Moving s390 kvm-unit-tests up the stack

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Outline

- Current Usage
- Moving up and sideways?
- Initial changes
- Results
- Looking into the future
Current usage

Use Cases

- Testing architecture compliance
- Testing new facilities
- Regression testing
- Error reproduction
- Backport verification
Current usage

Why?

- Small
- Fast
- Dead simple to write

→ Perfect fit for tests without much configuration
Current usage
Environments

- KVM as (a) host
- **Development / Verification**
  - Manual single run (.s390x-run s390x/test.elf)
  - Manual full run (.run_tests.sh)
  - Mostly as hardware virtualized guests
- **CI**
  - Automated full run
  - Hardware and nested virtualization (VSIE)
  - Only on s390 hardware
Moving up and sideways
Moving up and sideways
Use Cases

- We have a **lot** of testing kernels
- Not all of them run on all hypervisors
- Most of them aren’t open-source:
  - Architecture compliance assurance kernels
  - Architecture fuzzing kernels
  - Hand written loops
  - More than one framework similar to KVM unit tests...
Moving up and sideways
Environments

• We have a **lot** of environments to run tests on
  - Hypervisors (LPAR, z/VM, KVM)
  - Emulation (TCG, zPDT)
  - Simulation (lots...)
    - Various firmware levels on hardware also affect instruction execution

• Emulation of a instruction can vary widely depending on environment
• For example z/VM handles page table changes way different than KVM
Moving up and sideways
Goal & expectations

• Let’s make kvm unit tests run on the maximum amount of environments!
  - We could uncover implementation differences in KVM
  - Some might lead us to implementation errors
  - In any case we will learn something when uncovering the reason of the difference

• Let’s push adoption of kvm unit tests to other teams!
  - Maybe we can replace some hand made tests with the unit test framework
  - The more people use the tests, the more bugs we can find and fix
Initial changes
Initial changes

Boot / IPL

- Unit tests were only bootable with direct ELF kernel boot
  - Very KVM specific
  - Other hypervisors expect 8 or 16 bytes of boot information at specific locations (PSW)
  - BSS is not cleared

- Unit tests expect 64 bit zArch architecture
  - Depending on age of machine that might work out
  - But we want to be able to run tests also on old machines

→ Added binary test generation
→ Added switch to zArch and 64 bit
Initial changes
SCLP Console

• SCLP (console) emulation IRQs:
  – QEMU delivers the IRQ synchronously to the end of the instruction emulation
  – No other s390 hypervisor does that
  – KVM unit tests didn’t wait for IRQ

• SCLP EBCDIC support:
  – Most s390 environments speak EBCDIC, KVM uses ASCII...

→ Added external sclp interrupt handling
→ Added EBCDIC output
Results
Results

SCLP Console

• SCLP identified as a low hanging target in initial changes
  - Immense architectural complexity
  - KVM / QEMU implementation was done to “make Linux guests work”

→ Extended testing showed LPAR did output different error codes than QEMU / KVM
  - Error priority was wrong
  - Boundary checks were missing
  - Size error reporting was done in a wrong way
Results
Firmware testing

- Firmware developers needed help testing new features on IBM Z 15 before release
- We ran KVM unit tests under KVM, LPAR and in simulation

- In simulation we were able to find errors easier than in LPAR
- Simulation lets us update firmware within seconds

→ Improved development speed
Results
STHYI & Storage Keys

- **STHYI:**
  - KVM was running in a previously untested environment
  - Input for STHYI emulation was different in that environment
  - A STHYI output field was wrongly flagged as valid but contained only zeroes
  - KVM fix

- **SKEYS**
  - Storage key test under z/VM showed fails
  - I had made false assumptions when writing the test
  - Test was fixed
Looking into the future
Looking into the future
Possible additions

• Being able to run under more environments is great
• But now we need automatic runs for those environments:
  – CI inclusion of the unit tests under LPAR, z/VM and nested KVM
  – CI inclusion of TCG
  – Early execution of the tests for pre-release HW and SW

• Integration of these environments is harder than on KVM
• LPAR for example needs sftp or disk boot for tests
• z/VM could use the virtual punch card reader
Looking into the future
Possible additions

- Nested / VSIE (WIP)
- IO
  - VIRTIO
  - PCI
  - Crypto
- SMP stressors
  - Signaling
  - Yielding
Looking into the future

Caveats

- We might want to or already added a library for new tests
- With additional library code comes complexity
- With complexity we lose the ease of use

→ We need to make sure that our changes do not affect our fellow developers
Go out and test!
Thank You