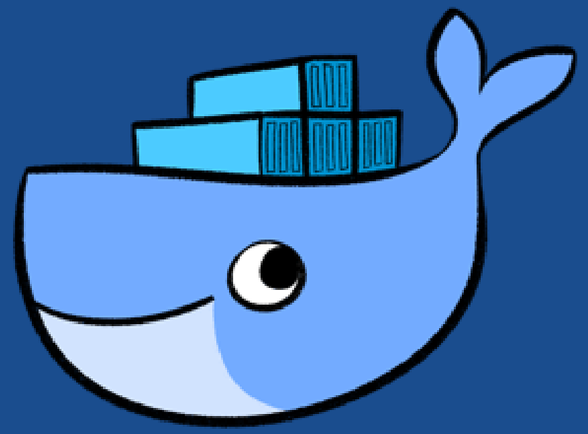
HSSIP 2021

QA: Static Code Analysis

CERN BE-ICS-FT, Philipp Burkhardt and Nik Lehmann



What the ICS group does

Run and maintain the control system for CERN experiments

- Some of the world's largest and most complex infrastructures
- ICS-CS provides power to them and many other "fundamental services"
- Lots of mission critical software, historical and heterogenous, some of it in C++
- Need to do Quality Assurance (QA) on a large scale on this C++ code base

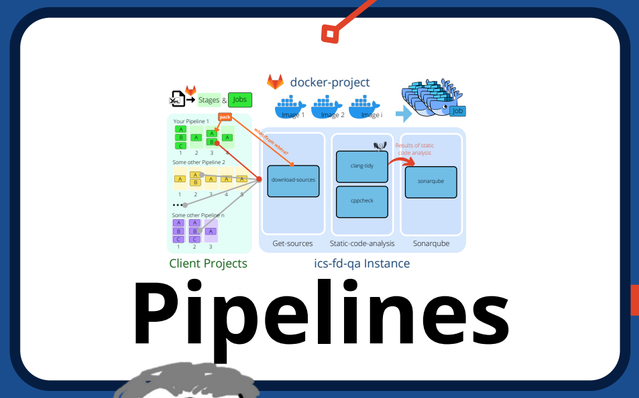
Over

1'000'000

Lines of code

Code powers CERN

Pipelines are the magic behind it



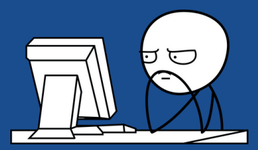
pipelines go brrr

What did we do?

QA pipelines: virtualisation & clang-tidy

Automate Quality Assurance in a pipeline, using advanced tools for static code analysis

- Understand & document what is going on
- Contribute to the QA pipeline

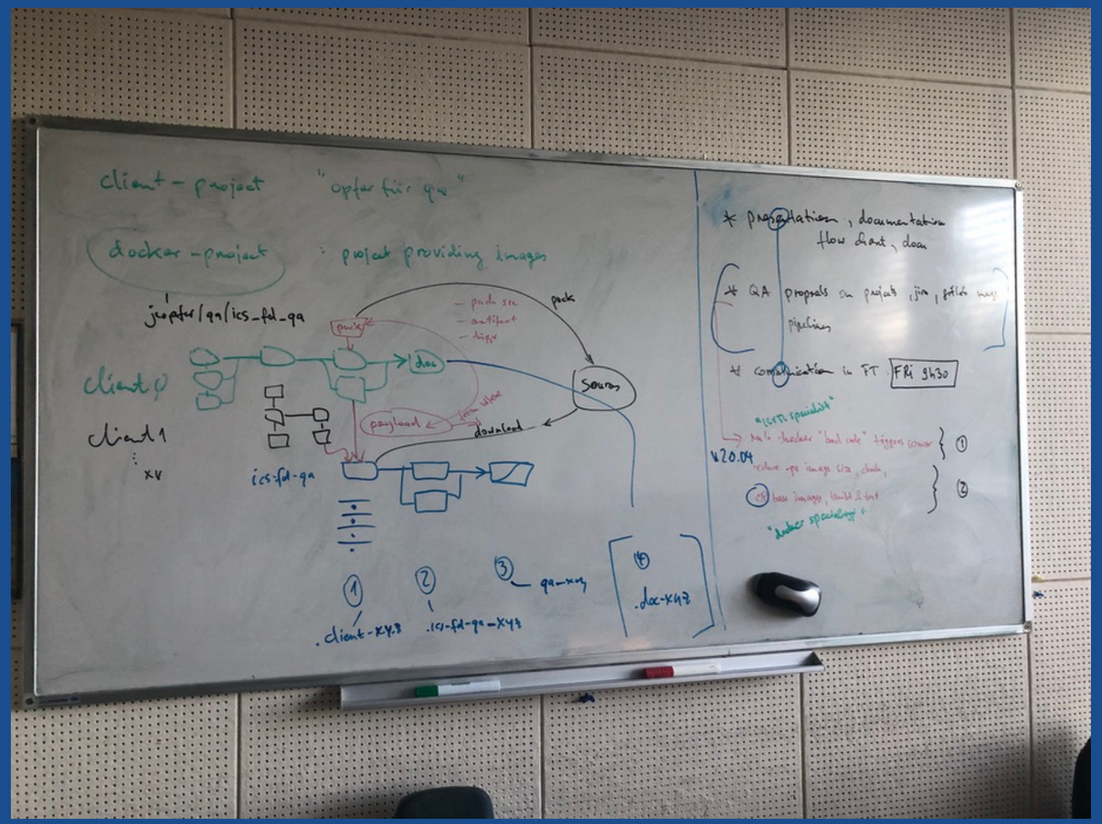


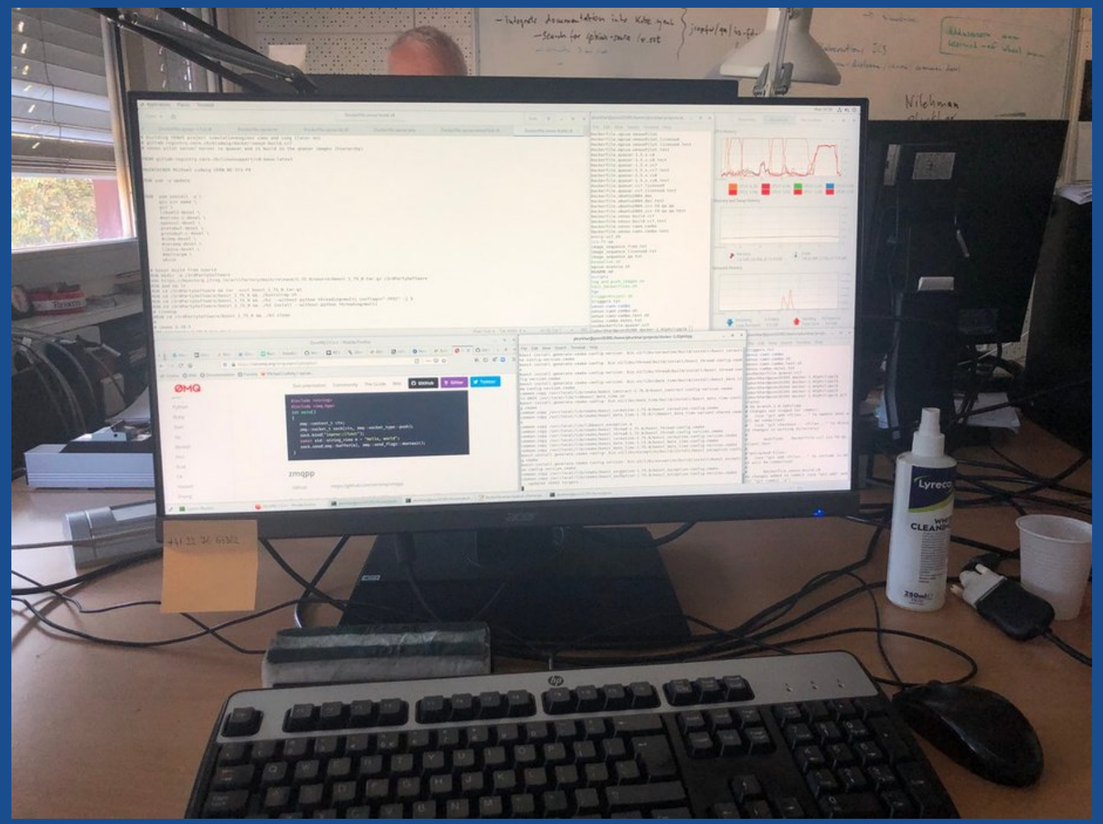
  - ***Nik:*** *Static code analysis project*
    - LLVM clang-tidy 8 ➜ 10

