9th Central and Eastern
European Software
Engineering Conference
in Russia - CEE-SECR 2013
October 23 - 25, Moscow

2013 CEE-SEC(R)
Software Engineering
Conference in Russia

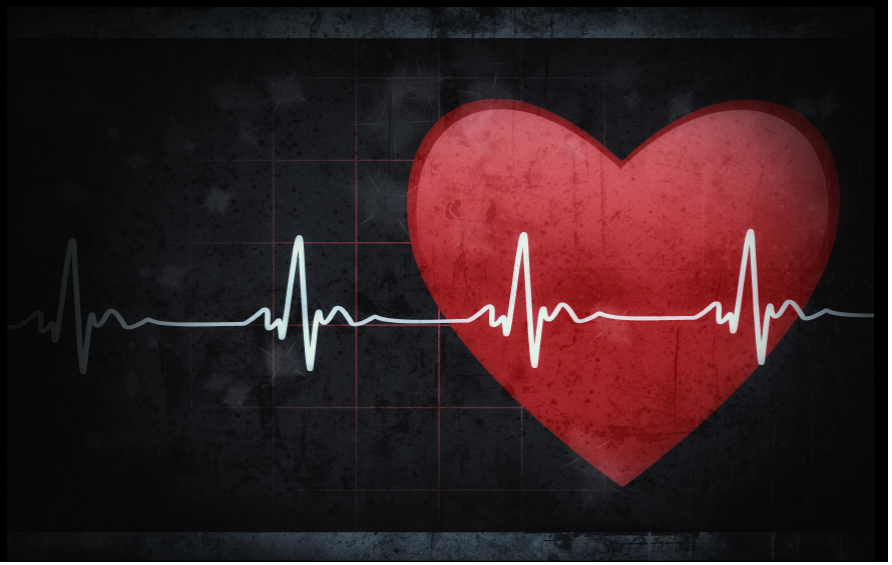
LLVM and Clang
Advancing Compilers and Tools

Chris Lattner
http://llvm.org

October 25, 2013

LLVM is everywhere

- Industry
- Open Source
- Academia



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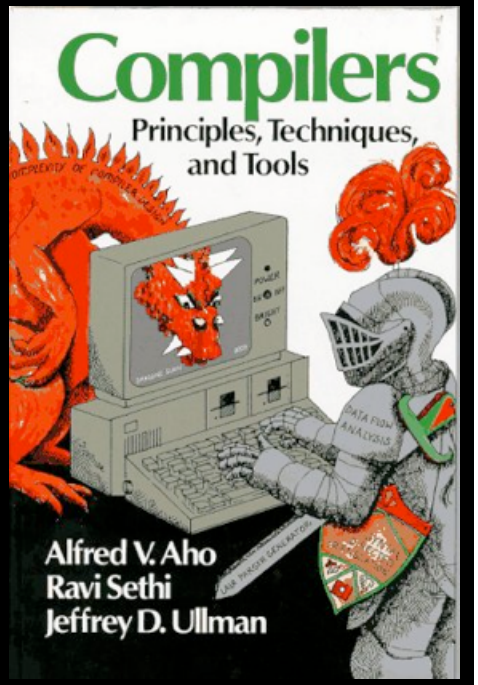
- Games, Playstation 4

So… , what is it?

What is a compiler?



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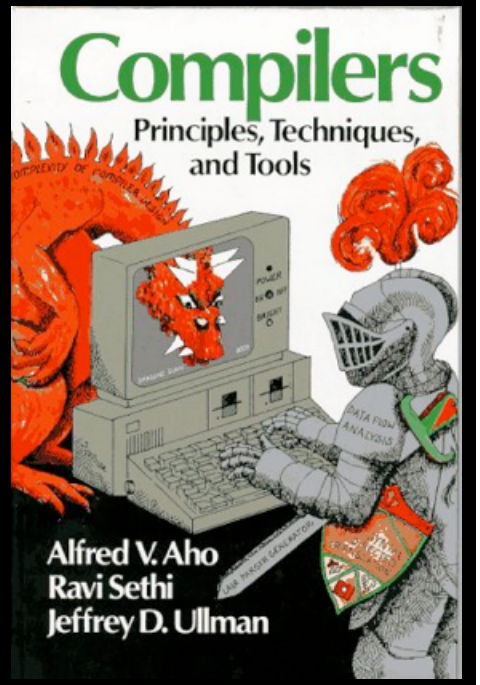

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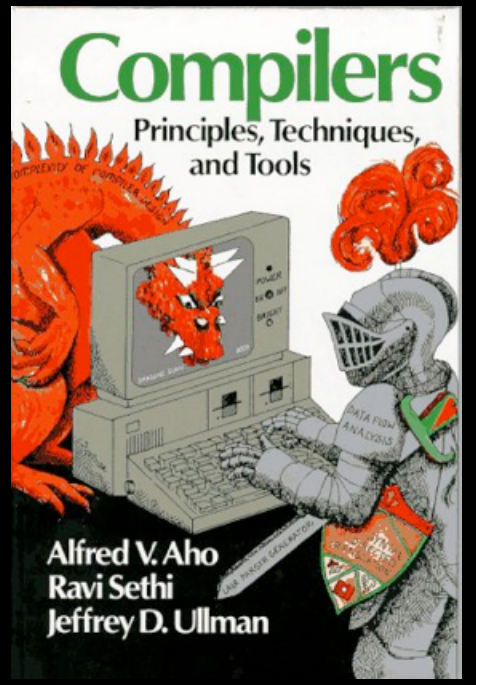

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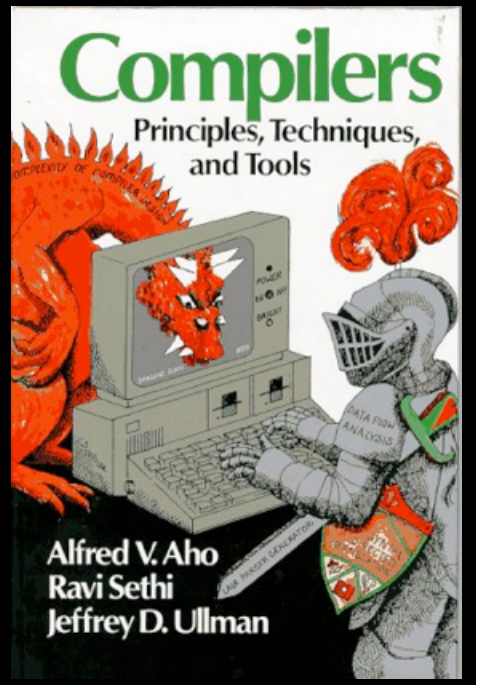

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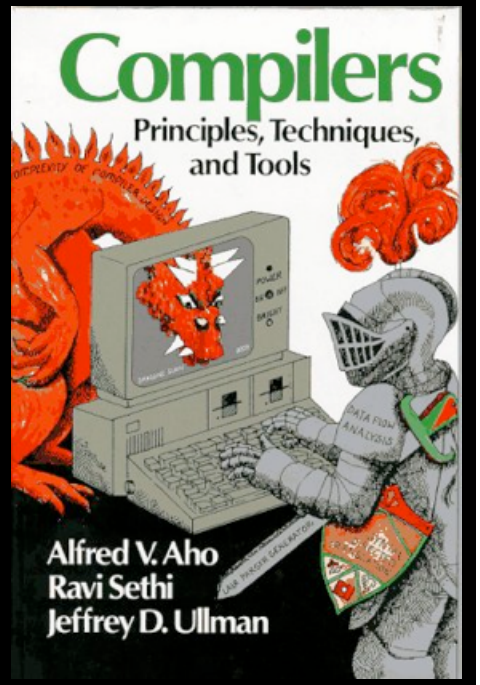

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- LLVM is a compiler **infrastructure**!


