Supporting a Vendor ABI Variant in Clang

Paul T. Robinson, Sony Interactive Entertainment

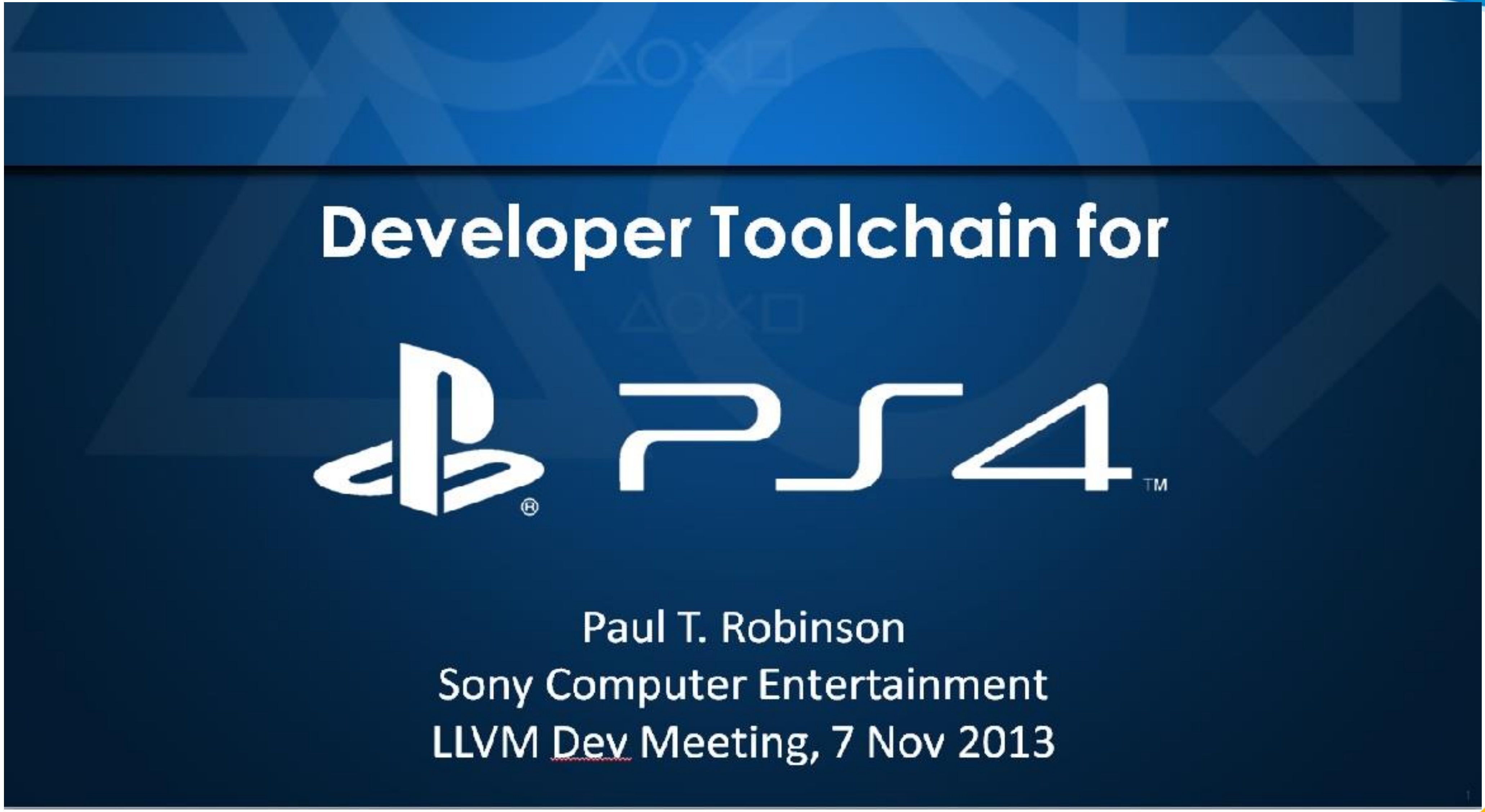
LLVM Developers' Meeting, October 2019

In the Beginning…

First-release PS4® toolchain centered on Clang 3.2

- With an assortment of tweaks, customizations, etc
- Used to build the OS, apps, games – *everything* that runs on PS4
- Very well received by the studios

