TCG enhancements on PowerPC

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About me

- Guest firmware(SLOF) developer
- QEMU user/developer
Agenda

- QEMU TCG – Quick look
- Power ISA 3.0 Support
- PowerNV Platform
- PowerPC support for Multi-threaded TCG
- Other Optimizations
- Future work
How is emulation done?

POWER ISA

PowerPC Machine Code

Translate

Intel ISA

x86 Machine Code

Runs On

LAPTOP(x86)

Credits: Alexander Graf’s QEMU’s Recompilation Engine

```
addi r9, r9, 127
add  $0x7f, %rbp
```
More architectures!

- ARM Binary
- PowerPC Binary
- X86 Binary

X86 Instructions

X86 Hardware

Credits: Alexander Graf's QEMU's Recompilation Engine
N x N Support: Very complex

Credits: Alexander Graf's QEMU's Recompilation Engine
QEMU TCG – Tiny Code Generator

Target
- ARM Binary
- PowerPC Binary
- x86 Binary
- S390 Binary

Host
- ARM Hardware
- PowerPC Hardware
- x86 Hardware
- S390 Hardware

TCG
Machine Independent
Intermediate notation

tcg micro ops

Credits: Alexander Graf's QEMU's Recompilation Engine
QEMU Avatar – linux-user

- Input: Target binary and libraries
- Provides Linux system call emulation
- Emulates target ISA
- Can be used to debug user programs
POWER ISA 3.0

- POWER (Performance Optimization With Enhanced RISC)
- Adds ~180 new instructions
- Various instructions added in different classes
  - Atomic memory operations
  - Hashing support operations
  - String operations (character testing, string processing)
  - Arithmetic operations (multiply-add, modulo)
  - ..........

- http://ibm.biz/power-isa3 (needs registration)
Status - POWER ISA 3.0

- 24 instructions queued in ppc-for-2.8
  - Modulo, Special compare
  - Vector absolute, compare, shift
- 24 instructions posted under review
  - Load/Store vector/scalar
  - Vector insert, extract, count trailing zeros
- 25 instructions under test

https://github.com/nikunjad/qemu/commits/p9-tcg
Challenges: POWER ISA 3.0

- Testing and verifying the instructions
  - Correctness
  - Repeatability
  - Negative test cases
- Can use:
  - kvm-unit-test
  - QEMU qtest
- Anton Blanchard’s instruction fuzzer
  - Compares physical CPU to QEMU emulation
PowerNV Platform
QEMU Avatar – System Emulation

- Invoked as machines (-machine pseries)
- Runs isolated in its own memory space
- Can be used to debug firmware, kernel, etc.
**pSeries Machine Emulation**

- Based on sPAPR standard
- Guest Emulation
- Hyper-Call based
- Para-virtualized guest
- Has been supported since a while
PowerNV Machine Emulation

- Emulate Bare Metal POWER platform
- Model Board Management controller (BMC)
- Supports Hypervisor mode
- Can run nested guest
- Assists in early bringup
- Support IPMI
Status: PowerNV

- Initiated by Benjamin Herrenschmidt
- Cédric Le Goater developing and pushing patches upstream
- PowerNV ~50 preparatory patches upstream
  - POWER8 Hypervisor SPRs
  - Split Instruction and Data caches
  - Batching TLB flushes
  - XICS rework to support new native model
PowerPC support for Multi-threaded TCG
System emulation - runs vCPUs serially

- Emulates multi-processor VM: but serially.
- vCPUs run in round robin mode
- Can’t emulate **concurrent behaviour**

PowerPC Emulation on X86

Credits: Alex Bennée
Towards Multithreaded TCG
QEMU Multi-threaded TCG

- QEMU for multi-core system bringup
- Community effort in progress
- Challenges: Atomics, Memory Barriers, TLB Flush, etc.

PowerPC Emulation on X86

Credits: Alex Bennée
Status – PPC support for MTTCG

- Based on MTTCG base patches and atomic cmpxchg
- Take iothread locks during hcalls
- Load with reservation (lwarx and family)
- Store conditional (stwcx. and family) with atomic cmpxchg micro-ops
- Booted VM with 4 vCPUs
- Ebizzy performance (ebizzy -S 300 -t 16)

Single-Threaded TCG
Single Core, 4 Threads

1514 records/s
real 300.00 s
user 222.74 s
sys 976.80 s

Multi-Threaded TCG
Single Core, 4 Threads

5415 records/s
real 300.00 s
user 420.01 s
sys 778.93 s

3.5x
Challenges: PPC support for MTTCG

- Still unstable
  - https://github.com/nikunjad/qemu/commits/pseries_mttcg_wip
- pSeries uses hcall for page table update/invalidate.
- Memory barriers
- Supporting PowerNV platform
Misc TCG Improvements

- Load/Store improvements – Benjamin Herrenschmidt
- Exception handling improvements – Benjamin Herrenschmidt
- Load/Store consolidation – Nikunj
Future

- Complete POWER ISA 3.0 support
- Upstreaming PowerNV in QEMU
- Future - POWER9 PowerNV support
- Stabilize MTTCG on POWER
- 128bit Load/Store support in TCG
- Testing mechanism for instructions
Credits

- Benjamin Herrenschmidt
- Cédric Le Goater
- Alexander Graf – QEMU’s Recompilation Engine
  https://dl.dropboxusercontent.com/u/8976842/TCG.pdf
- Alex Bennée – Towards Multithreaded TCG
  http://www.linux-kvm.org/images/c/cf/02x02-Alex_Benee-Towards_Multithreaded_TCG.pdf
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धन्यवाद

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