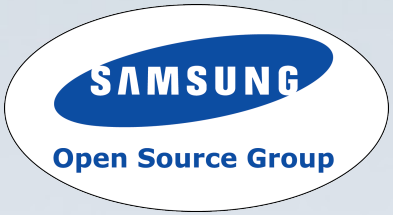


Fast JIT Code Generation

Tilmann Scheller

Overview

- Introduction
- tiny-llvm-codegen
- SkyEye
- Performance Numbers
- Summary

Introduction

- Traditional LLVM JIT has a relatively high overhead since it's essentially using the same code generator like the static compiler
- Only useful for really hot code
- Fast-isel solves part of the problem but overhead still significant
- It would be nice to just flip a switch and get a different tradeoff in terms of compile time/runtime performance

tiny-llvm-codegen

- Work is based on tiny-llvm-codegen
- tiny-llvm-codegen is a really simple JIT for LLVM IR targeting x86-32
- Developed by Mark Seaborn in March 2013
- Ported tiny-llvm-codegen to x86-64
- Added basic support for the AMD64 System V ABI

tiny-llvm-codegen

- Extremely simple translator
- Very small (about 2000 LOC)
- No register allocation
- No instruction selection
- No instruction scheduling
- Just translating every LLVM IR instruction one by one
- All values go into memory

Example

```
define i64 @foo(i64 %a, i64 %b) {
  %1 = add i64 %b, %a
  ret i64 %1
}
```

```
foo:
push   %rbp
mov    %rsp,%rbp
sub    $0x1c,%rsp
mov    %rdi,-0x8(%rbp)
mov    %rsi,-0x10(%rbp)
mov    -0x10(%rbp),%rax
mov    -0x8(%rbp),%rcx
add    %rcx,%rax
mov    %rax,-0x18(%rbp)
mov    -0x18(%rbp),%rax
leaveq
retq
```