Product Launch – 2013



Developer Toolchain for

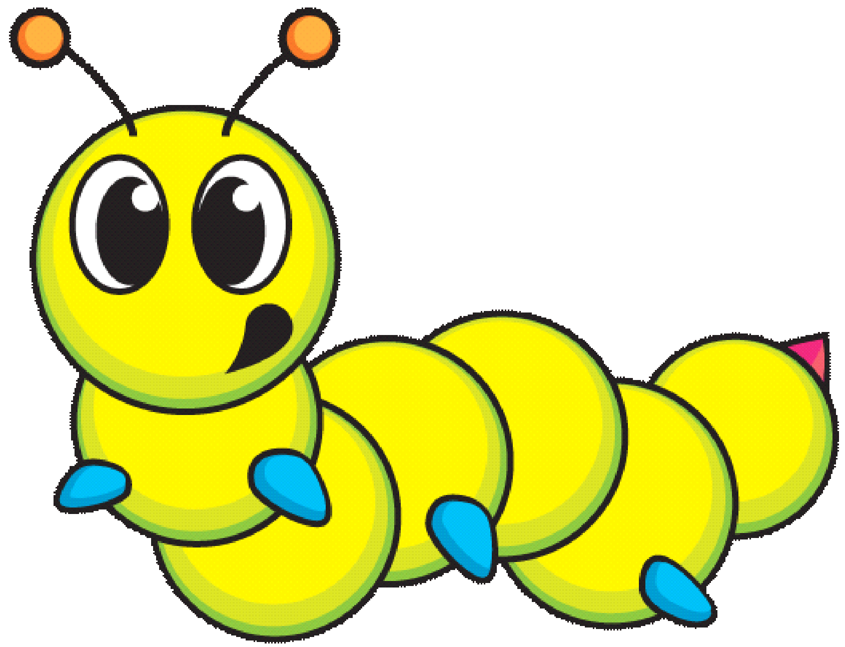
Paul T. Robinson

Sony Computer Entertainment

LLVM Dev Meeting, 7 Nov 2013

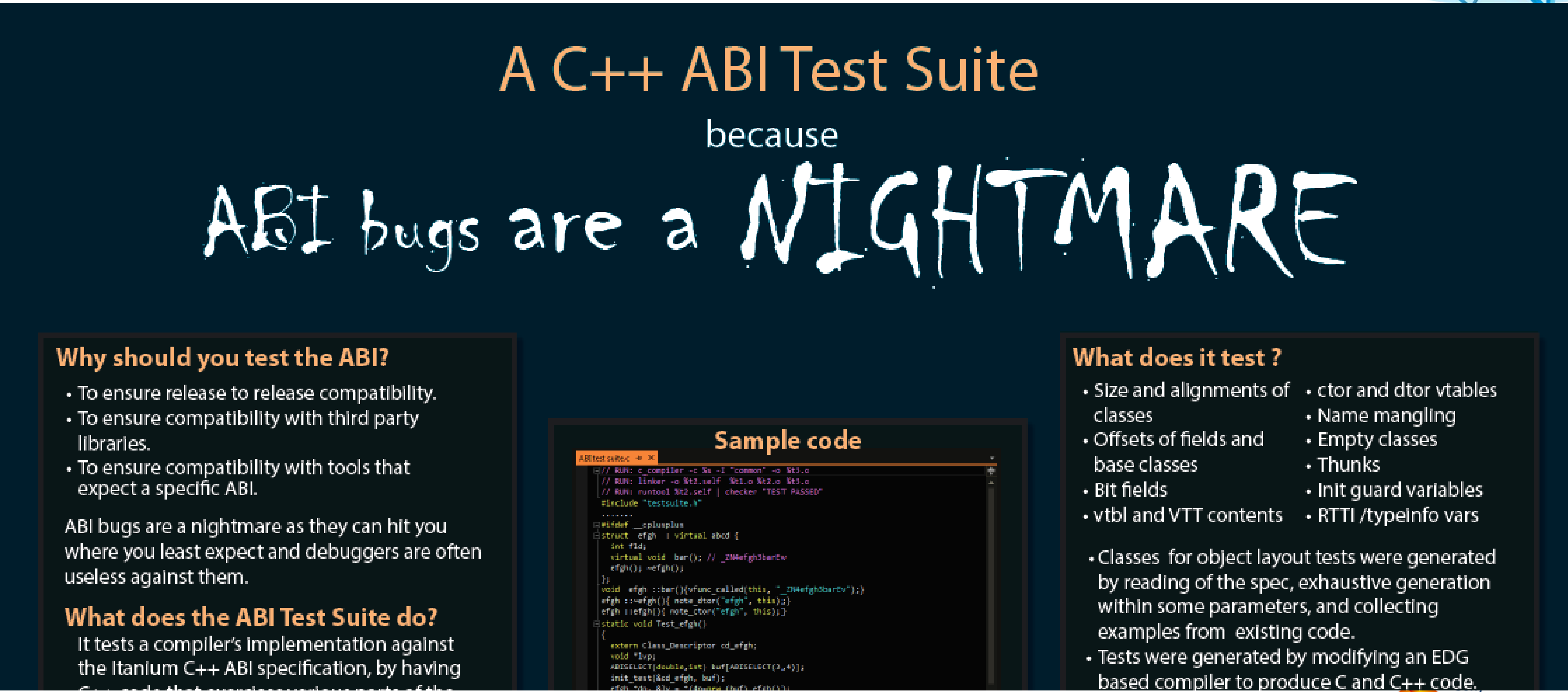
CPU Compiler ABI Overview

The First ABI Bug



The First ABI Bug – FIXED upstream

Oopsie



A C++ ABI Test Suite

because

ABI bugs are a NIGHTMARE

Why should you test the ABI?