Compiler Infrastructure 101

How does a compiler work?

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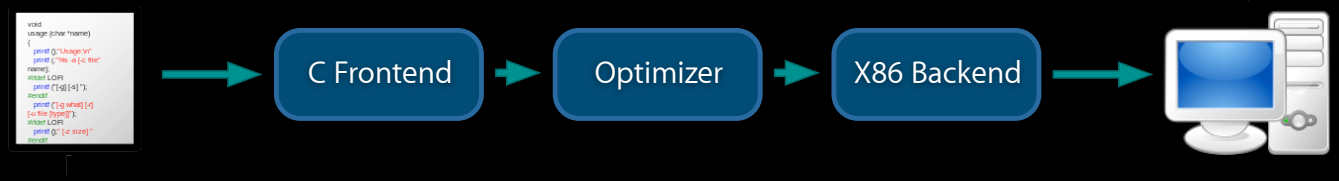
- Frontend: Parse and validate source code
- Optimizer: Improve intermediate form
- Backend: Generate target specific code



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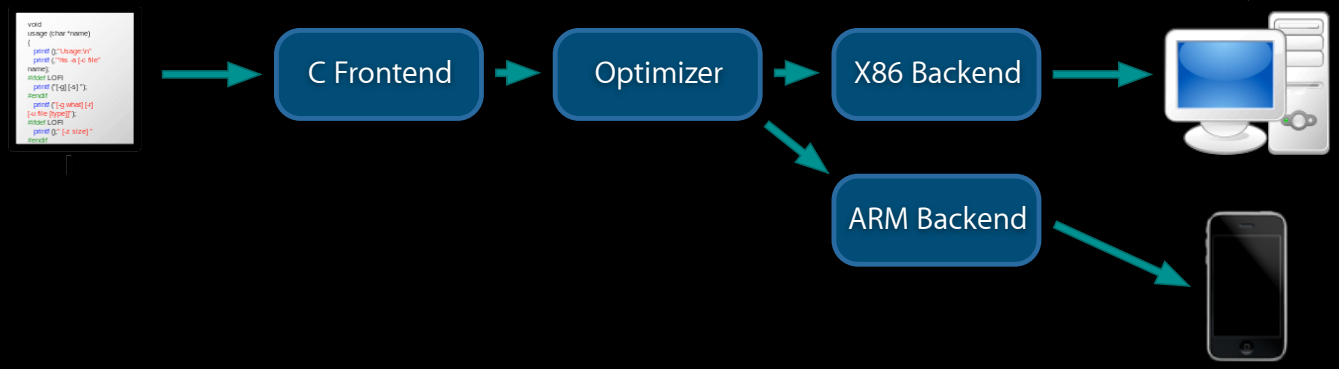

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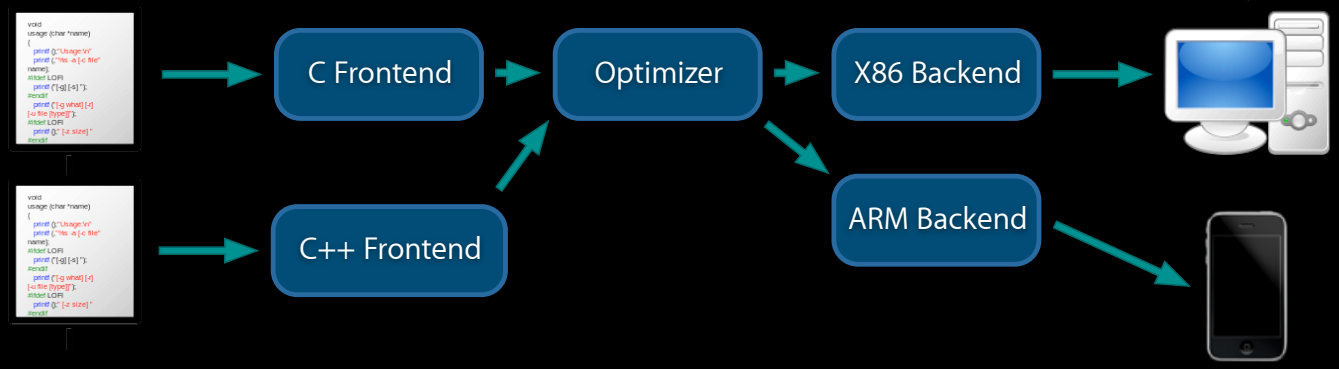

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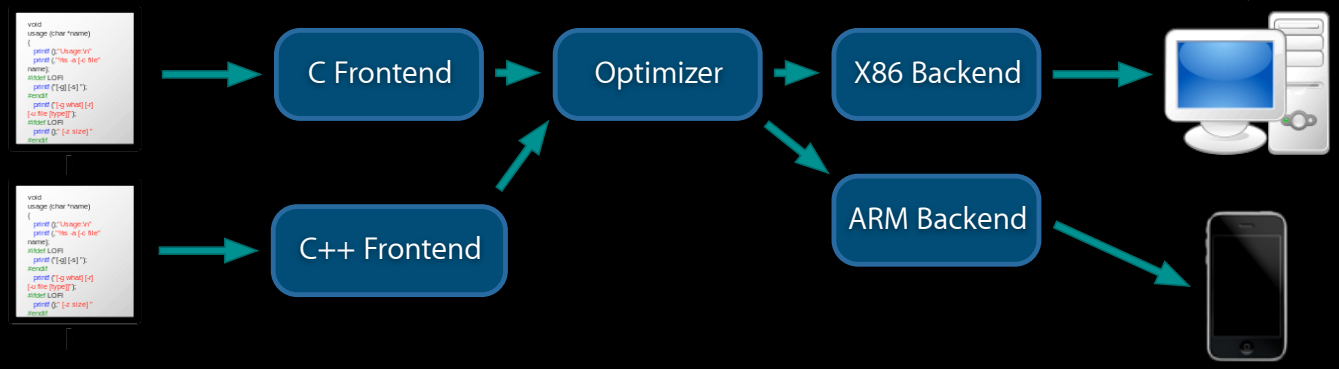

Standard approach for at least 35 years!

In 2013, this is not good enough!