  - ***Philipp:*** *Virtualisation project*
    - *Docker images cc7 ➜ c8*

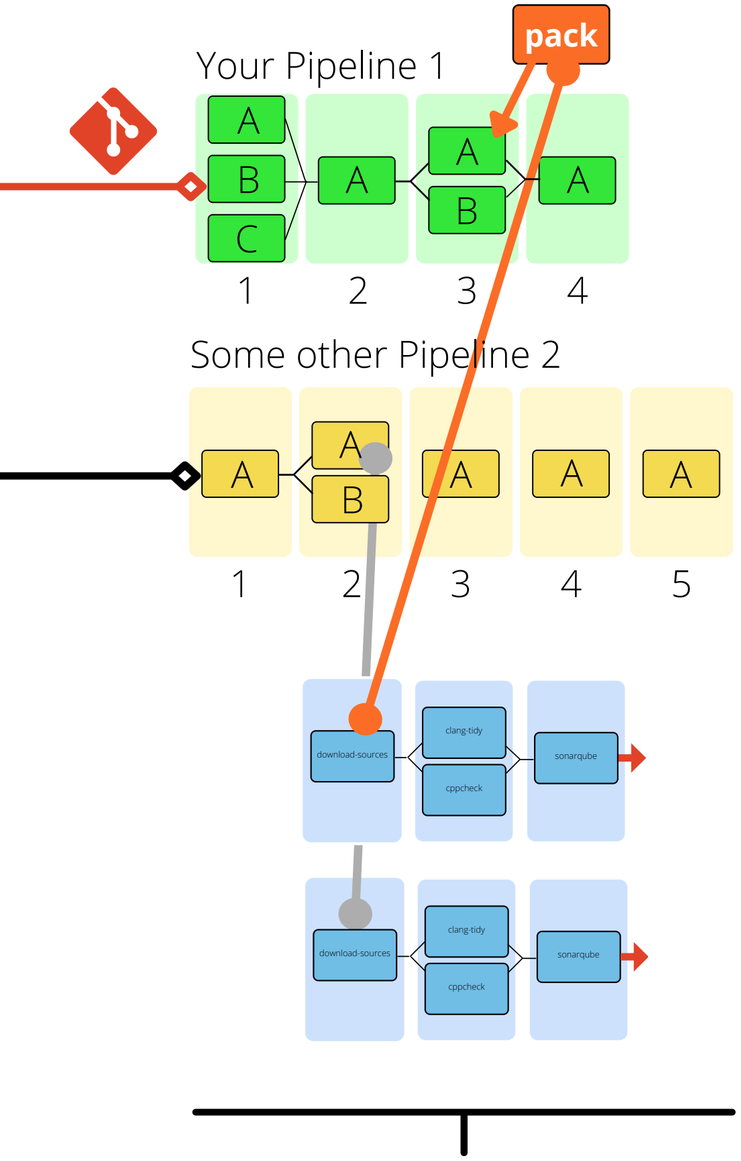
Work as a "Software Engineer"

From big picture to details and fueled by coffee



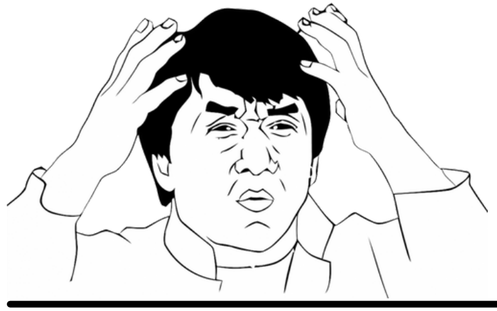


Pipelines



Abstraction

ics-fd-qa?



Various Client Projects

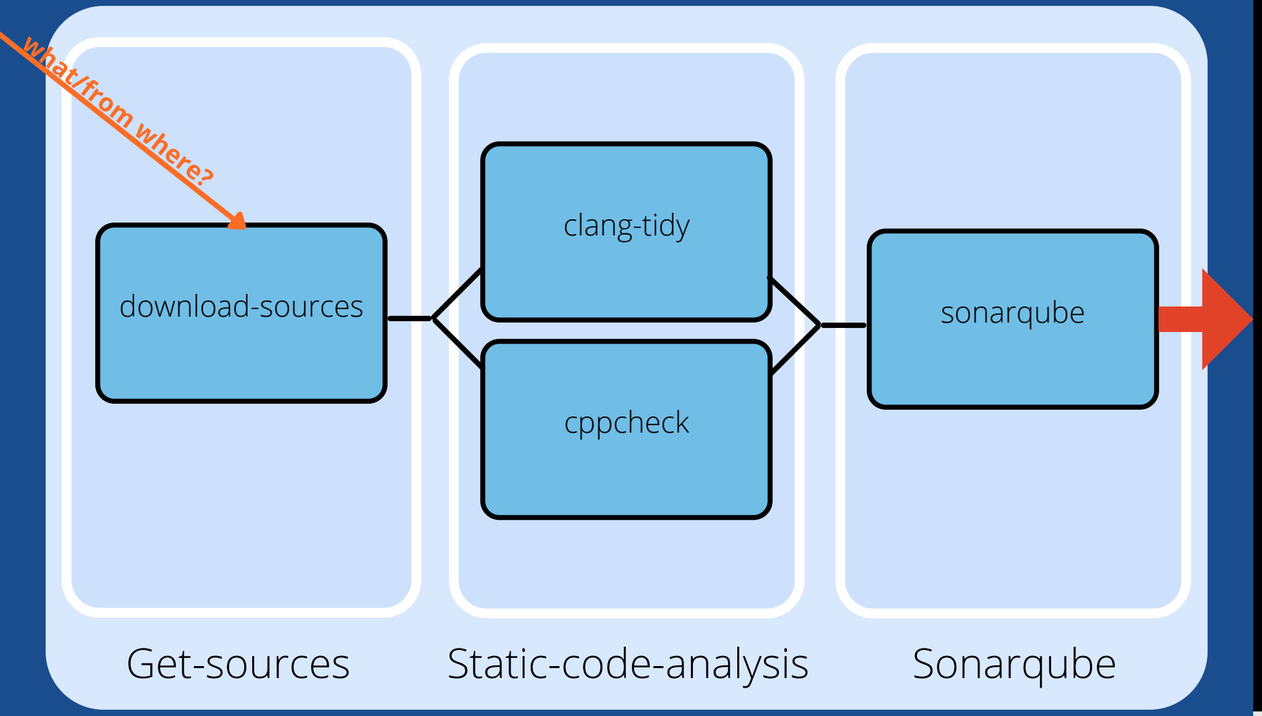
QA Pipeline Instances

Example

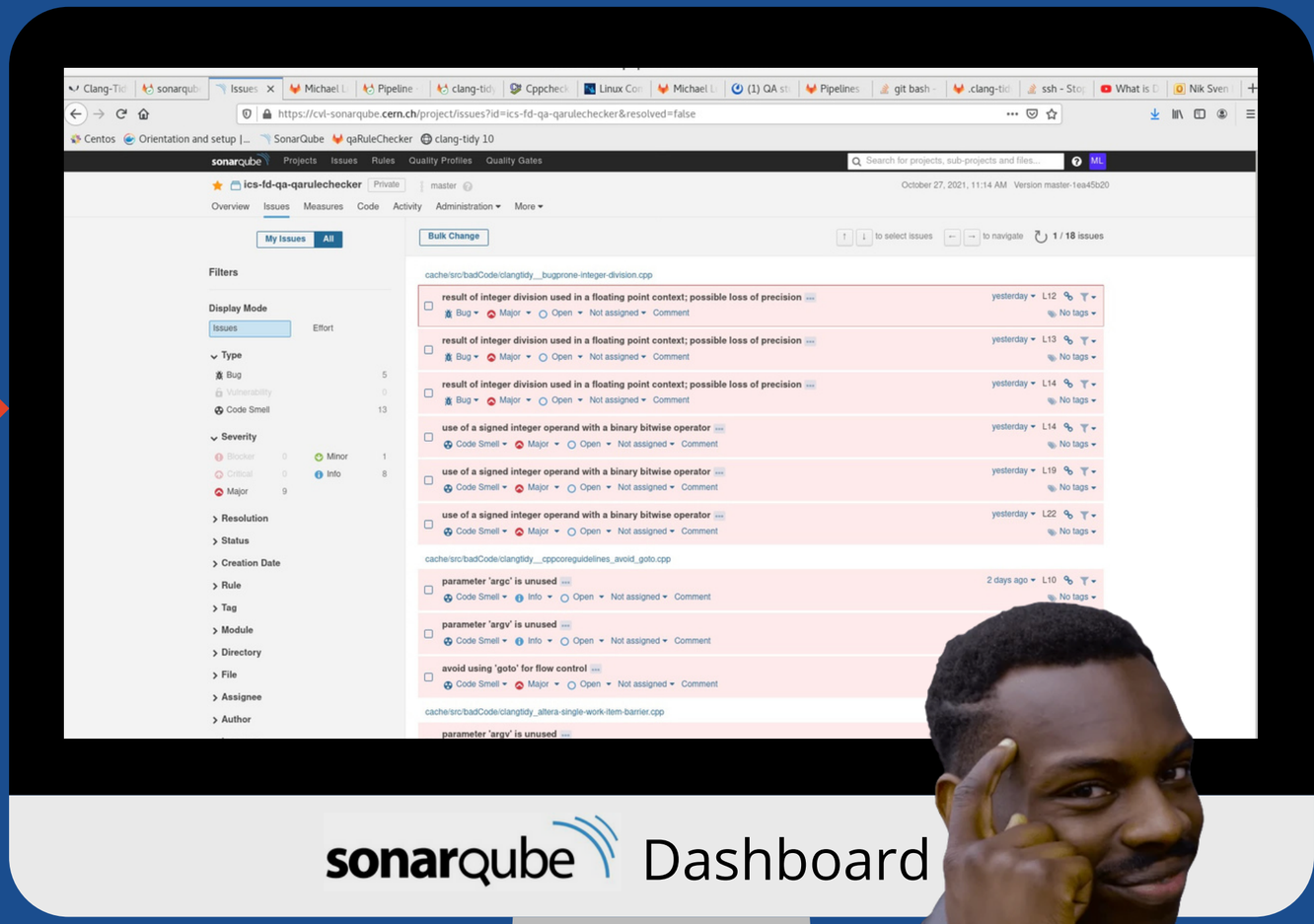
Explanation:

