FrTp

FrIf

Ethernet

EthSa

EthNm

EthSm

EthIf

Diagnostic cluster

Dem

DCM

FiM

3,000 pages of specifications

20,000 lines of QuickCheck

1,000,000 LOC, 6 suppliers

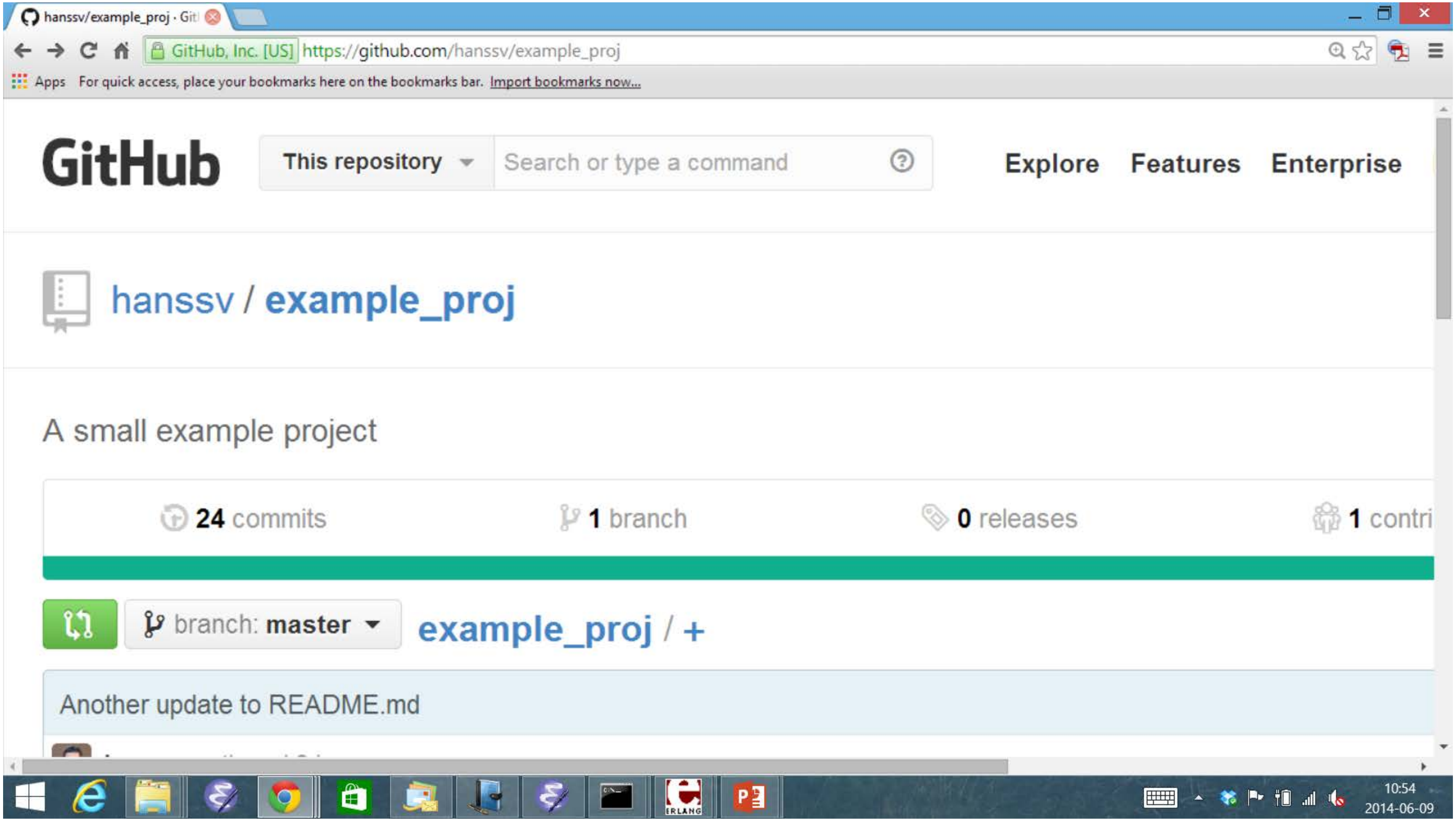
200 problems

100 problems in the standard

10x shorter test code

# Want to try it out?

- Go to https://github.com/hanssv/example_proj



hanssv/example_proj · Git
GitHub, Inc. [US] https://github.com/hanssv/example_proj
Apps For quick access, place your bookmarks here on the bookmarks bar. Import bookmarks now...
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Enterprise