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- Great compilers are a huge investment:
  - Source code analysis framework
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  - Performance optimization

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- Great compilers are a huge investment:
  - Source code analysis framework
  - Machine specific code generation
  - Performance optimization
- Other tools want these capabilities too!
  - Compiler “plugins” are not enough

Decomposing a processor target in LLVM

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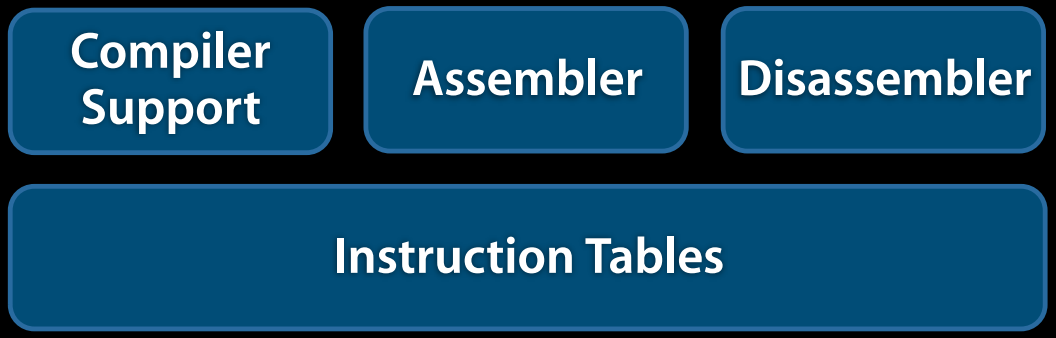

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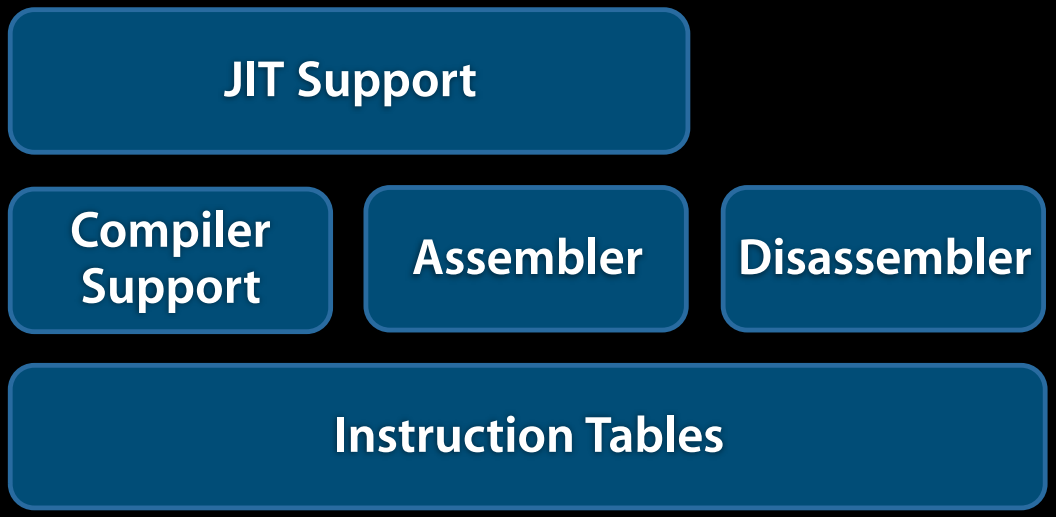

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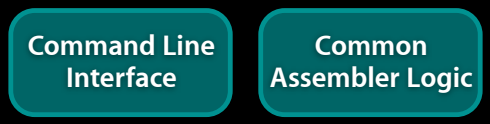

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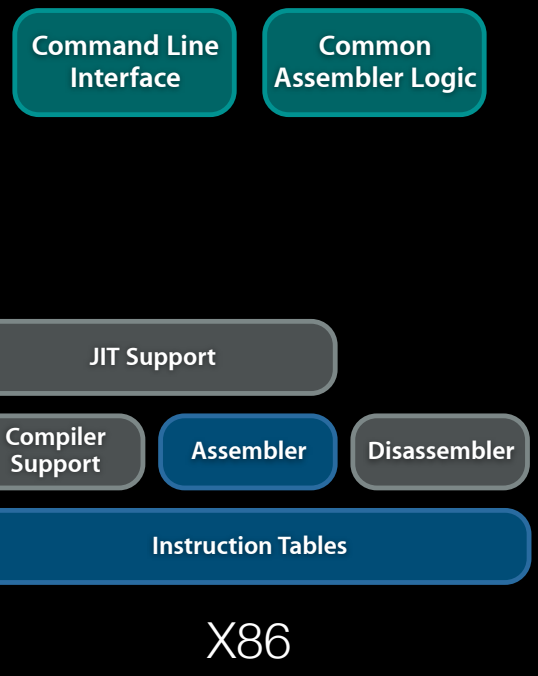

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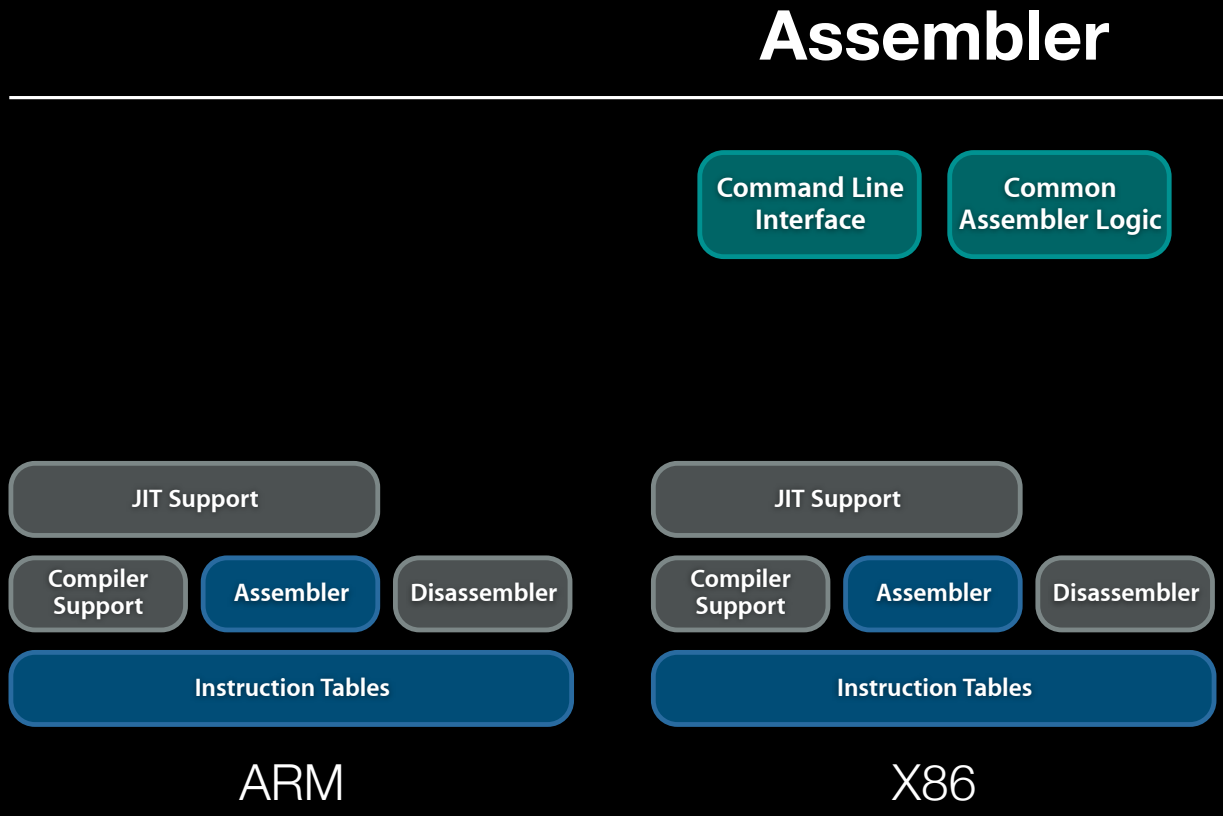