Stages & Jobs

Quality Assurance Pipeline



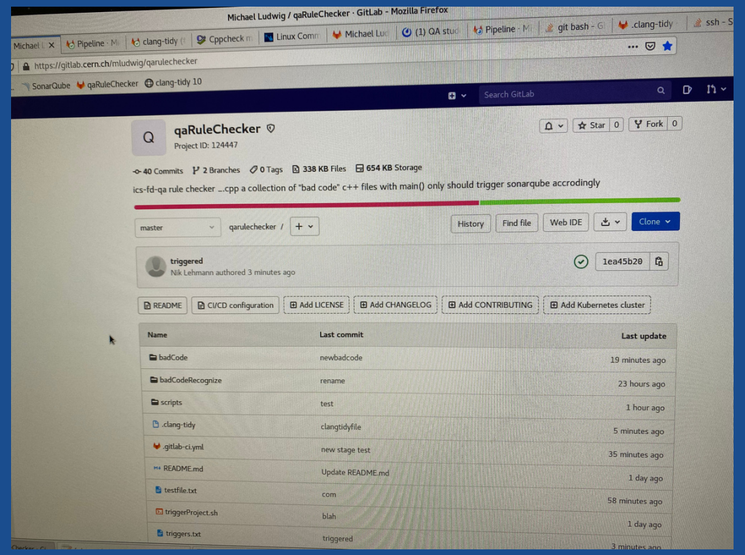
ics-fd-qa Pipeline Instance

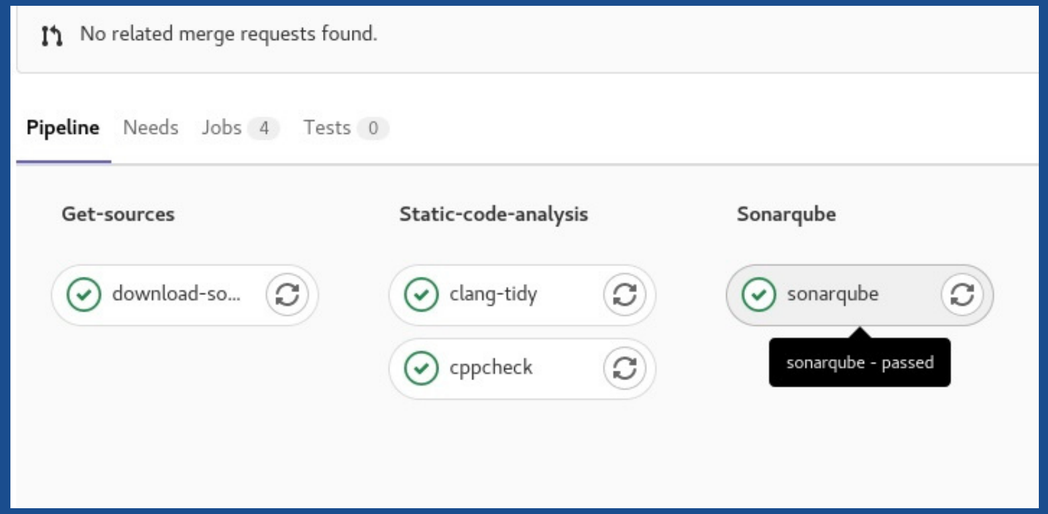


sonarqube Dashboard

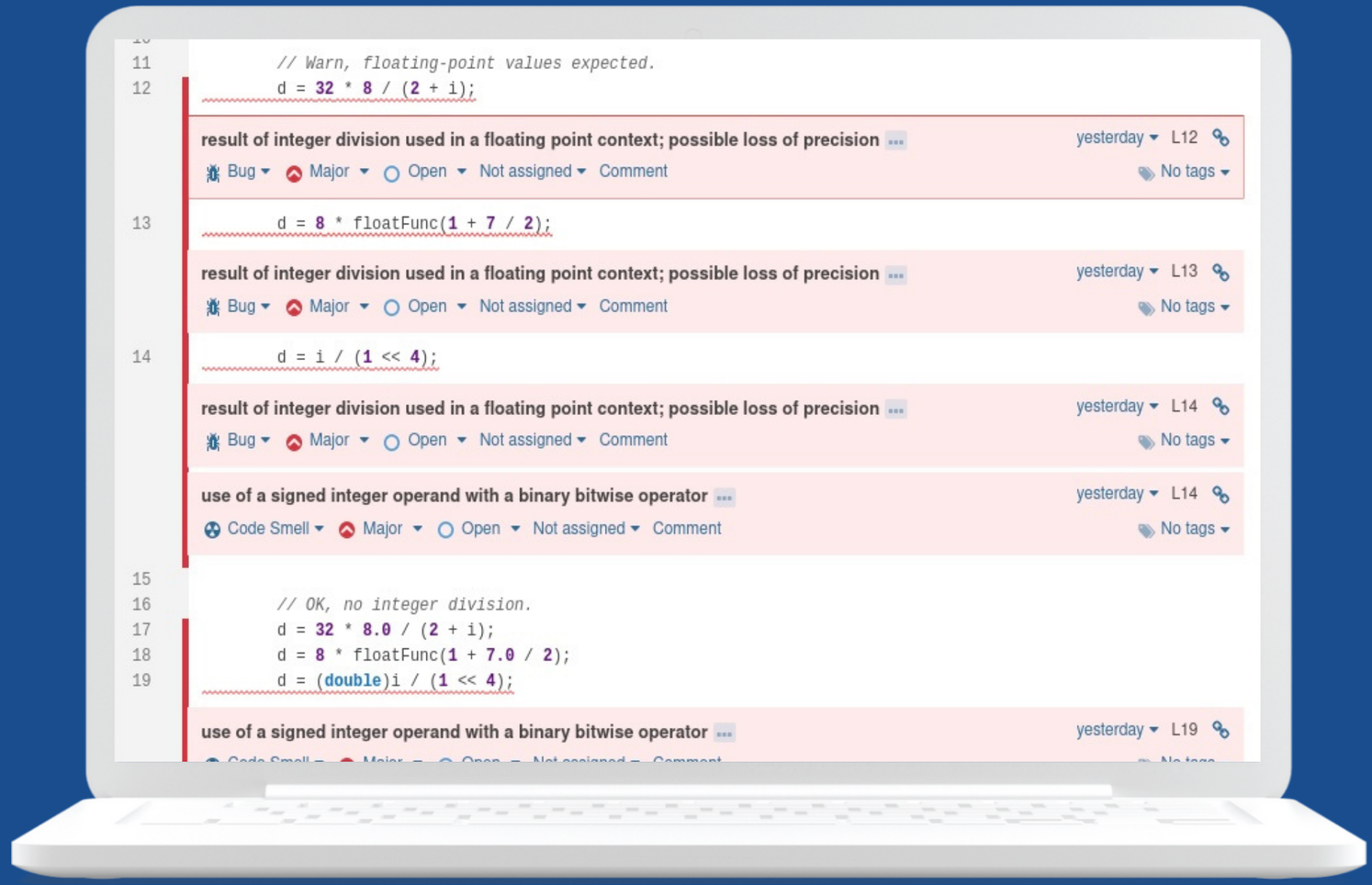
LLVM project – clang-tidy

The purpose of clang-tidy is to provide an extensible framework for diagnosing and fixing typical programming errors, like style violations, interface misuse, or bugs that can be deduced via static analysis.





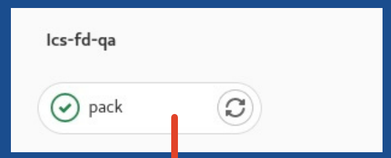
- Update clang-tidy image from llvm.v8 to llvm.v10
- Check rules
- Optimize and configure code checker, update configs
- Test llvm.v10 image inside container



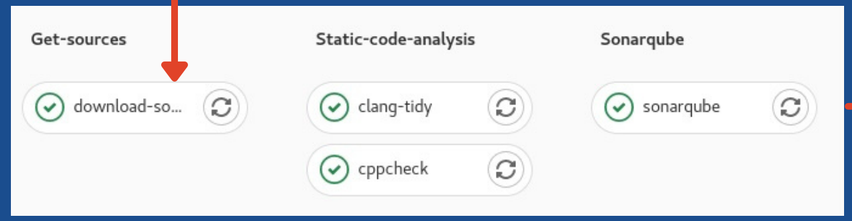
Example for automatically found and reported bugs from injected bad code

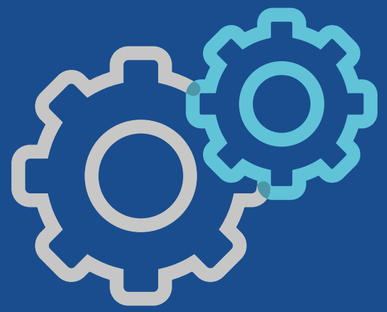
How clang-tidy is used

client pipeline: "qaRuleChecker"



"ics-fd-qa" pipeline





ics-fd-qa-qarulechecker
cache/src/badCode/clangtidy__cppcoreguidelines_avoid_goto.cpp