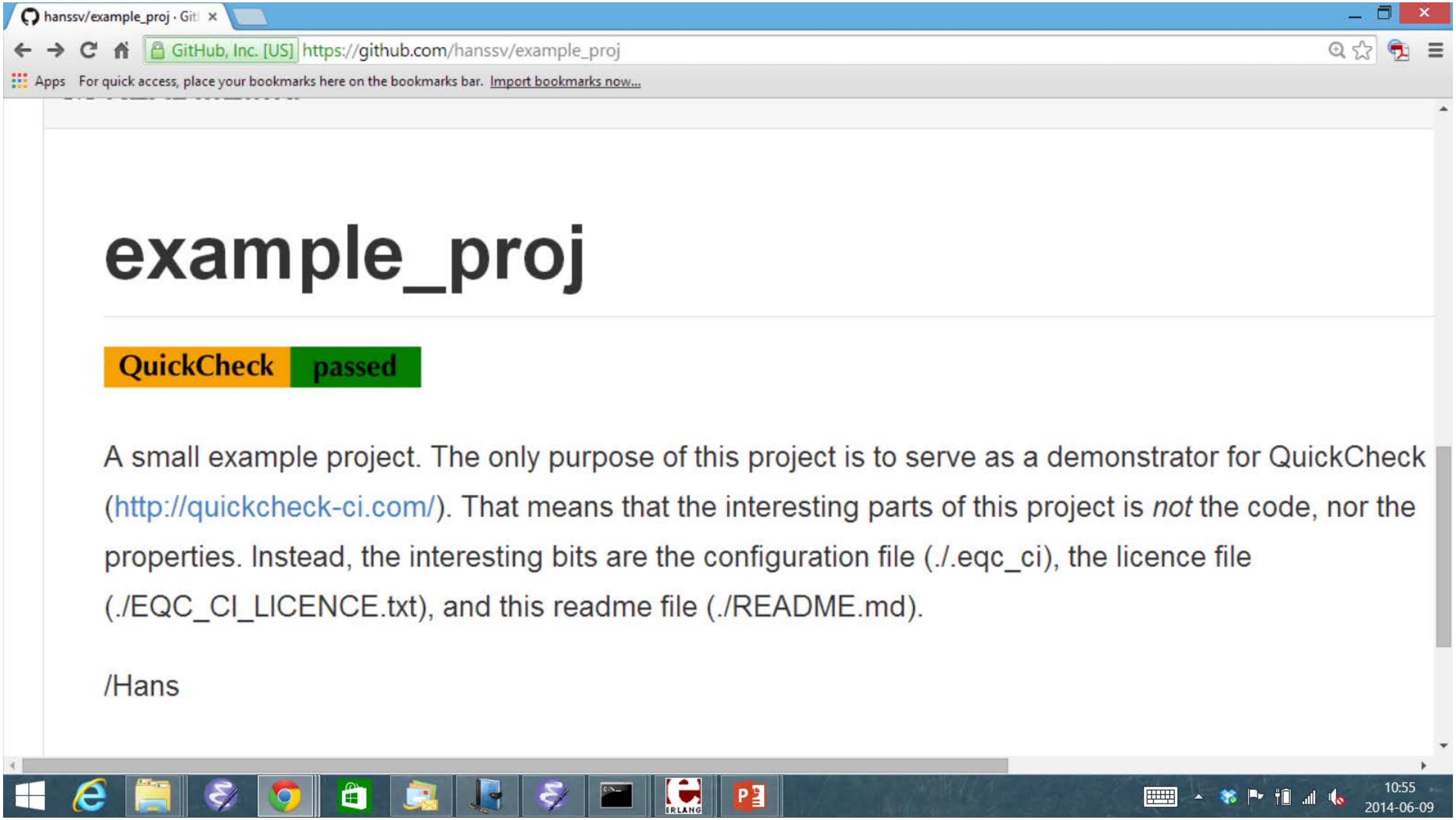
hanssv / example_proj

A small example project

24 commits
1 branch
0 releases
1 contri
branch: master

example_proj / +

Another update to README.md



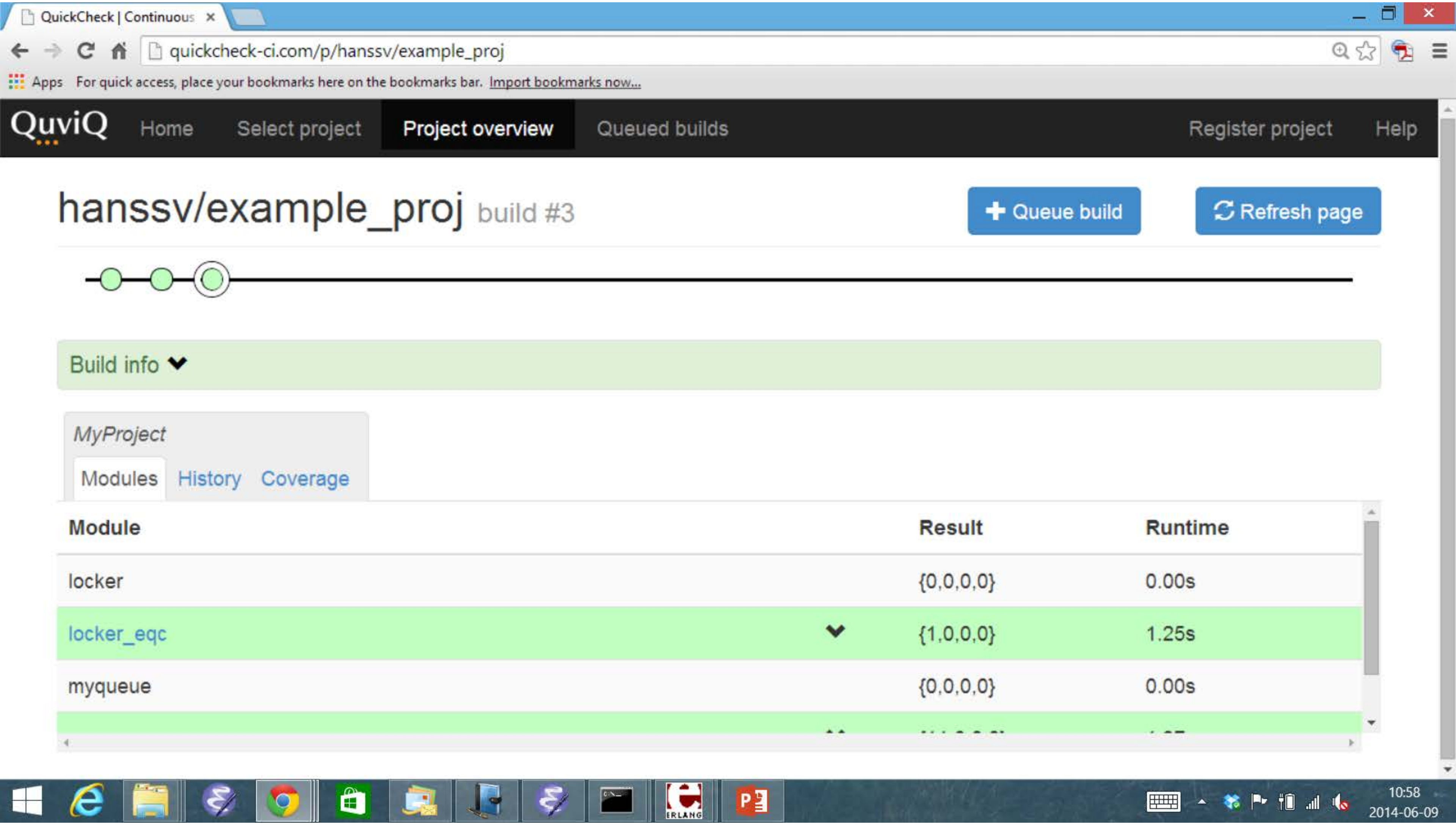
hanssv/example_proj · Git
GitHub, Inc. [US] https://github.com/hanssv/example_proj
Apps For quick access, place your bookmarks here on the bookmarks bar. Import bookmarks now...
10:55
2014-06-09

# example_proj

QuickCheck passed

A small example project. The only purpose of this project is to serve as a demonstrator for QuickCheck (http://quickcheck-ci.com/). That means that the interesting parts of this project is *not* the code, nor the properties. Instead, the interesting bits are the configuration file (./.eqc_ci), the licence file (./EQC_CI_LICENCE.txt), and this readme file (./README.md).

/Hans



# hanssv/example_proj build #3

| Module | Result | Runtime |
|---|---|---|
| locker | {0,0,0,0} | 0.00s |
| locker_eqc | {1,0,0,0} | 1.25s |
| myqueue | {0,0,0,0} | 0.00s |

quickcheck-ci.com

QuviQ