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# Agenda

- Introduction
- LDC internals
- Porting and extending druntime
- Porting and optimizing Phobos
- Testing with Continuous Integration

# Introduction

- D is a systems programming language
- Should run everywhere
  - Needs at least a 32bit CPU
- Reference implementation targets x86/x86_64 based systems

# Introduction (2)

- There are more than x86 based devices
  - Tablets and smartphones are mostly ARM-based devices
  - IoT devices use AVR, ARM, MIPS or other CPUs
  - Servers use POWER, SPARC or AArch64 CPUs
  - ….

Non-x86 targets are required for success of D

# LDC: Supported targets

x86
x86_64
ARM
PPC

x86
x86_64

x86
x86_64

x86_64

x86

## Work in progress:

AArch64
MIPS64
SystemZ

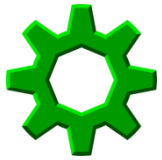
ARM

ARM

x86_64

# LDC: Not yet supported targets

- Partial list of not yet supported targets:
  - Any SPARC based operating system (32/64 bit)
  - OpenBSD, DragonFly
  - FreeBSD and NetBSD on non-Intel hardware
  - GPUs (NVIDIA, AMD)
  - AIX
- ... and many more

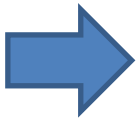



# What is the challenge?

- Very x86/x86_64 centric view in druntime and Phobos because of development history

- Example: Use of x86 assembler in test cases

```
void crash(int x)
{
  if (x==200) return;
  asm { int 3; }
}
```



```
void crash(int x)
{
  if (x==200) return;
  import ldc.intrinsics;
  llvm_debugtrap();
}
```

# LLVM challenges

- Not all targets are feature-complete
- Typical areas which can require improvement
  - TLS
  - Exception handling

- clang is often the only client
  - Using LDC can discover some hidden bugs

# Current way of porting

- We treat the last C++ version of LDC as a version with long-term support

- Steps for porting to a new platform:
  - Compile or install LLVM and libconfig
  - Compile LDC
  - Fix all compile errors and test suite failures
  - Create pull request

# LDC internals

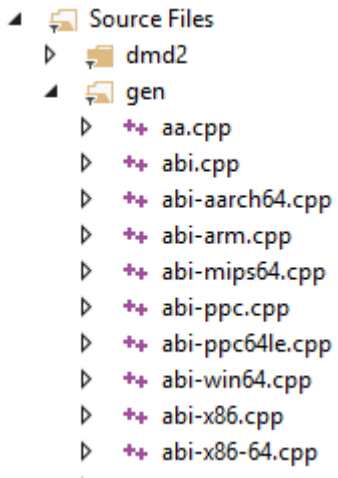
- LDC driver may need some tweaks
  - Check definition of D version identifier

```
static void registerPredefinedTargetVersions() {
  switch (global.params.targetTriple.getArch()) {
  case llvm::Triple::RISCV:
    VersionCondition::addPredefinedGlobalIdent("RISCV");
    break;
....
```

With `ldc -v` you can check which D version identifiers are defined

# LDC internals (2)

- LLVM requires compilers to implement ABI (see `gen/abi*.cpp`)




Wrong or missing ABI implementation causes failures in test suite

# Extending druntime

- Adding basic support for an OS requires
  - Extending the POSIX modules if needed
  - Adding OS specific modules

- Examples: NetBSD, Android, iOS

In general: If you miss a crucial part then you will get compile or linker errors

# Porting druntime

- Adding a new CPU architecture requires more effort
  - Add assembly code to `core.thread`

```
private void callWithStackShell(void delegate(void* sp))
{
    version (LDC)
    {
        version (RISCV)
        {
            import ldc.llvmasm;

            size_t[1] regs = void;
            __asm(`sd $$16,  0($0)`, "r", regs.ptr);
        }
....
```

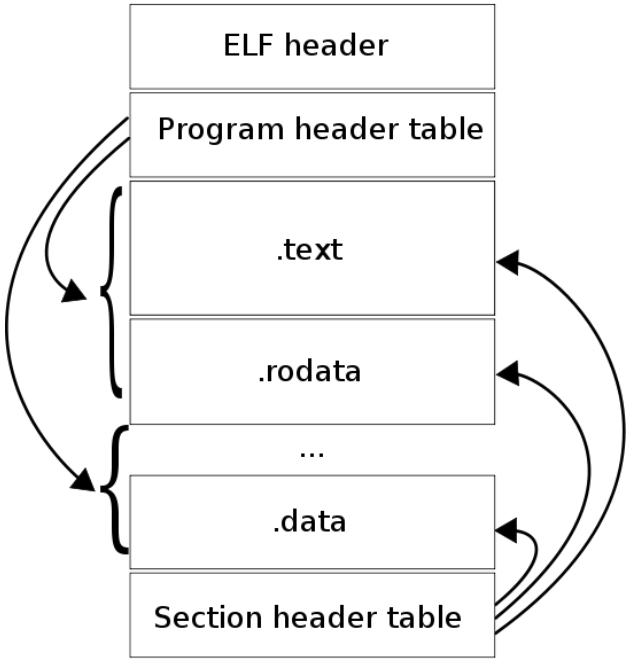
# Porting druntime (2)

- Add assembly code to `threadasm.S`
  - Not required if `ucontext_t` is supported
- Check 128bit CAS support in `core.atomic`
  - Simply run the unit test
- Implement `core.stdc.stdarg` if needed

Be aware if used: `core.cpuid` only supports x86/x86_64
I am working on an auxv-based solution for Linux

# Section support in druntime

- Sections determine location of code and data
- Example: ELF




- Crucial for GC support and shared libraries
- DMD solution not applicable for LDC