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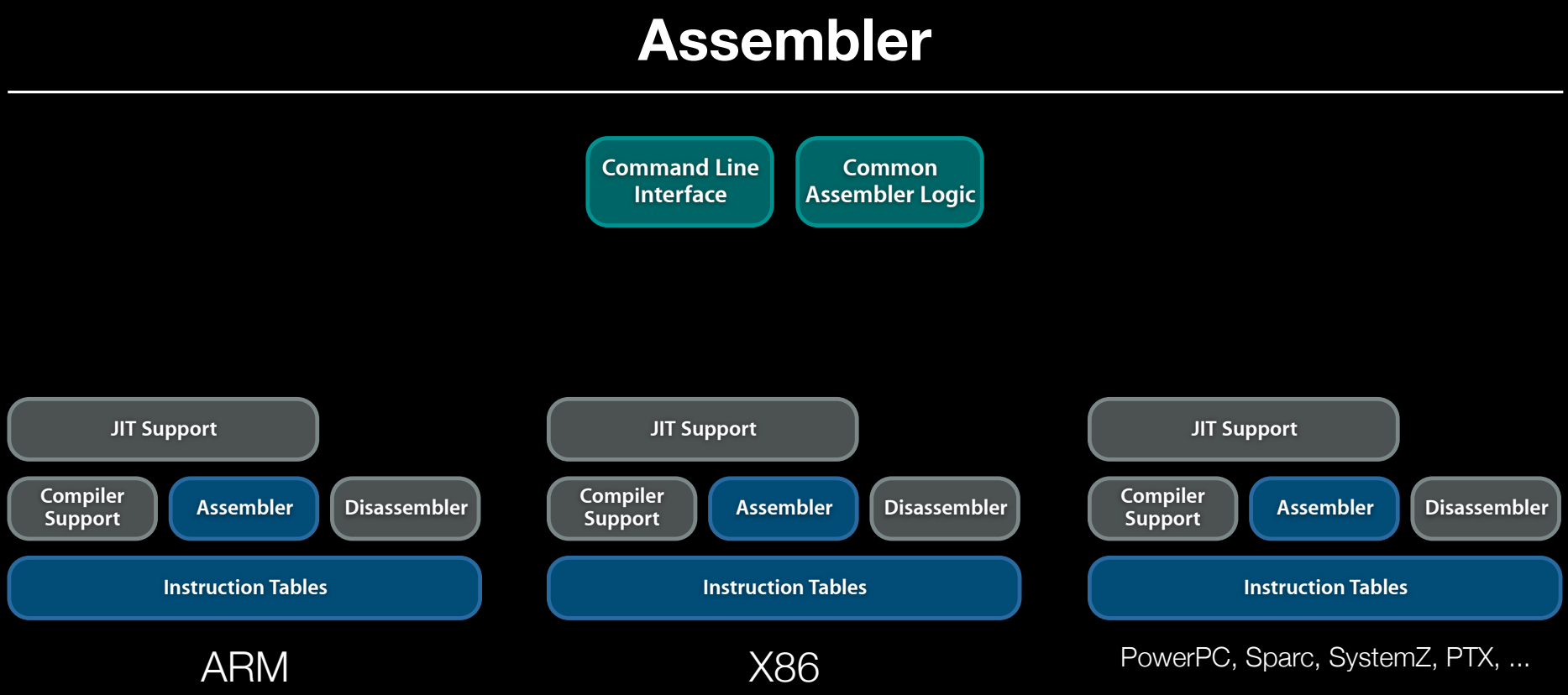

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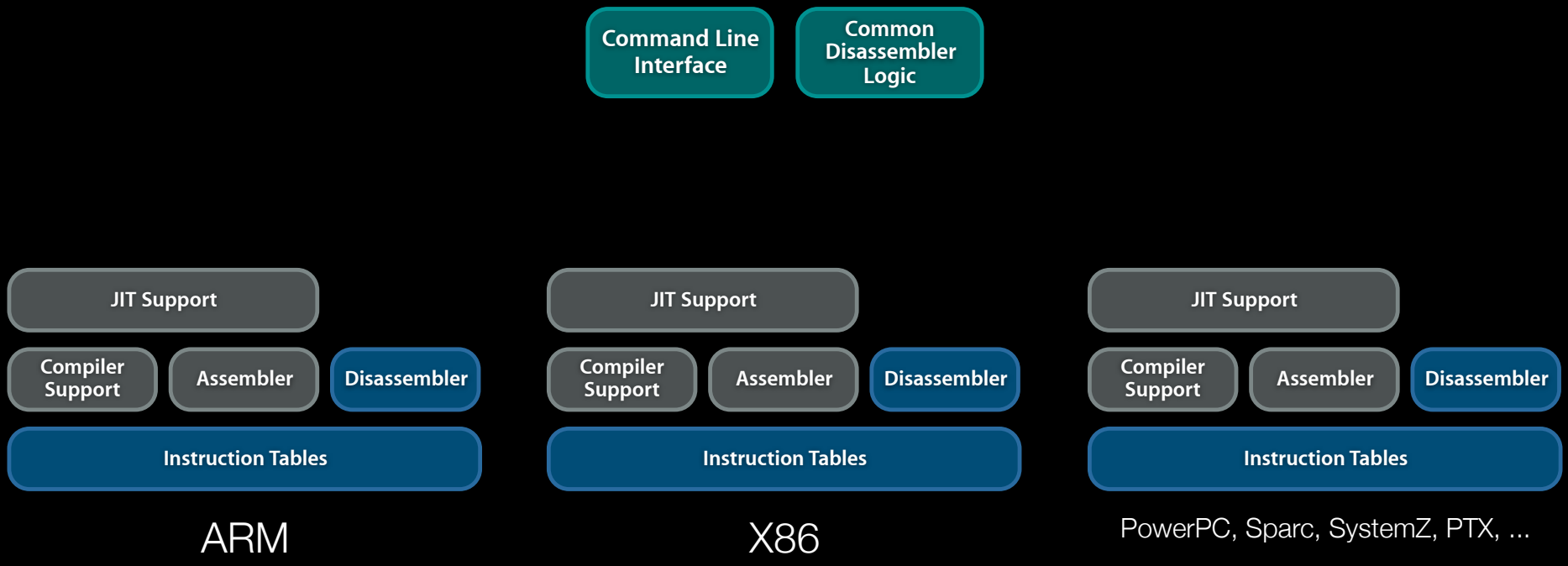

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- One truth for instructions:
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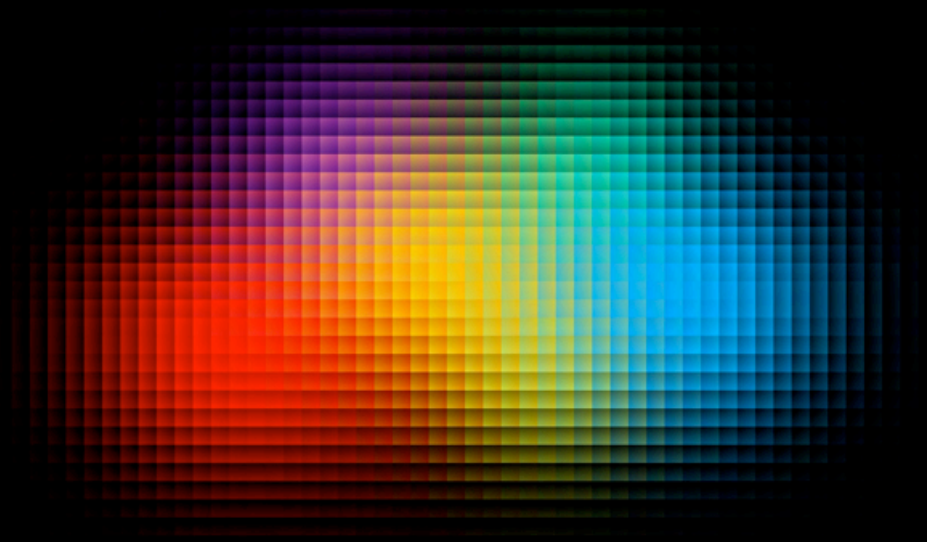