- To ensure release to release compatibility.
- To ensure compatibility with third party libraries.
- To ensure compatibility with tools that expect a specific ABI.

ABI bugs are a nightmare as they can hit you where you least expect and debuggers are often useless against them.

What does the ABI Test Suite do?

It tests a compiler's implementation against the Itanium C++ ABI specification, by having

Sample code

ABI test suite.c

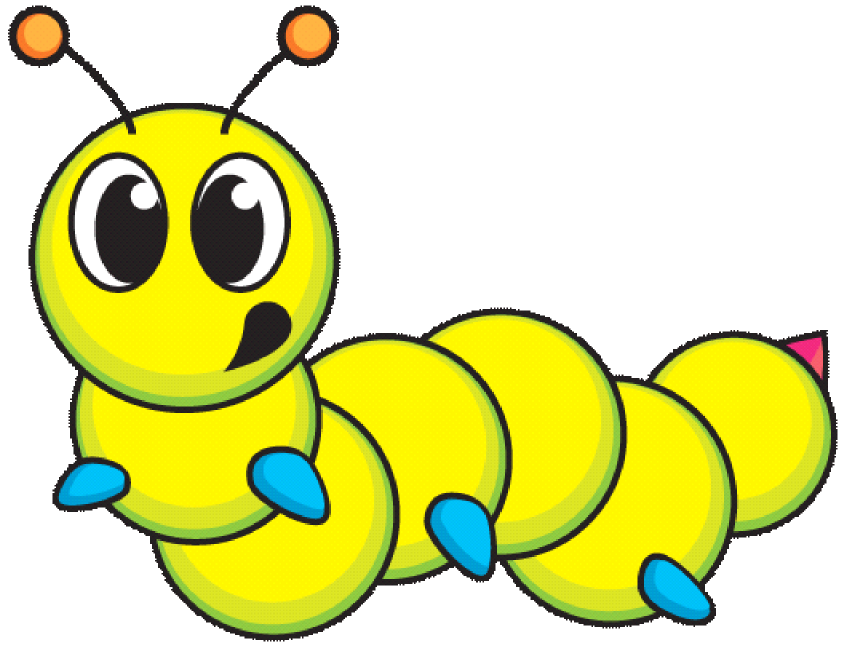
```
// RUN: c_compiler -c %s -I "common" -o %t3.o
// RUN: linker -o %t2.self  %t1.o %t2.o %t3.o
// RUN: runtool %t2.self | checker "TEST PASSED"
#include "testsuite.h"
.......
#ifdef __cplusplus
struct  efgh  : virtual abcd {
  int fld;
  virtual void  bar(); // _ZN4efgh3barEv
  efgh(); ~efgh();
};
void  efgh ::bar(){vfunc_called(this, "_ZN4efgh3barEv");}
efgh ::~efgh(){ note_dtor("efgh", this);}
efgh ::efgh(){ note_ctor("efgh", this);}
static void Test_efgh()
{
  extern Class_Descriptor cd_efgh;
  void *lvp;
  ABISELECT(double,int) buf[ABISELECT(3,4)];
  init_test(&cd_efgh, buf);
```

What does it test ?

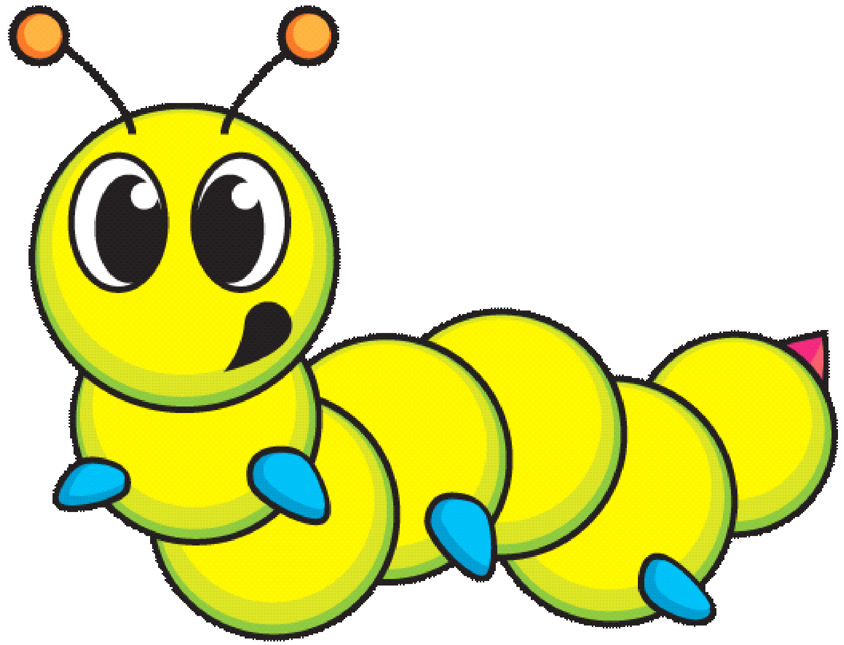
- Size and alignments of classes
- Offsets of fields and base classes
- Bit fields
- vtbl and VTT contents
- ctor and dtor vtables
- Name mangling
- Empty classes
- Thunks
- Init guard variables
- RTTI /typeinfo vars