24 Lines | 3 Issues | 0.0% Coverage

```
1  /**
2   https://releases.llvm.org/12.0.0/tools/clang/tools/extra/docs/clang-tidy/checks/cppcoreguidelines-avoid-goto.html
3
4   The usage of goto for control flow is error prone and should be replaced with looping constructs. Only forward jumps in nested
5   This check implements ES.76 from the CppCoreGuidelines and 6.3.1 from High Integrity C++.
6   For more information on why to avoid programming with goto you can read the famous paper A Case against the GO TO Statement..
7   The check diagnoses goto for backward jumps in every language mode. These should be replaced with C/C++ looping constructs.
8  */
9  using std;
10 int main( int argc, char** argv ){
```

parameter 'argc' is unused — 3 days ago · L10
Code Smell · Info · Open · Not assigned · Comment · No tags

parameter 'argv' is unused — 3 days ago · L10
Code Smell · Info · Open · Not assigned · Comment · No tags

```
11
12        // Bad, handwritten for loop.
13        int i = 0;
14        // Jump label for the loop
15        loop_start:
16                std::cout << "do dummy" << std::endl;
17
18        if (i < 100) {
19          ++i;
20          goto loop_start; // jump backwards
```

avoid using 'goto' for flow control — 3 days ago · L20
Code Smell · Major · Open · Not assigned · Comment · No tags

```
21        }
22        return 0;
23 }
24
```

ics-fd-qa-qarulechecker
cache/src/badCode/clangtidy__cppcoreguidelines_avoid_goto.cpp

19 Lines | 0 Issues | 0.0% Coverage

```cpp
/**
 https://releases.llvm.org/12.0.0/tools/clang/tools/extra/docs/clang-tidy/checks/cppcoreguidelines-avoid-goto.html

 The usage of goto for control flow is error prone and should be replaced with looping constructs. Only forward jumps in nested loops are accepted.
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 The check diagnoses goto for backward jumps in every language mode. These should be replaced with C/C++ looping constructs.
*/
using std;
int main(){
        int i = 0;

        if (i < 100) {
          ++i;
          std::cout << "do dummy" << std::endl; //execute here
        }
        return 0;
}
```

ics-fd-qa-qarulechecker
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int main( int argc, char** argv ){
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parameter 'argc' is unused — 3 days ago · L10
Code Smell · Info · Open · Not assigned · Comment · No tags