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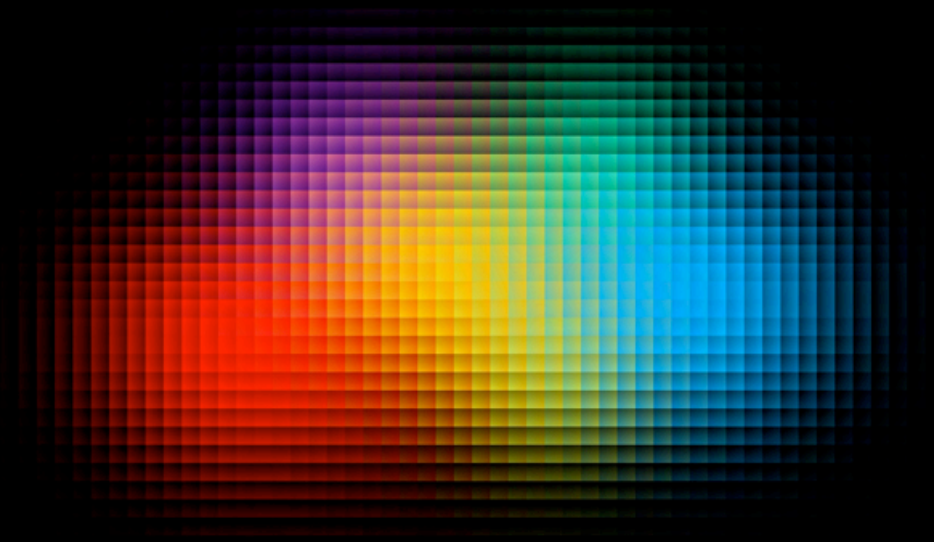

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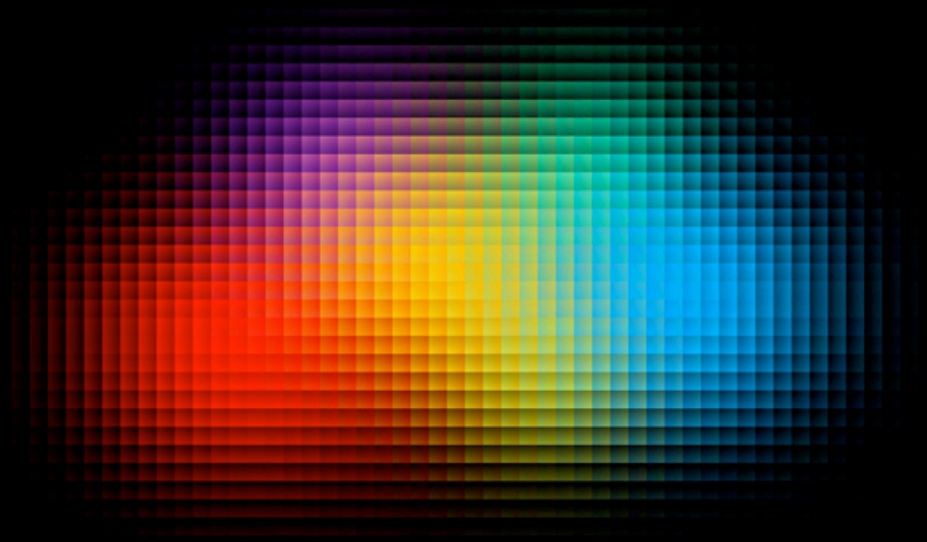

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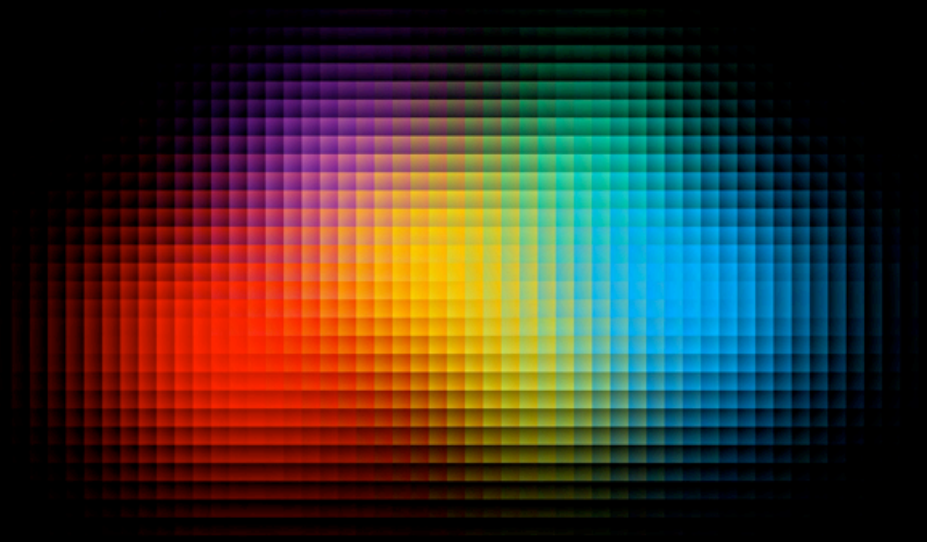
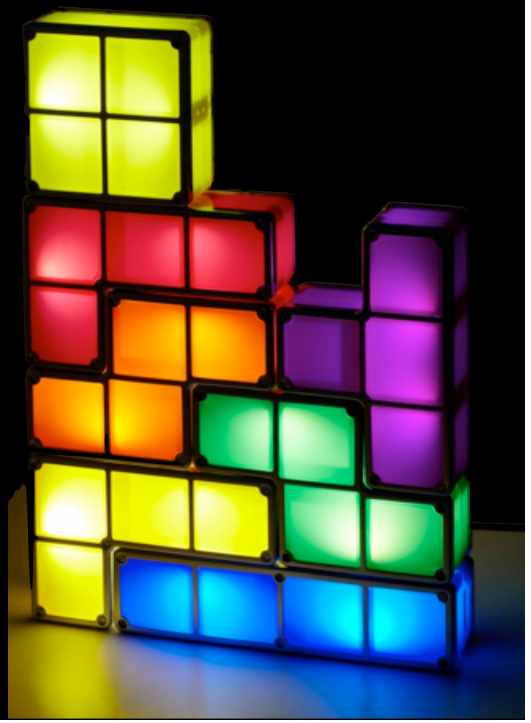


Compiler Infrastructure?