- Classes for object layout tests were generated by reading of the spec, exhaustive generation within some parameters, and collecting examples from existing code.
- Tests were generated by modifying an EDG based compiler to produce C and C++ code.

Nice buggie…



Um… how many are there?



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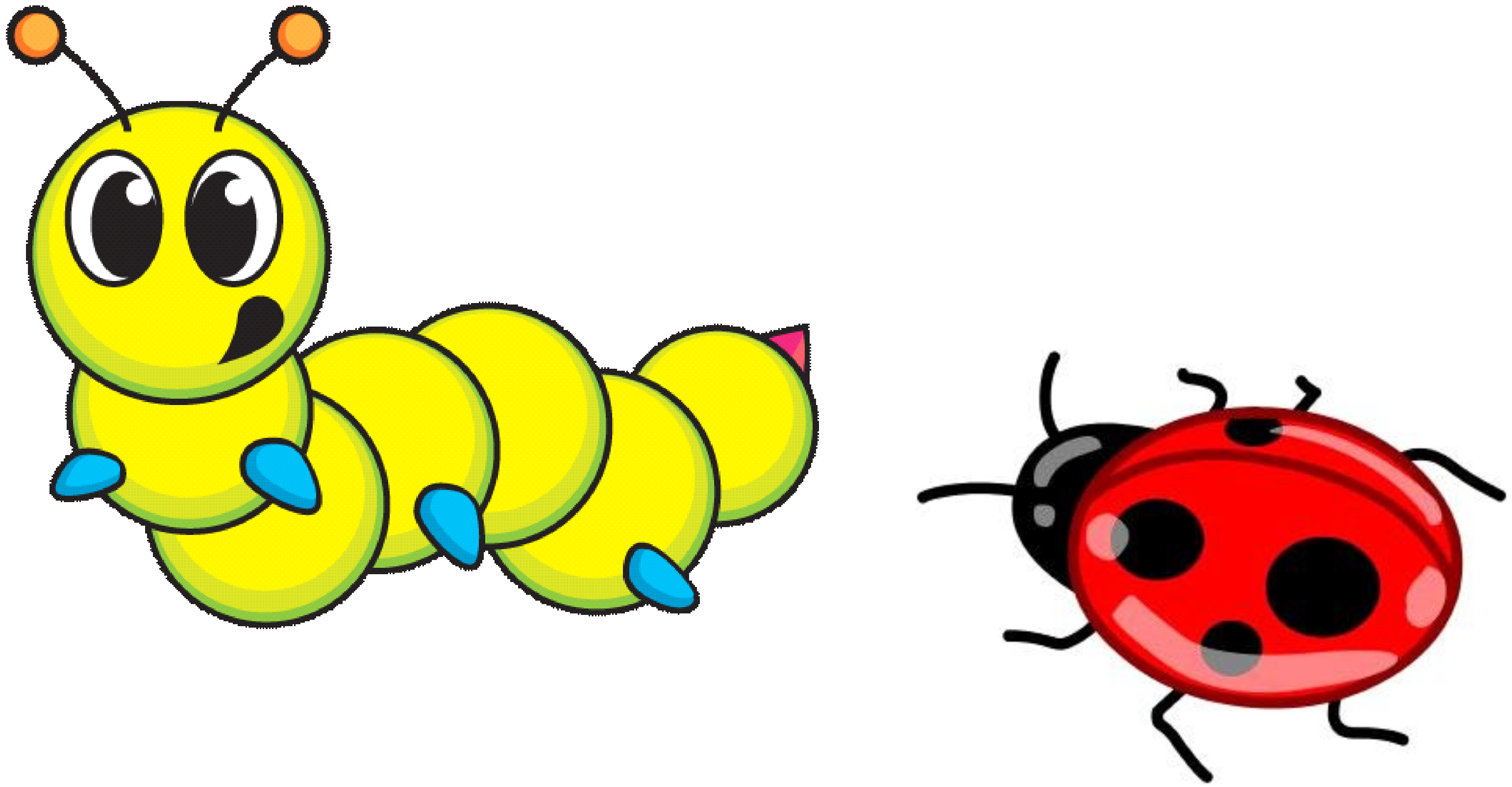