parameter 'argv' is unused — 3 days ago · L10
Code Smell · Info · Open · Not assigned · Comment · No tags

```cpp

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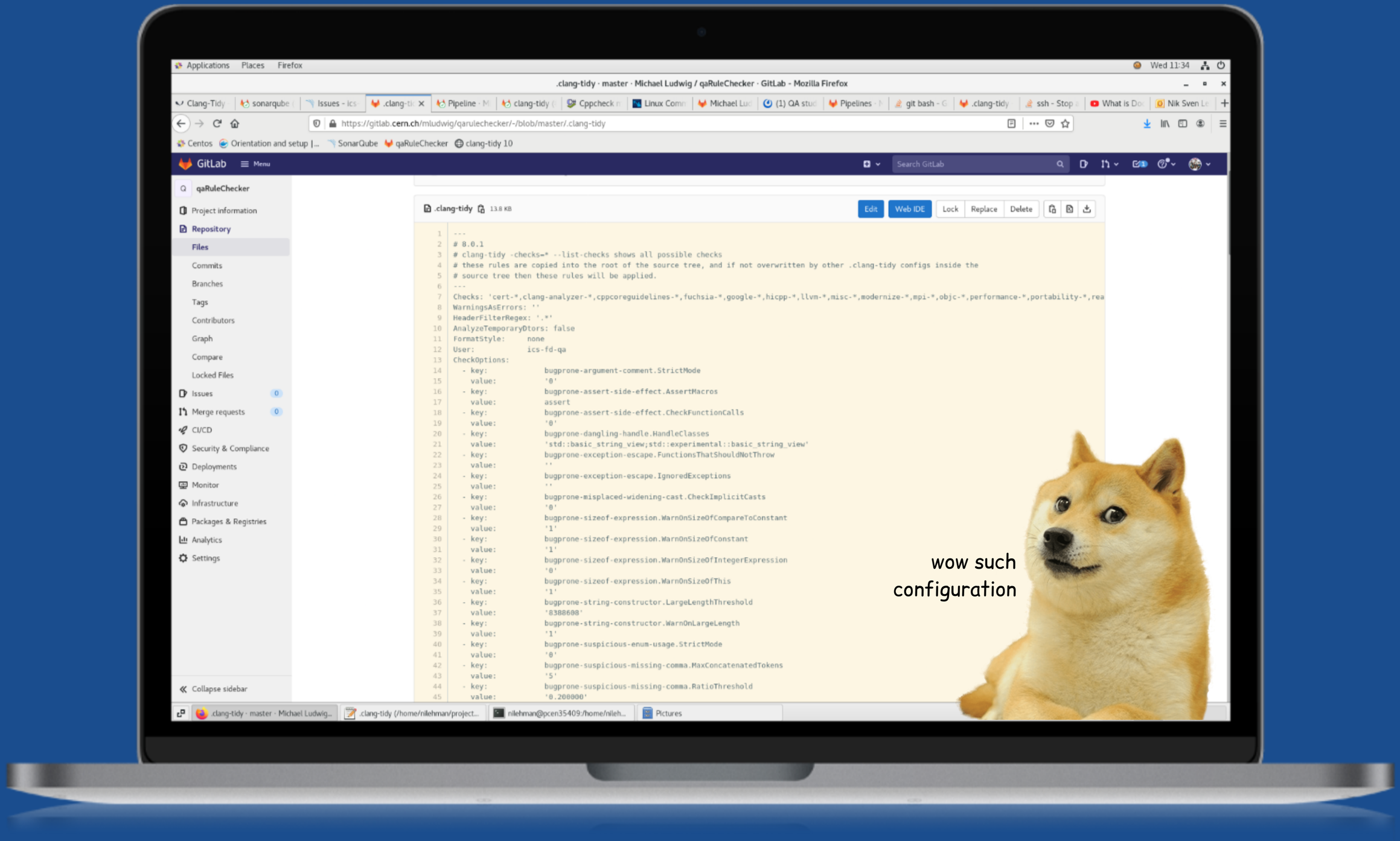
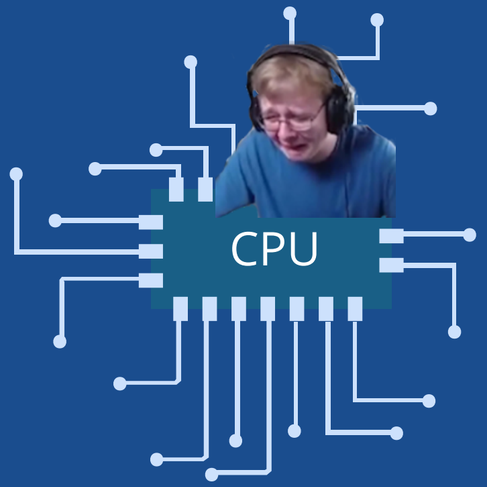
```cpp
        }
        return 0;
}
```


Applications Places Firefox
Wed 11:34
.clang-tidy · master · Michael Ludwig / qaRuleChecker · GitLab - Mozilla Firefox
https://gitlab.cern.ch/mludwig/qarulechecker/-/blob/master/.clang-tidy
GitLab
Menu
Search GitLab
qaRuleChecker
Project information
Repository
Files
Commits
Branches
Tags
Contributors
Graph
Compare
Locked Files
Issues
Merge requests
CI/CD
Security & Compliance
Deployments
Monitor
Infrastructure
Packages & Registries
Analytics
Settings
Collapse sidebar
.clang-tidy 13.8 KB
Edit
Web IDE
Lock
Replace
Delete

8.0.1
clang-tidy -checks=* --list-checks shows all possible checks
these rules are copied into the root of the source tree, and if not overwritten by other .clang-tidy configs inside the
source tree then these rules will be applied.

Checks: 'cert-*,clang-analyzer-*,cppcoreguidelines-*,fuchsia-*,google-*,hicpp-*,llvm-*,misc-*,modernize-*,mpi-*,objc-*,performance-*,portability-*,rea
WarningsAsErrors: ''
HeaderFilterRegex: '.*'
AnalyzeTemporaryDtors: false
FormatStyle: none
User: ics-fd-qa
CheckOptions:
- key: bugprone-argument-comment.StrictMode
value: '0'
- key: bugprone-assert-side-effect.AssertMacros
value: assert
- key: bugprone-assert-side-effect.CheckFunctionCalls
value: '0'
- key: bugprone-dangling-handle.HandleClasses