# Section support in druntime (2)

- Porting effort varies: ELF not used everywhere
- Even differences if ELF is used
  - Different offsets for TLS section
  - zLinux does not have `__tls_get_addr()`
  - LDC does not support shared libraries on Solaris

Symptoms if there is an issue:

- Unit tests allocating a lot of memory fail in unpredictable ways
- Failure goes away if linked against stub GC

# Floating point support

- Complete support only for 32bit, 64bit and 80bit reals
- 128bit IEEE quadruple and IBM extended doubledouble formats have only partial support

Unit tests of `c.i.convert` and `c.i.hash` do not compile for these types

# Porting Phobos

- Phobos builds on druntime and requires usually less changes
- Most changes are due to use of system specific modules

You get a compile error if you need to add Code. Example: A missing import

# Phobos and floating point

- `std.math` is very x87 FPU centric
  - A lot of inline assembly
  - Accuracy of unit tests tuned for 80bit reals
- Struct `IeeeFlags` must be implemented
- 128bit floating point formats only partial implemented

`std.math` causes a lot of trouble if you have an incomplete supported float format

# Optimizing Phobos

- Re-Implement D module `s.i.m.biguintnoasm` with assembly (partially done for ARM)
- Explore efficient implementations of digest algorithms
  - POWER8 and AArch64 have special instructions
  - MIPS OCTEON has crypto co-processor
- Research other possible optimizations!

# Typical Porting Trap

- The D spec says:

> The `extern (C)` and `extern (D)` calling convention matches the C calling convention used by the supported C compiler on the host system.

- Does not mention non-POD structs!
- NRVO implies that all non-POD structs are passed in memory

CTFE test cases (and others) can fail if you do not pay attention to the ABI

# Future way of porting

- DMD frontend is now written in D
- Preferred way of porting is cross-compiling
- Cross-compiling requires floating point support independent of host (pending PR #5471)

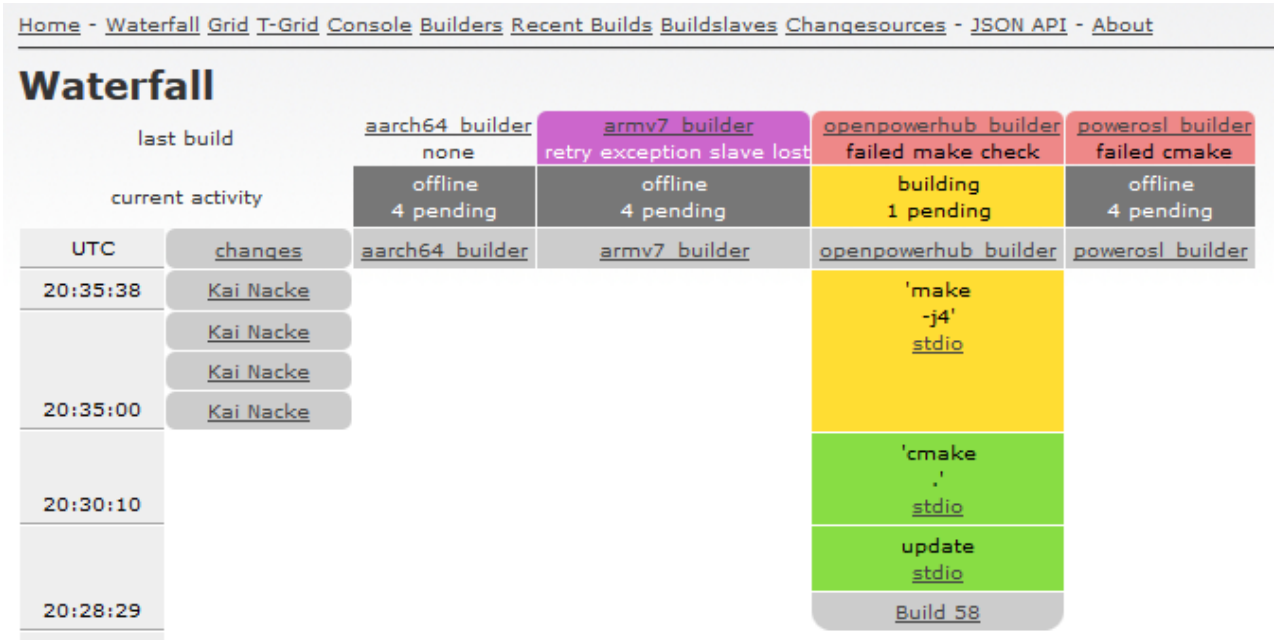
Currently you can get wrong results wrt. floatings points if you use cross-compiling

# Continuous Integration

- Tests are very important for a compiler
- The LDC developers use Continuous Integration
  - Test suite executed for each commit / PR
- Different CI servers for x86_64
  - Travis CI: Linux and OS X, LLVM 3.5-3.9
  - CircleCI: Linux with LLVM 3.9
  - AppVeyor: Windows

# Continuous Integration (2)

- buildbot is used for ARM and OpenPOWER
- See http://buildbot.ldc-developers.org/
- More builders can be added



# Let's port LDC!

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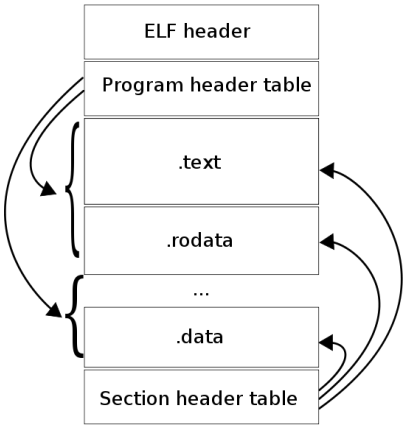


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