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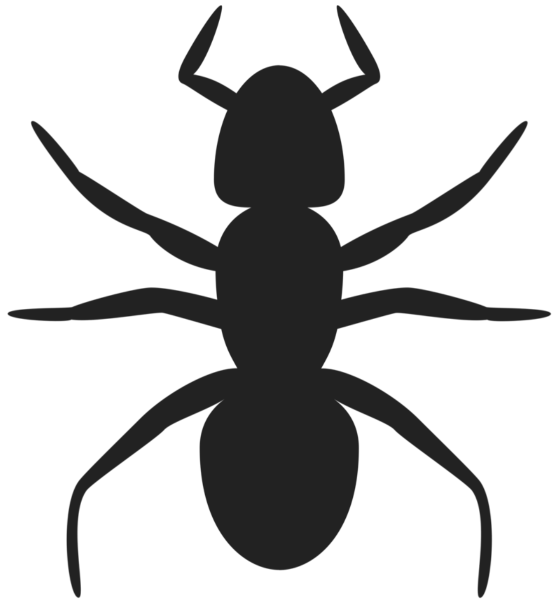

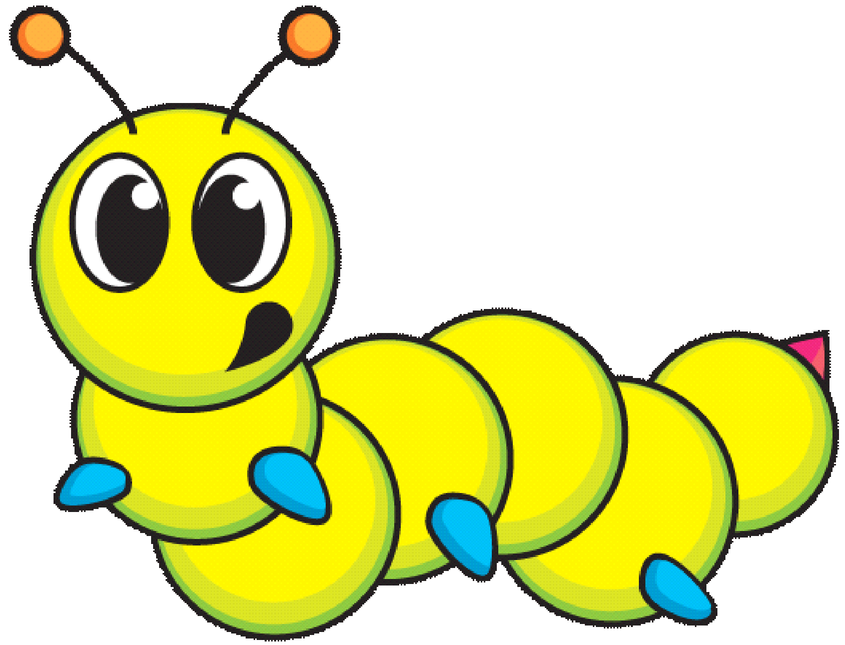

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