value: 'std::basic_string_view;std::experimental::basic_string_view'
- key: bugprone-exception-escape.FunctionsThatShouldNotThrow
value: ''
- key: bugprone-exception-escape.IgnoredExceptions
value: ''
- key: bugprone-misplaced-widening-cast.CheckImplicitCasts
value: '0'
- key: bugprone-sizeof-expression.WarnOnSizeOfCompareToConstant
value: '1'
- key: bugprone-sizeof-expression.WarnOnSizeOfConstant
value: '1'
- key: bugprone-sizeof-expression.WarnOnSizeOfIntegerExpression
value: '0'
- key: bugprone-sizeof-expression.WarnOnSizeOfThis
value: '1'
- key: bugprone-string-constructor.LargeLengthThreshold
value: '8388608'
- key: bugprone-string-constructor.WarnOnLargeLength
value: '1'
- key: bugprone-suspicious-enum-usage.StrictMode
value: '0'
- key: bugprone-suspicious-missing-comma.MaxConcatenatedTokens
value: '5'
- key: bugprone-suspicious-missing-comma.RatioThreshold
value: '0.200000'
wow such
configuration
.clang-tidy · master · Michael Ludwig...
.clang-tidy (/home/nilehman/project...
nilehman@pcen35409:/home/nileh...
Pictures

Current situation

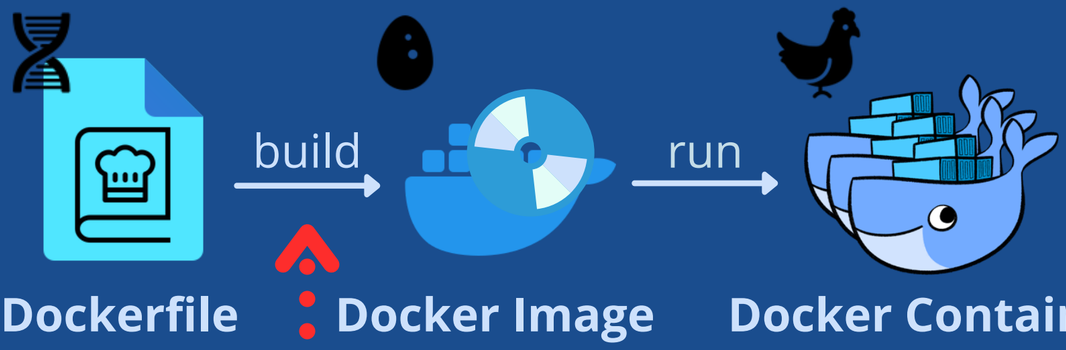


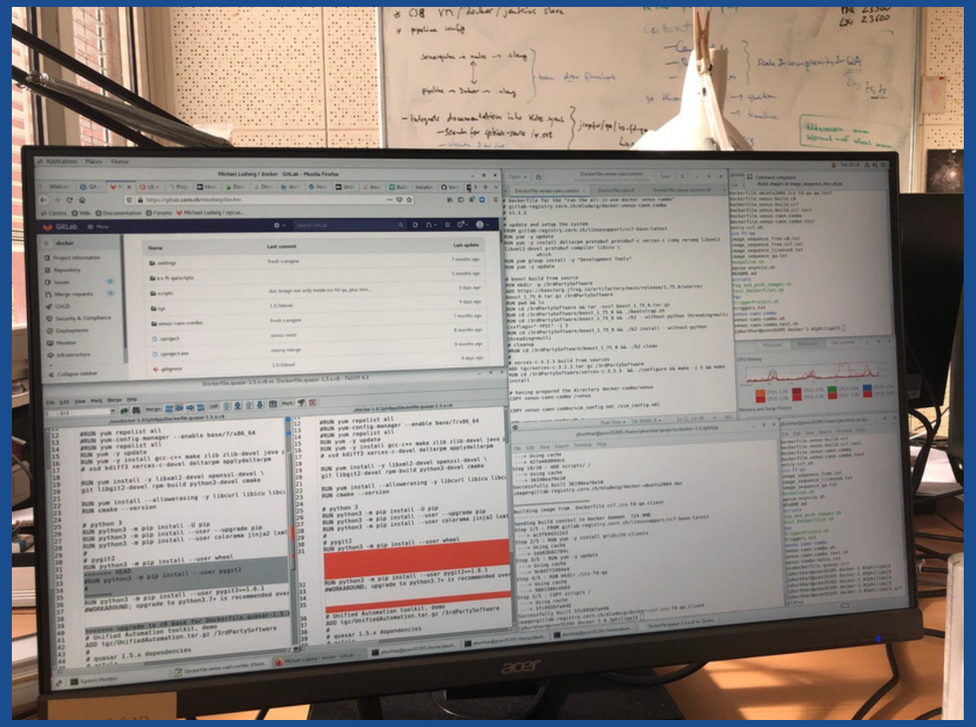
Not enough CPU power → Lack of time

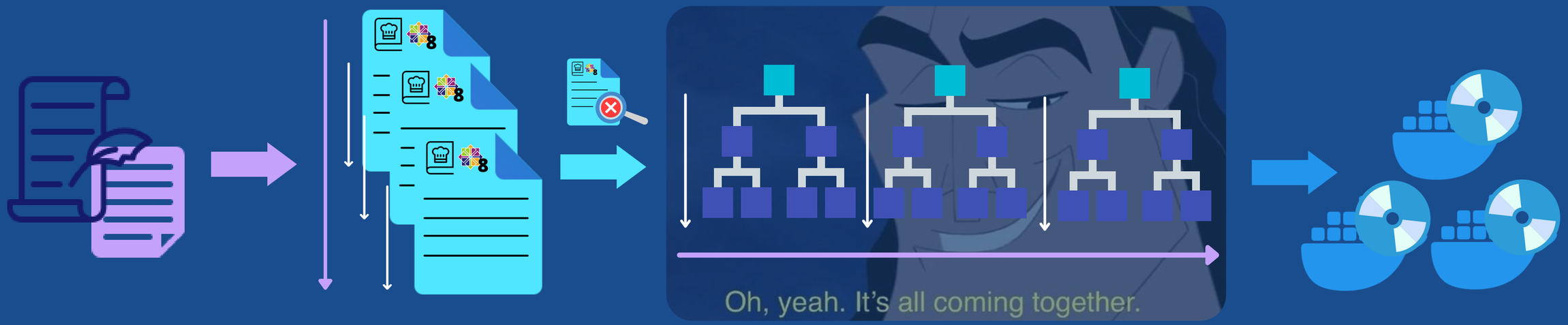
Next steps: Overview of differences between llvm.v8 to llvm.v10 & reasons for upgrade.

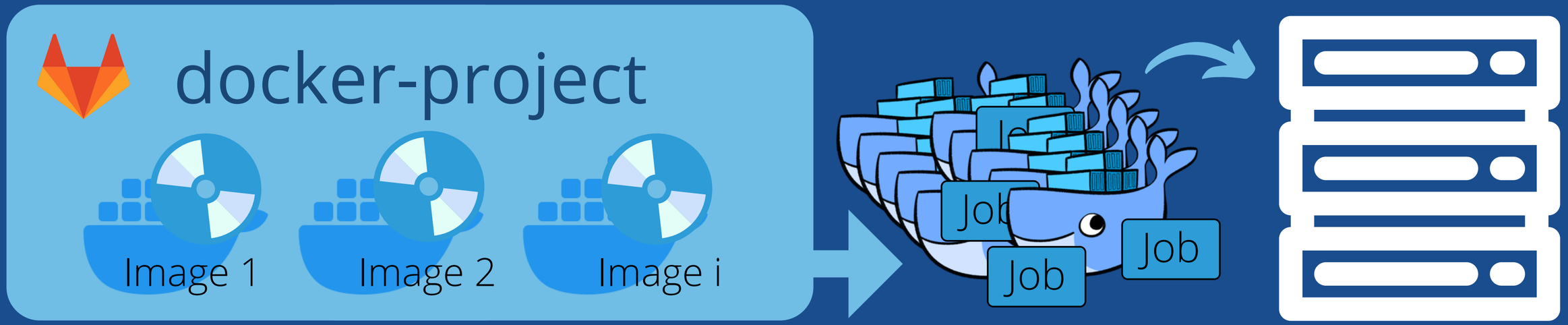
Virtualisation project using Docker

Migrating from CentOS 7 to CentOS 8






Oh, yeah. It's all coming together.

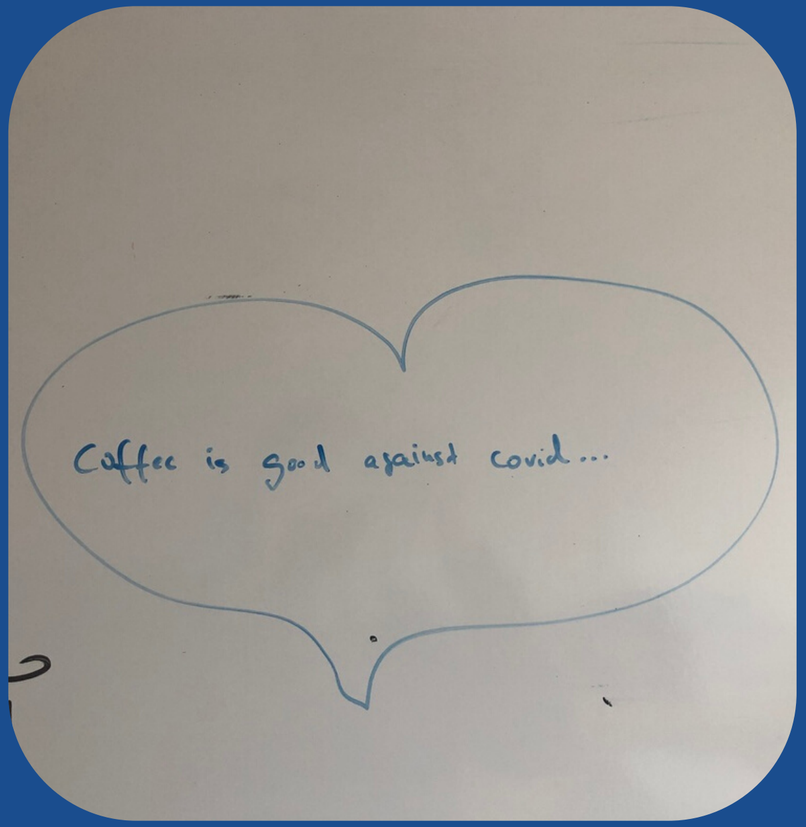

docker-project