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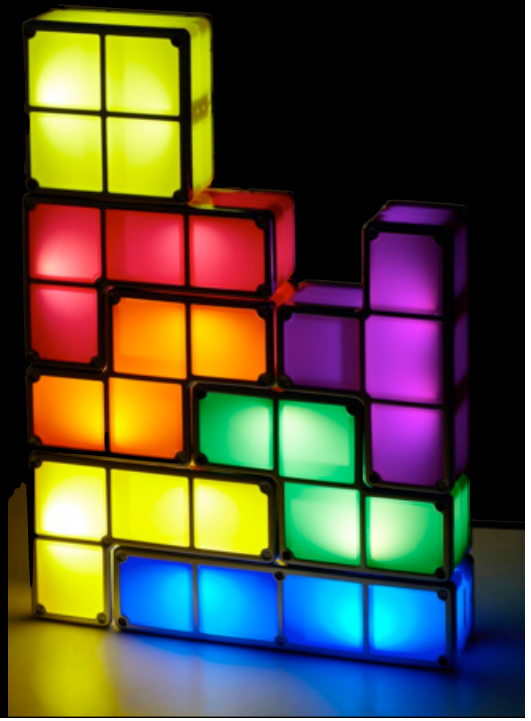

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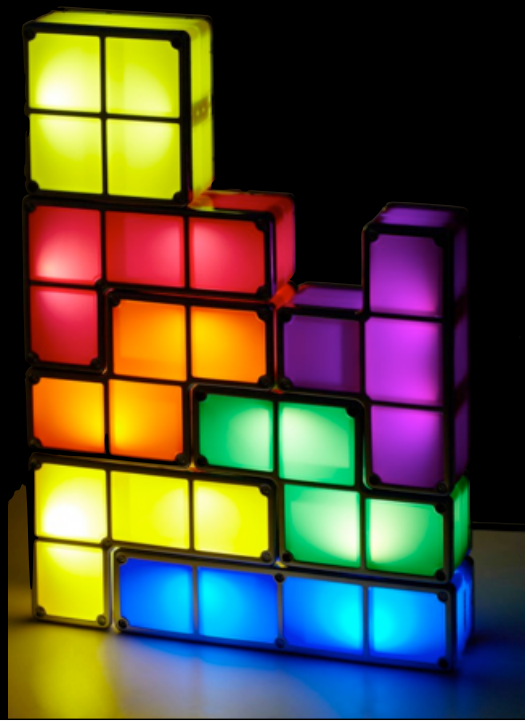

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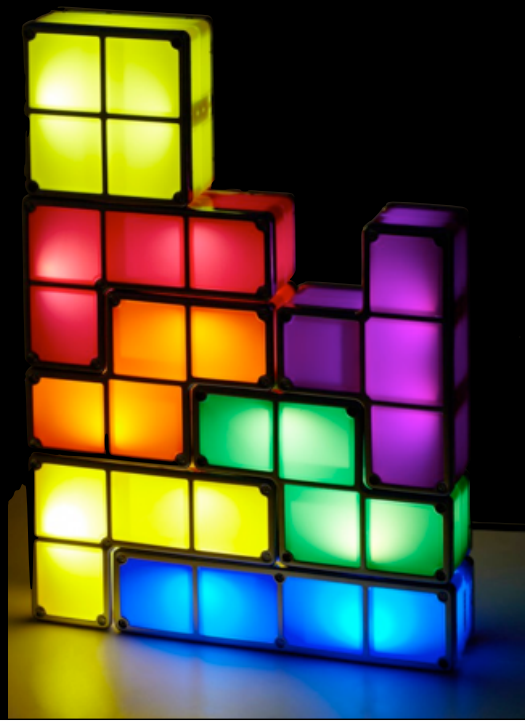
- Enables building things we never anticipated!




Applications of LLVM

mesa 3d - LLVMpipe Software Rasterizer

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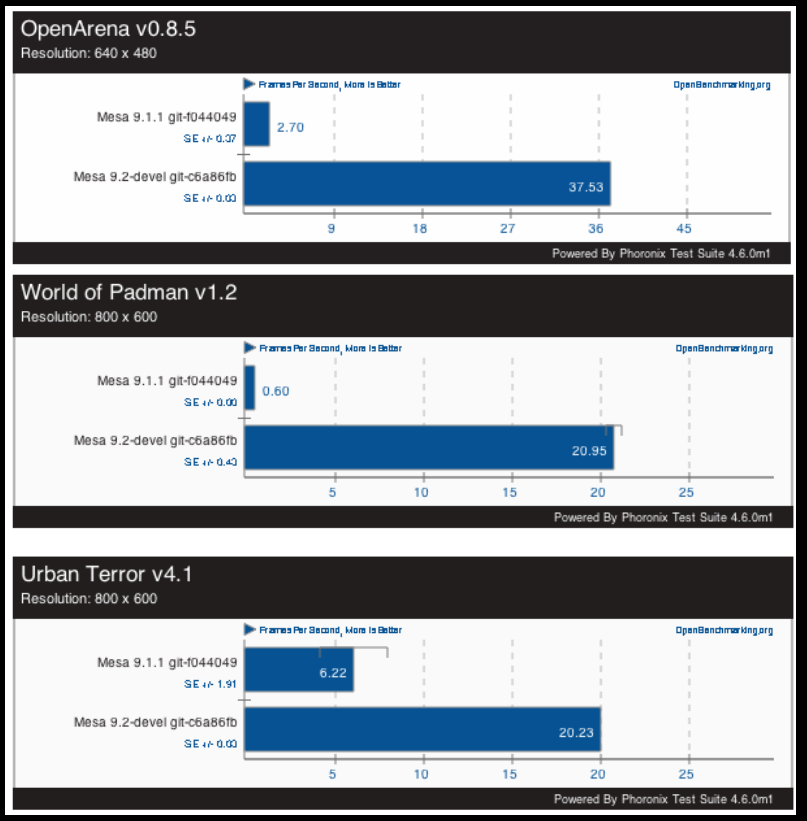

Benchmarks from phoronix.com

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- Special effects rendering engine:
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C#, Cross Platform

Research and Independent Languages

Rust

LLVM D compiler

LLVM Pascal Compiler

Intel SPMD Program Compiler

Clang Compiler

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  - Full C++’11 language and library
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- Follows the LLVM library-based “infrastructure” design
  - Builds on powerful LLVM backend
  - Reusable in other tools

Clang has great diagnostics

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$ clang t.cpp
t.cpp:5:3: error: no template named 'vector'; did you mean 'std::vector'?
  vector<int> V;
  ^~~~~~
  std::vector
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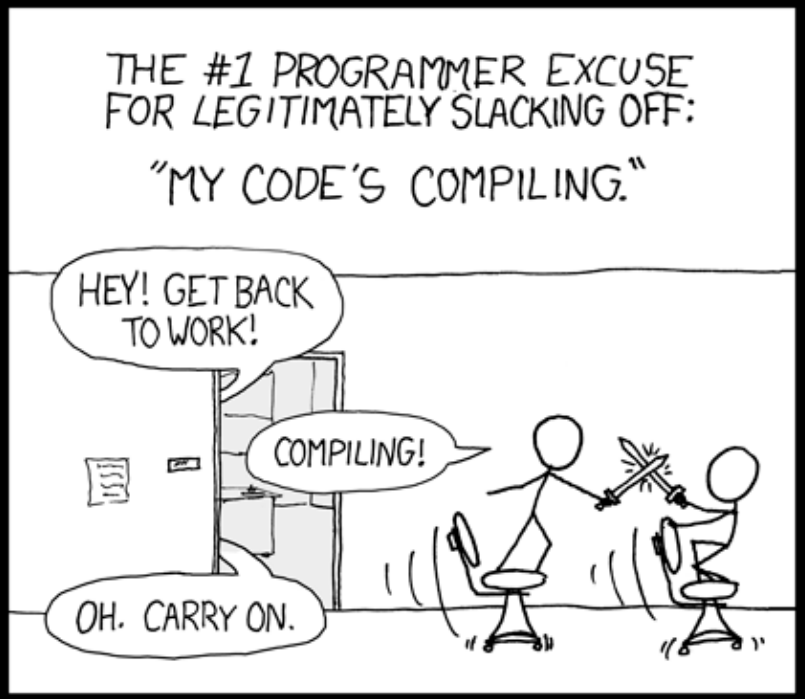
Clang compiles fast