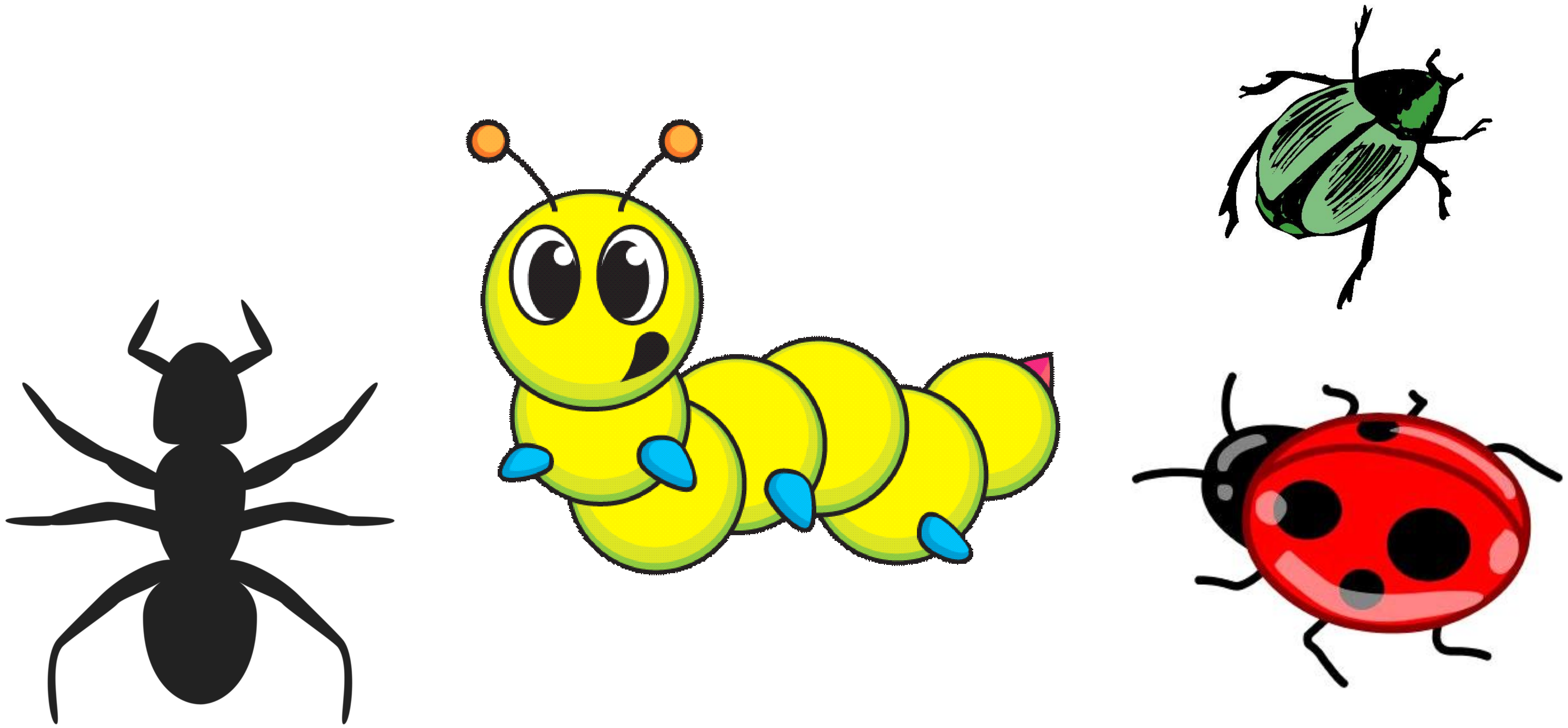
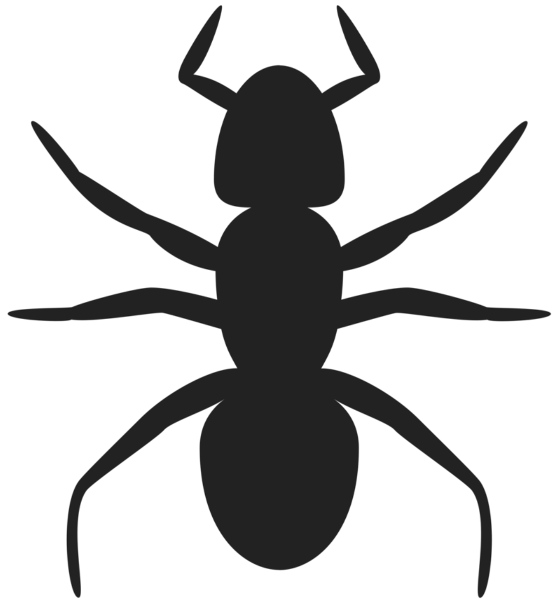
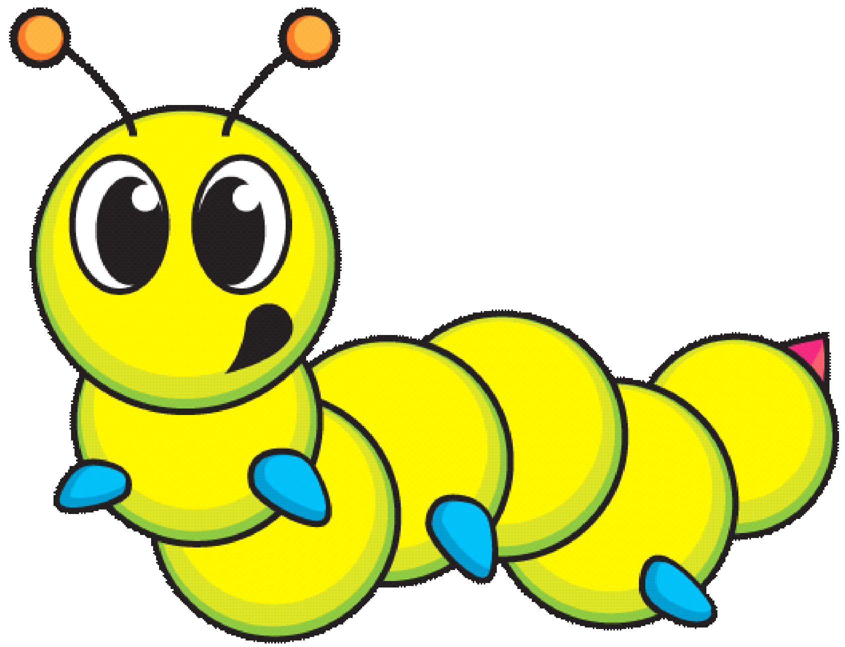
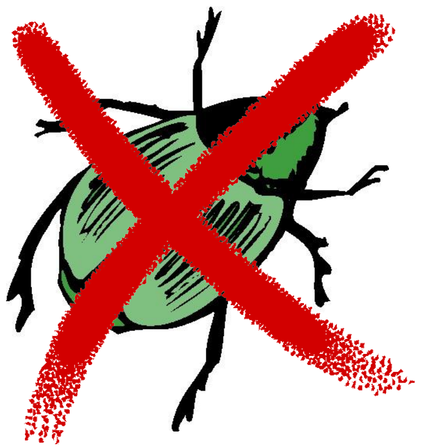
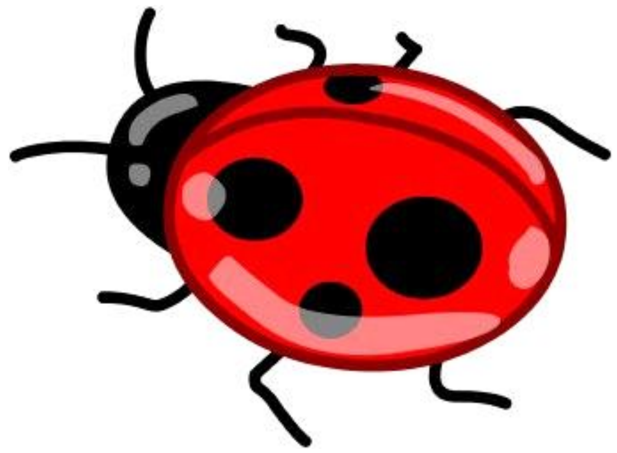