Image 1
Image 2
Image i
Job
Job
Job

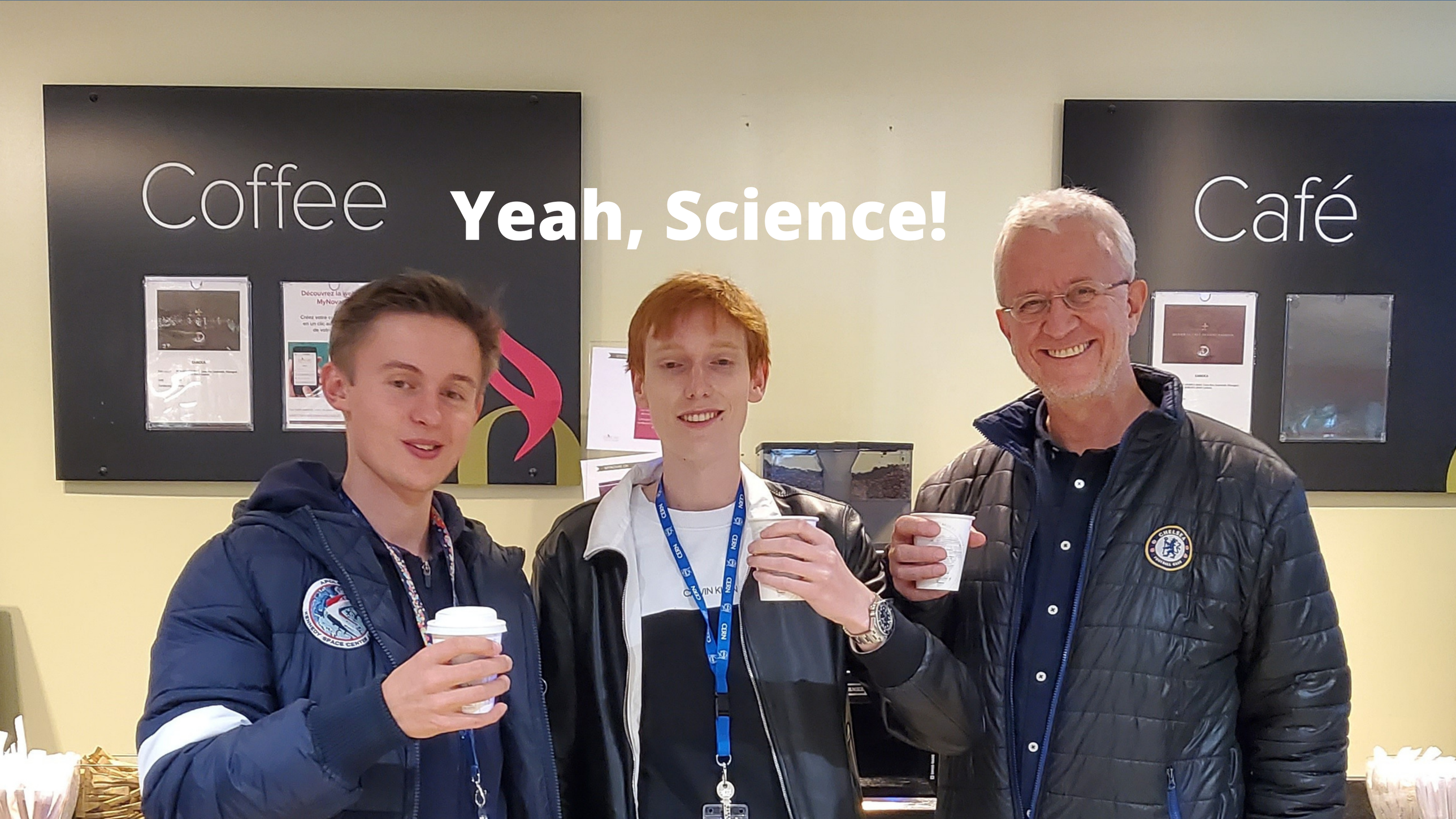
Results

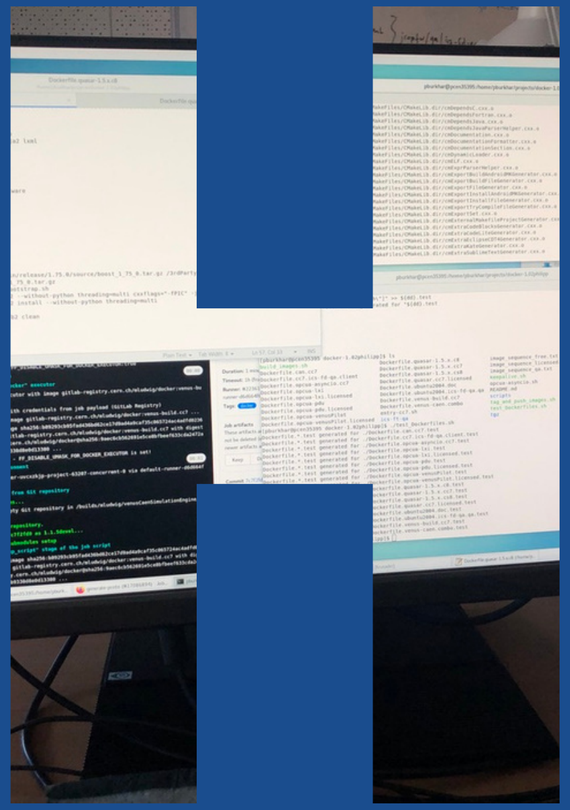
Lessons learned

What we take with us from HSSIP

- Coffee is love, coffee is life
- Software projects are complex, require focus and lots of brain power
- Virtualisation as part of CI/CD is very powerful gitlab, docker, containers
- Linux, Git CLI, Gitlab, Docker and more crazy tools
- Automation becomes absolutely necessary above a certain scale of things
- Communication and keeping the overview is vital

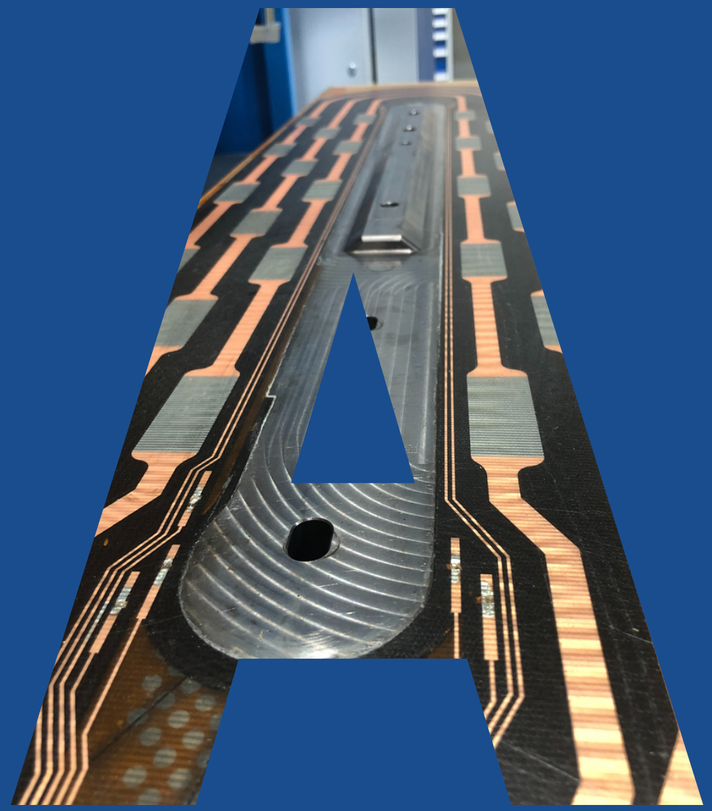


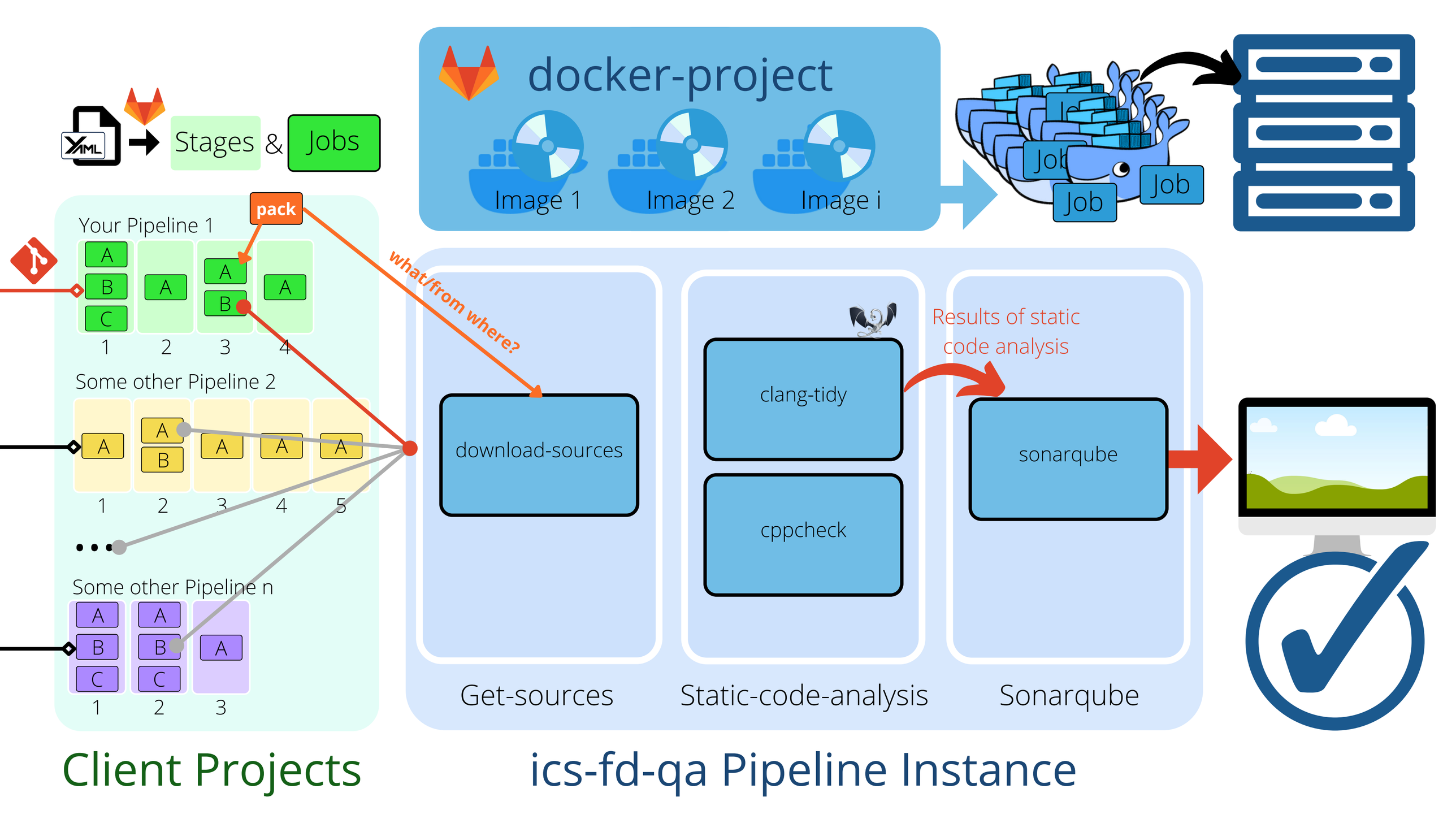

Coffee
Café
Yeah, Science!


for your attention

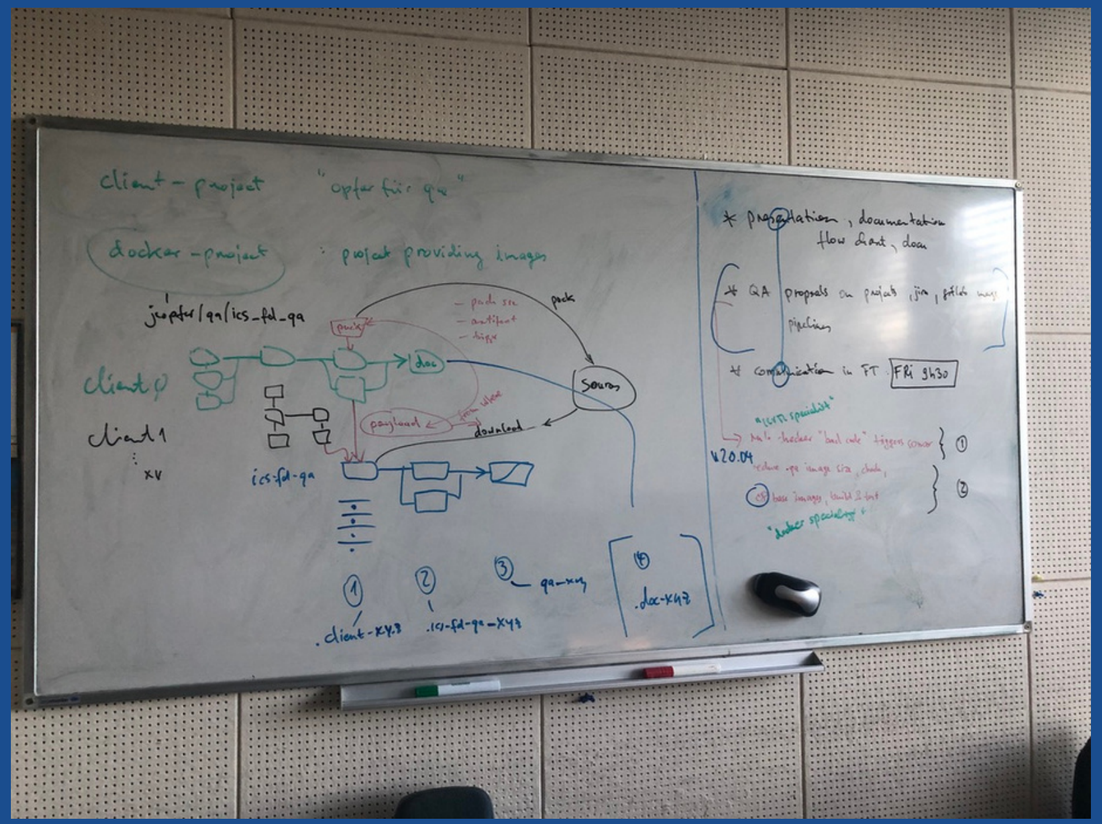

ANTIMATTER
FACTORY
ELENA

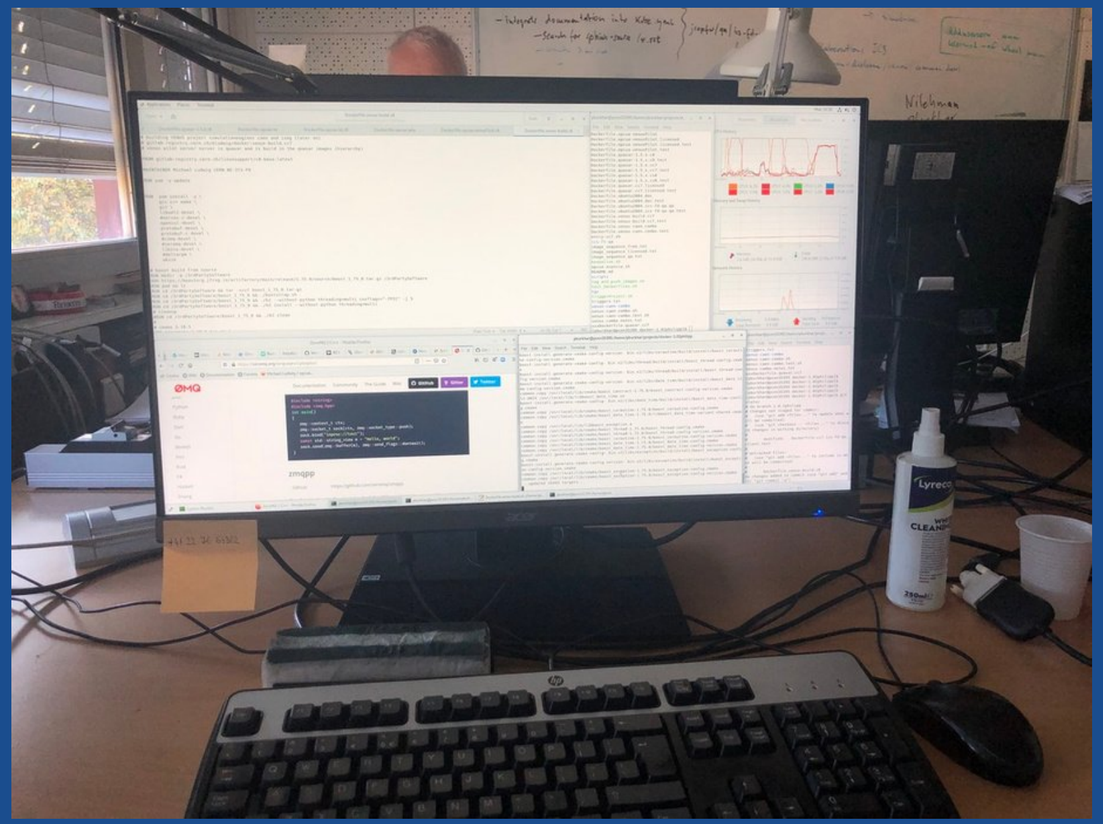



Stages & Jobs
docker-project
Image 1
Image 2
Image i
Job
Job
Job
Your Pipeline 1
pack
A
B
C
A
A
A
B
A
1
2
3
4
Some other Pipeline 2
A
A
B
A
A
A
1
2
3
4
5
Some other Pipeline n
A
B
C
A
B
C
A
1
2
3
what/from where?
download-sources
clang-tidy
cppcheck
Results of static code analysis
sonarqube
Get-sources
Static-code-analysis
Sonarqube
Client Projects
ics-fd-qa Pipeline Instance

Work as a "Software Engineer"

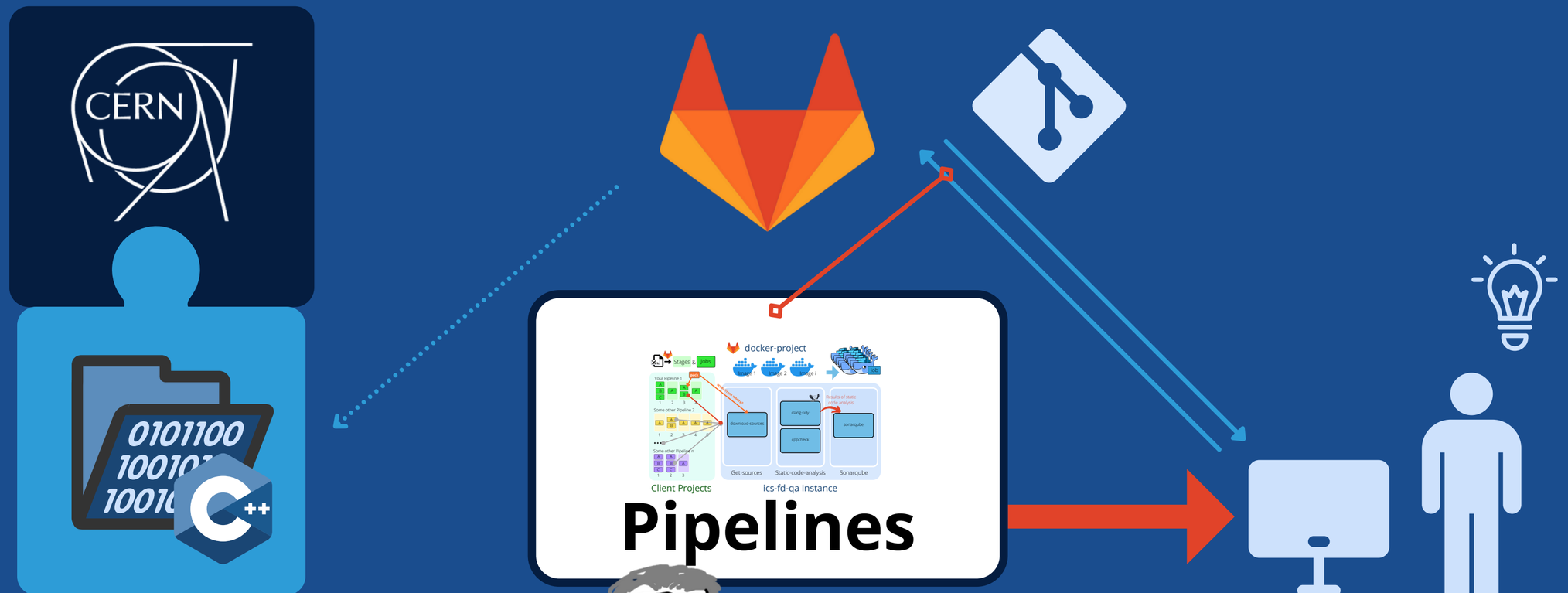
From big picture to details and fueled by coffee





Code powers CERN

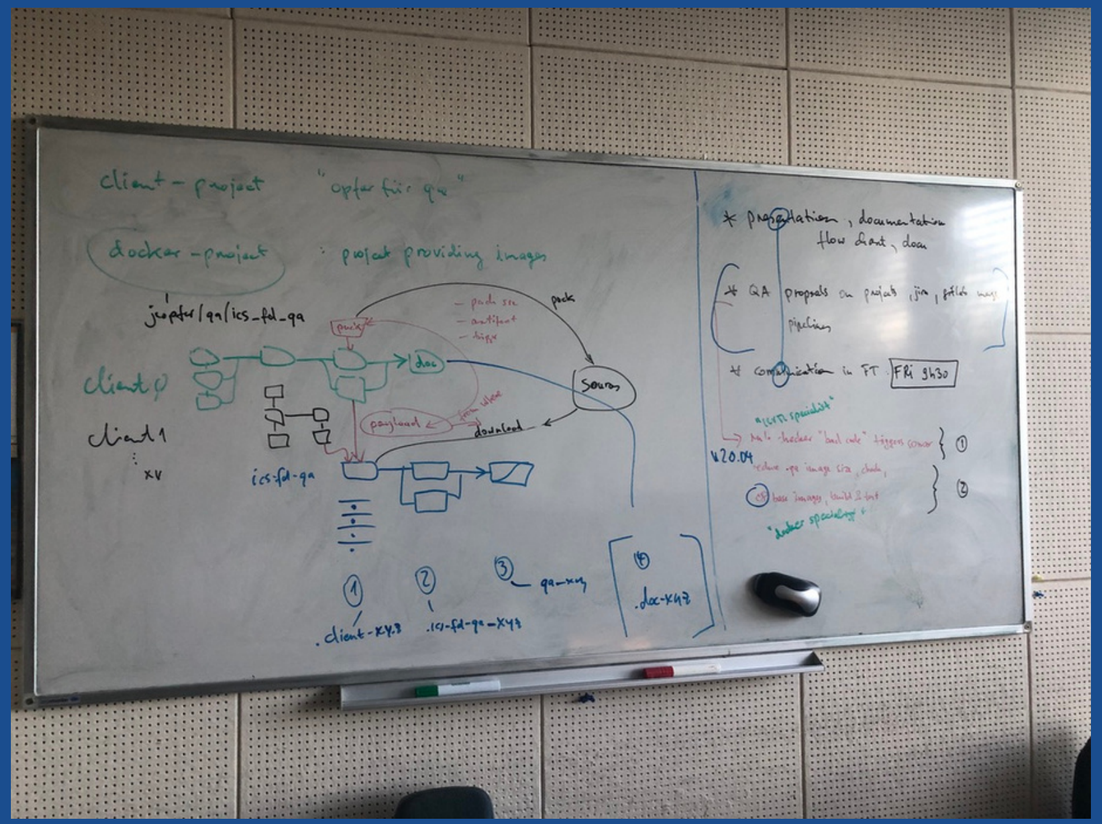
Pipelines are the magic behind it

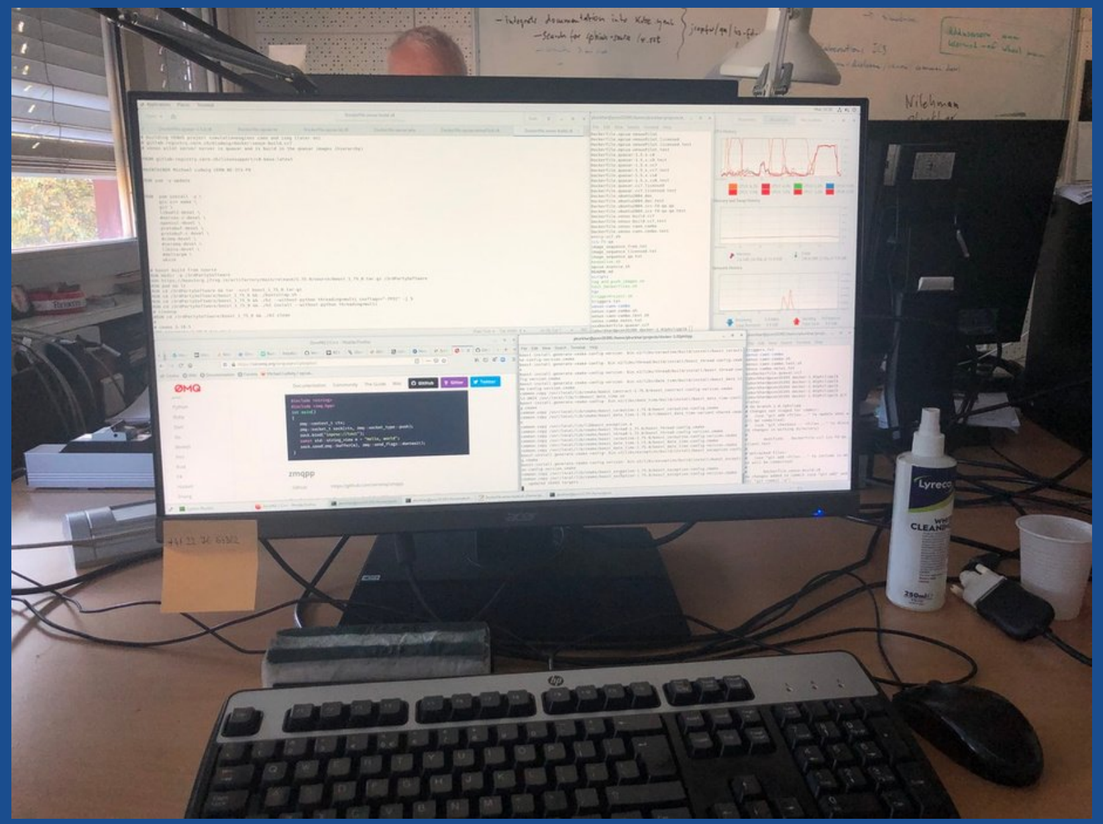


pipelines go brrr

Big picture to details

Working as a "Software Engineer"





cplusplus0.cpp [Read-Only]