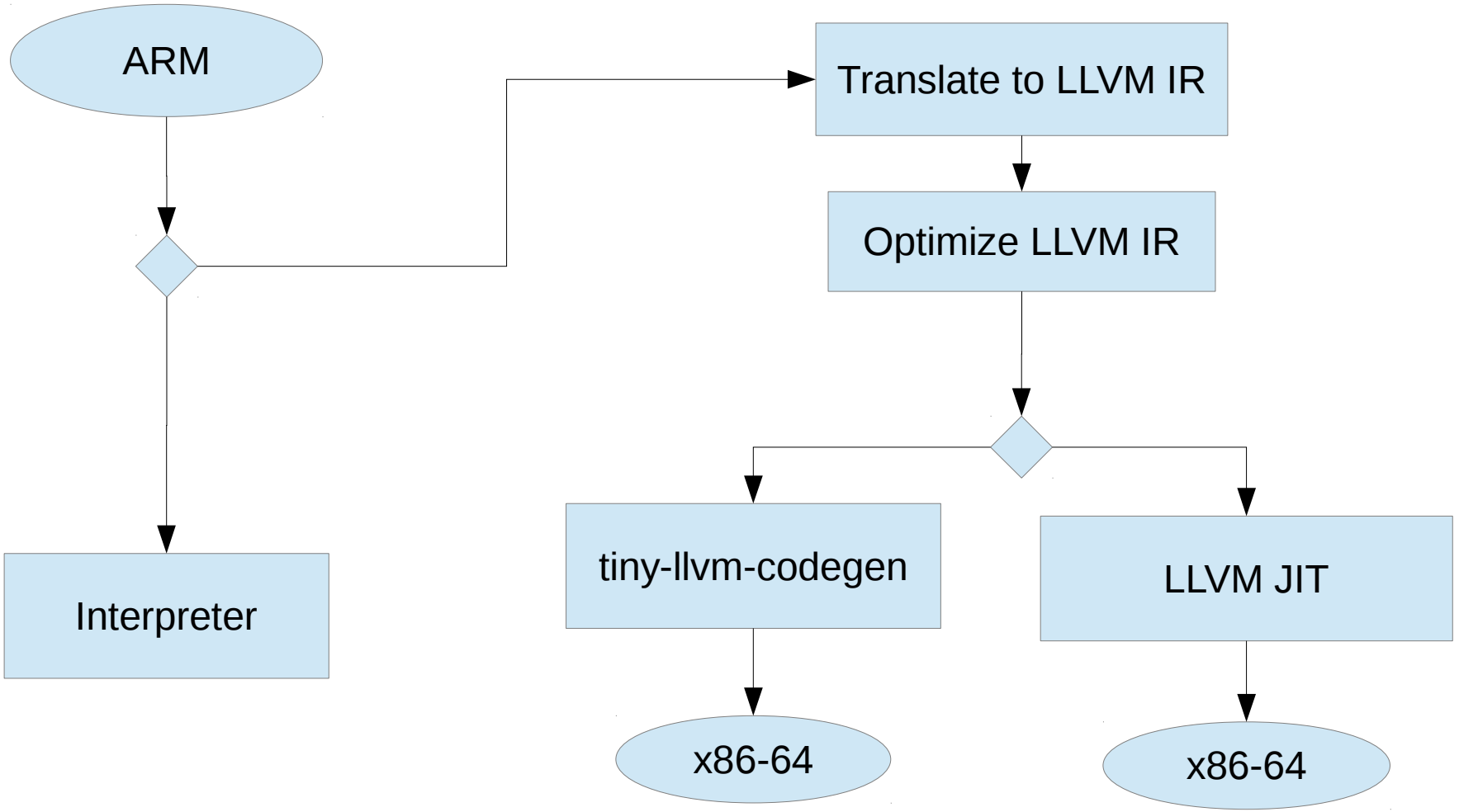
tiny-llvm-codegen

- Supported: Integer operations
- Missing: Floating-point operations, Vector operations
- No performance tuning yet
- Probably lots of low hanging fruit
- Supports i1, i8, i16, i32, i64

SkyEye

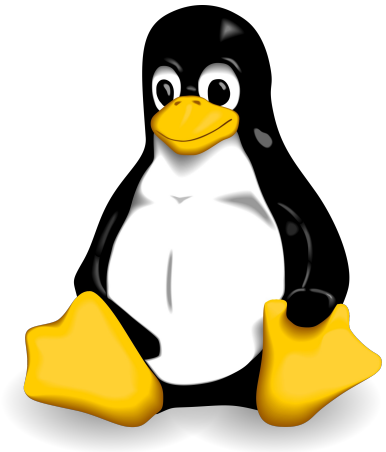
- Open Source full system simulator
- Supports a wide range of different architectures: ARM, PowerPC, MIPS, x86, SPARC, ColdFire, Blackfin
- Does interpretation as well as dynamic binary translation with LLVM (using a fork of the libcpu project)
- Can run an ARM Android 2.2 build

SkyEye Overview



Test workload

- Simulating a Samsung S3C6410X SoC with an ARM11 core
- Booting an ARMv6 Linux 3.0 kernel
- This requires about 150 million instructions
- Produces 33MB of optimized bitcode



Test workload

- Compiling the 33MB of bitcode offline:
  - 3.3 seconds with tiny-llvm-codegen
  - 67 seconds with llc
- JITing every basic block which is executed at least twice to compare the performance of both JITs
- Booting the kernel on the simulated system: about 3x faster when using tiny-llvm-codegen (24 sec vs. 76 sec)
- Measured on an Intel Core i7-4770K

Summary

- Ported tiny-llvm-codegen to x86-64
- Successfully compiles a substantial amount of LLVM IR
- Performance numbers look promising
- Future:
    - Support the remaining LLVM IR instructions
    - Performance tuning
    - Add support for another architecture
    - Add a simple register allocator?

SAMSUNG
SRUK

Thank you.

References

- http://github.com/mseaborn/tiny-llvm-codegen
- http://skyeye.sourceforge.net
- http://libcpu.org