…and how many do we keep?

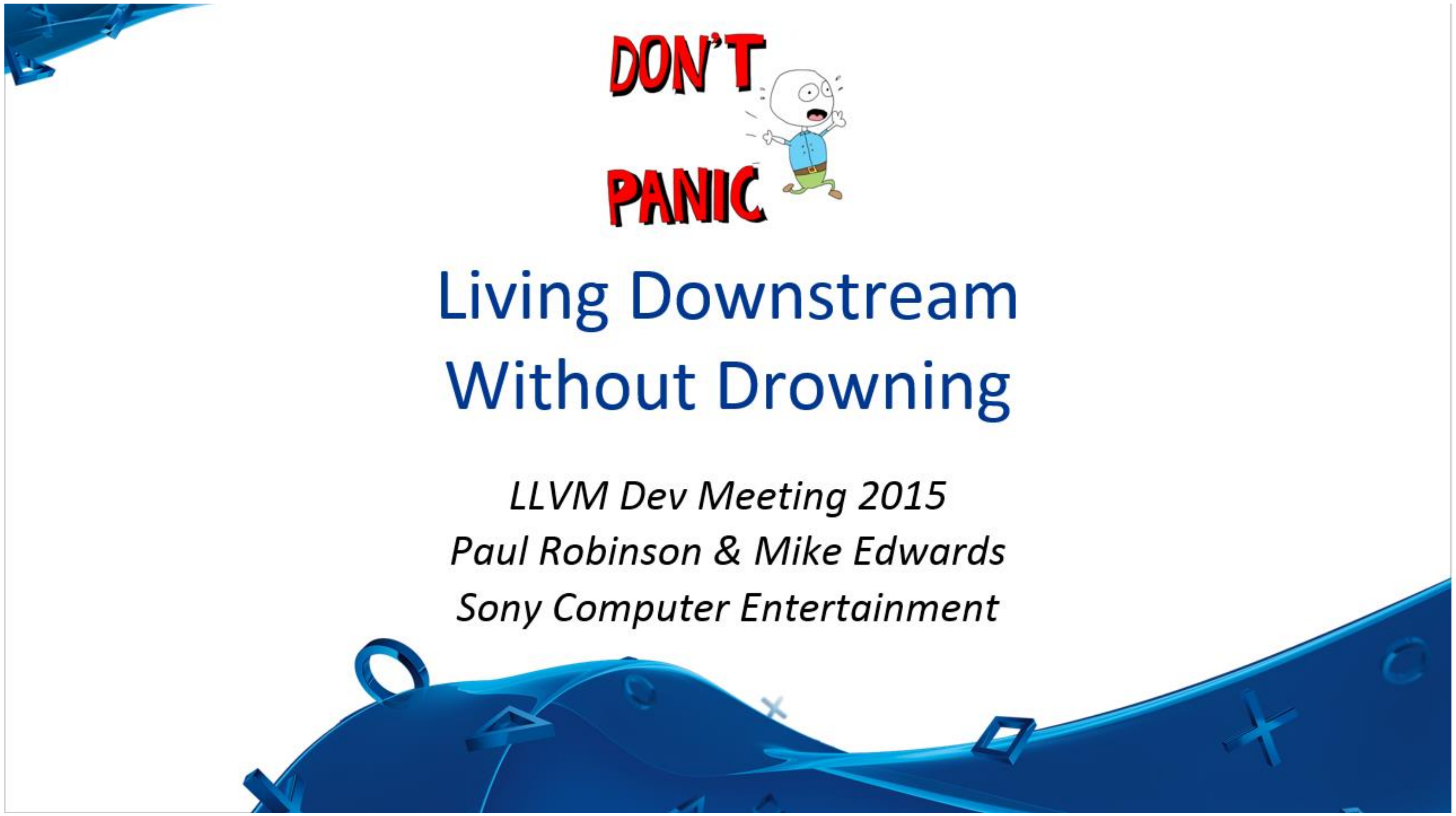








Don’t Panic



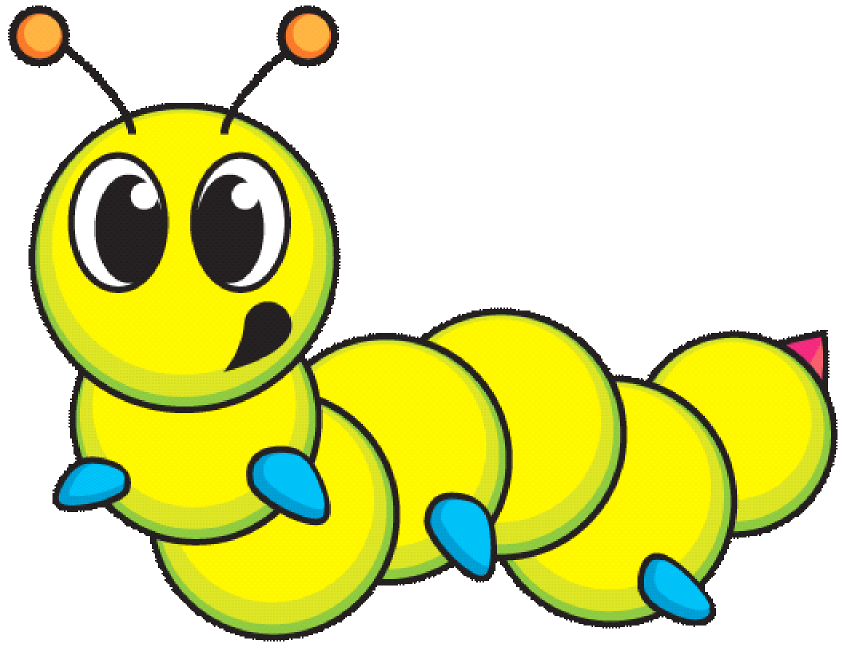
Living Downstream Without Drowning

LLVM Dev Meeting 2015

Paul Robinson & Mike Edwards

Sony Computer Entertainment

That’s a ~~bug~~ feature!



Clang ABI Compatibility Mode

Specify **`-fclang-abi-compat=<version>`**

- Attempts to match the ABI behavior of Clang <version>
- Useful in certain scenarios

This is the WRONG APPROACH for a “closed” platform like PS4!

- With strict backward compatibility requirements
  - Version 1.000 games must run on ALL later system versions
- With no need for compatibility with other compilers
  - There really is only one ABI

PS4 ABI “Mode”

PS4 ABI selected by –target alone

- Places that check Clang ABI compatibility are often the right places to put a PS4 target check
- Plus a small number of places where we just do our own thing

Not all ABI bug fixes are bad!

- Mangling changes in particular are often acceptable
  - We verify our exported symbols don’t depend on them
- These obviously don’t need a PS4 target check

Summary

- Test the heck out of your ABI differences (that you know about!)
    - Compare a “v1” compiler to your latest
- For a closed ecosystem with strict backward compatibility requirements, check Triple not Clang ABI mode
- Keep a close eye on upstream changes that could affect you
    - RecordLayoutBuilder.cpp
    - ItaniumMangle.cpp
    - Any patch with a Clang ABI Mode check
    - Phabricator’s Herald rules are your friend
- When things change, it *might* be okay
    - We’ve allowed some mangling changes that our symbols don’t use