```cpp
// clang.llvm.org/docs/analyzer/checkers.html#cplusplus-newdeleteleaks-c


// 1.1.2.1. cplusplus.InnerPointer (C++)
void deref_after_assignment() {
  std::string s = "llvm";
  const char *c = s.data(); // note: pointer to inner buffer of 'std::string' obtained here
  s = "clang"; // note: inner buffer of 'std::string' reallocated by call to 'operator='
  consume(c); // warn: inner pointer of container used after re/deallocation
}

const char *return_temp(int x) {
  return std::to_string(x).c_str(); // warn: inner pointer of container used after re/deallocation
  // note: pointer to inner buffer of 'std::string' obtained here
  // note: inner buffer of 'std::string' deallocated by call to destructor
}


// 1.1.2.3. cplusplus.NewDeleteLeaks (C++)
void test() {
  int *p = new int;
} // warn


// 1.1.2.4. cplusplus.PlacementNewChecker (C++)
#include <new>

void f() {
  short s;
  long *lp = ::new (&s) long; // warn
}


// 1.1.2.2. cplusplus.NewDelete (C++)
void f(int *p);

void testUseMiddleArgAfterDelete(int *p) {
  delete p;
  f(p); // warn: use after free
}

class SomeClass {
public:
  void f();
};

void test() {
  SomeClass *c = new SomeClass;
  delete c;
  c->f(); // warn: use after free
}

void test() {
  int *p = (int *)__builtin_alloca(sizeof(int));
```