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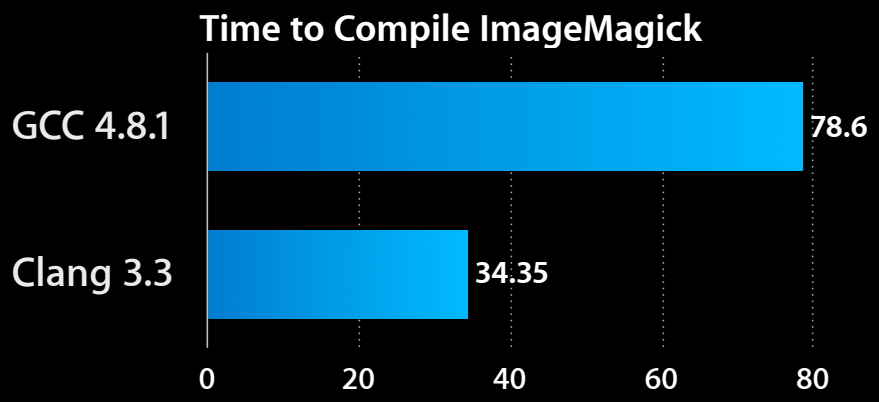

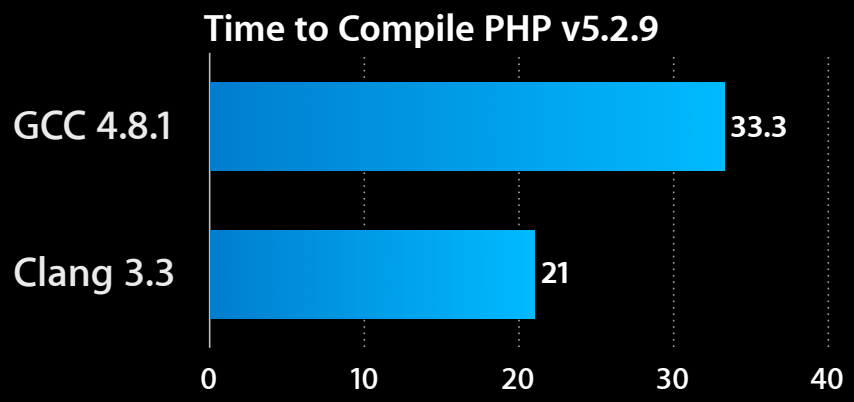

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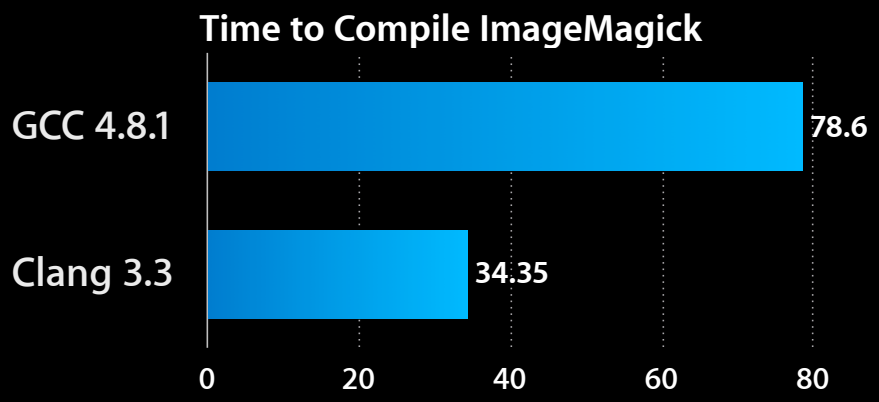

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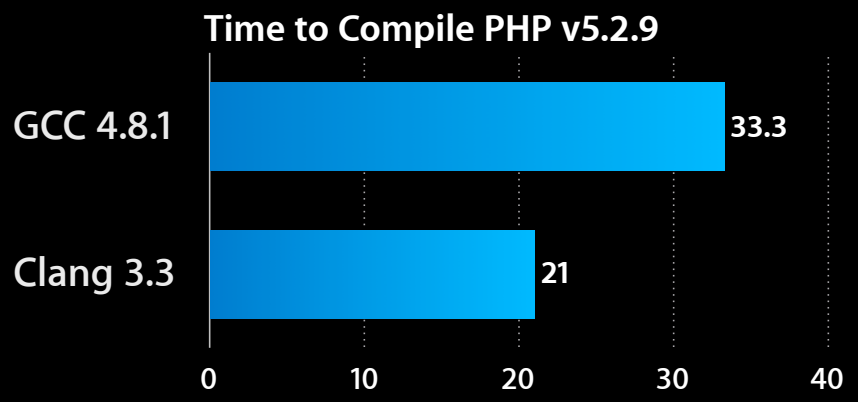

50% Faster!

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Generates fast code

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SciMark v2.0 - Composite Result

http://www.phoronix.com/scan.php?page=article&item=llvm_clang34_first

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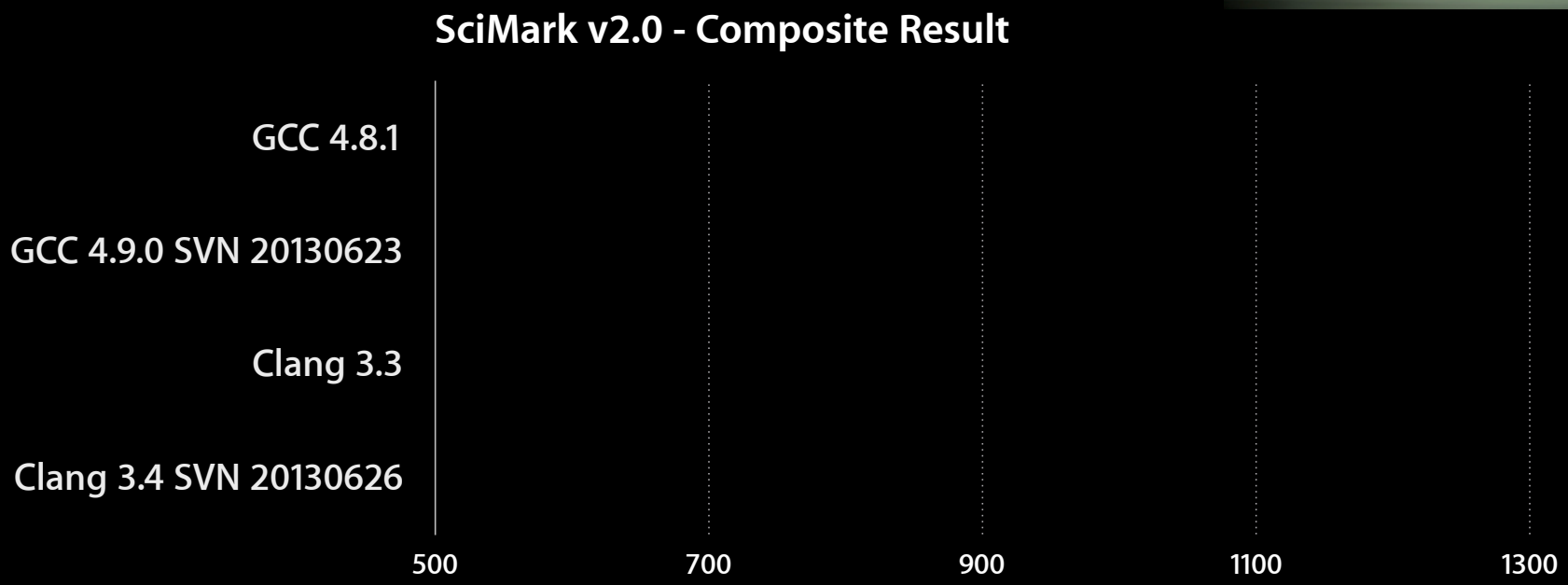

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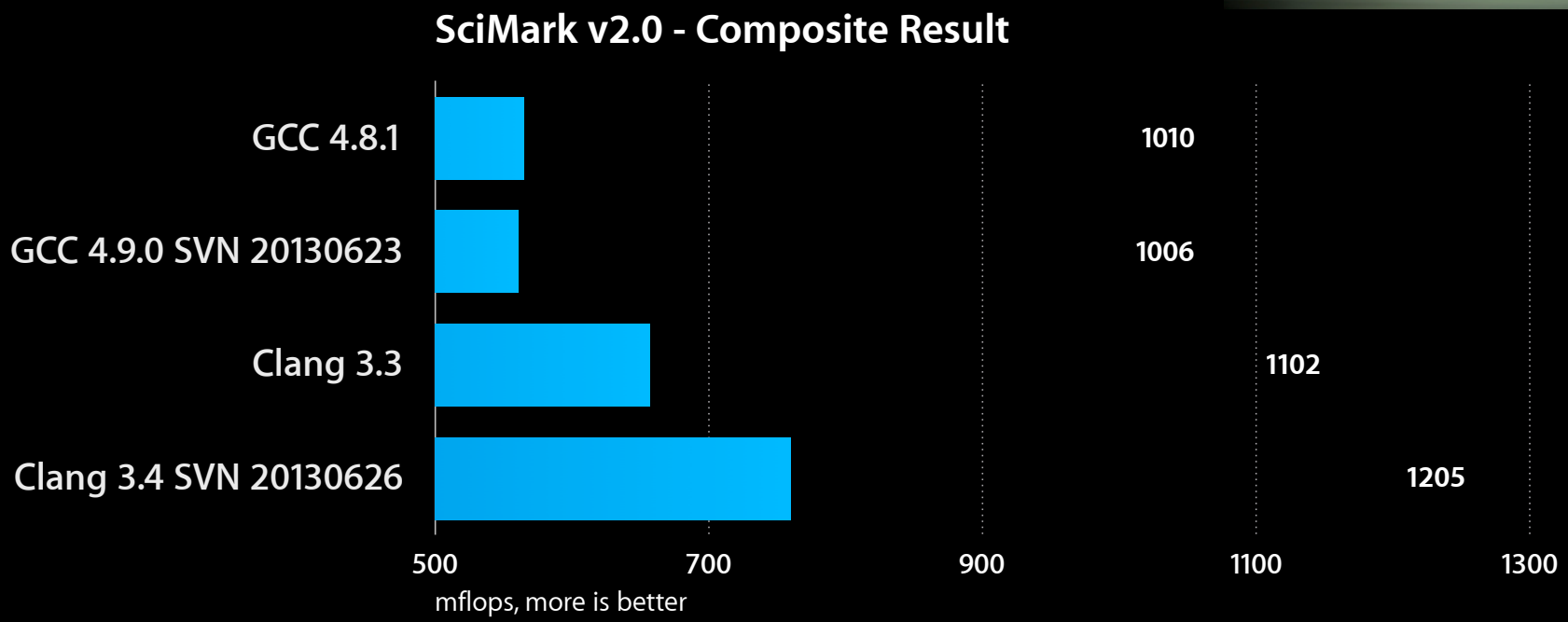

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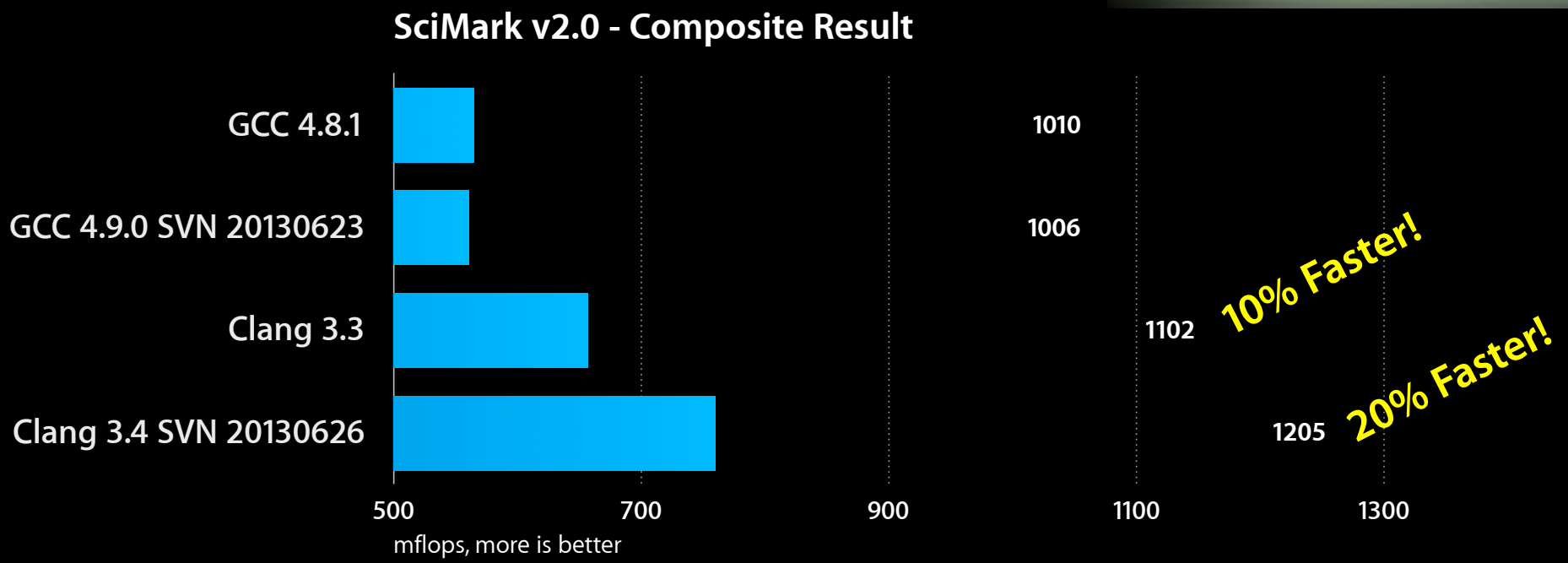

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Clang Applications

Clang Applications

- Clang static analyzer http://clang-analyzer.llvm.org

```
if (v1 > 0)
{
  if (v2 == 0)
  {
    myName = [[NSString alloc] initWithString:name1];
  }
  else if (v1 > v2)
  {
    myName = [[NSString alloc] initWithString:name2];
  }
}
else
{
  myName = [[NSString alloc] initWithString:name3];
}

myKey = [myName mutableCopy];   Receiver in message expression is an uninitialized value
```

Clang Applications

- Clang static analyzer http://clang-analyzer.llvm.org

```
if (v1 > 0)
{
  if (v2 == 0)
  {
    myName = [[NSString alloc] initWithString:name1];
  }
  else if (v1 > v2)
  {
    myName = [[NSString alloc] initWithString:name2];
  }
}
else
{
  myName = [[NSString alloc] initWithString:name3];
}

myKey = [myName mutableCopy];   Receiver in message expression is an uninitialized value
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- Address Sanitizer http://clang.llvm.org/docs/AddressSanitizer.html

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- Many more...

and so much more...

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http://**lldb**.llvm.org/	LLDB Debugger
http://**lld**.llvm.org/	LLD Linker
http://**libcxx**.llvm.org/	C++ Standard Library
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