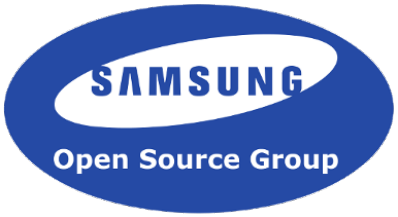

All about Kselftest

Linaro Connect - September 19 2018

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@ShuahKhan

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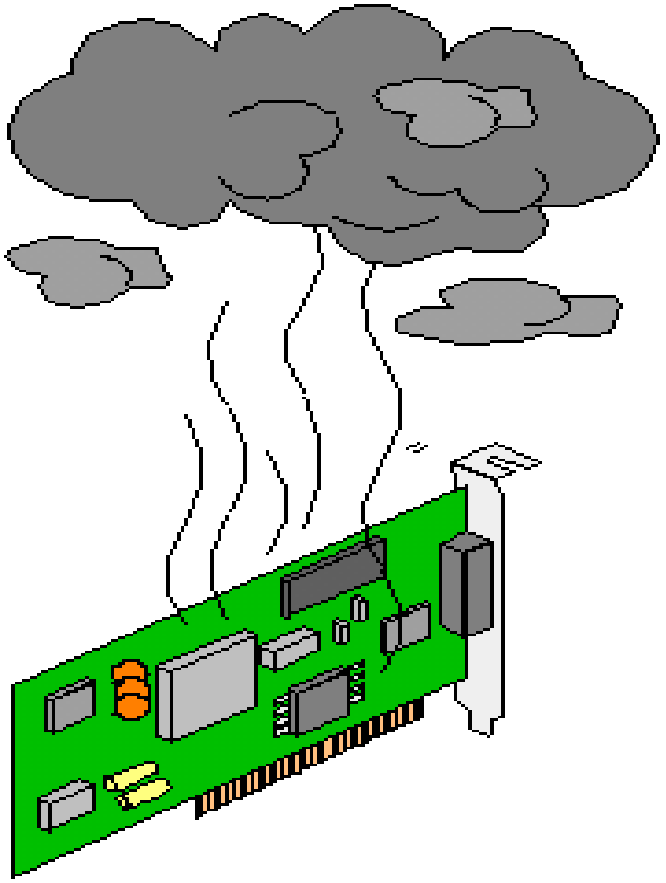
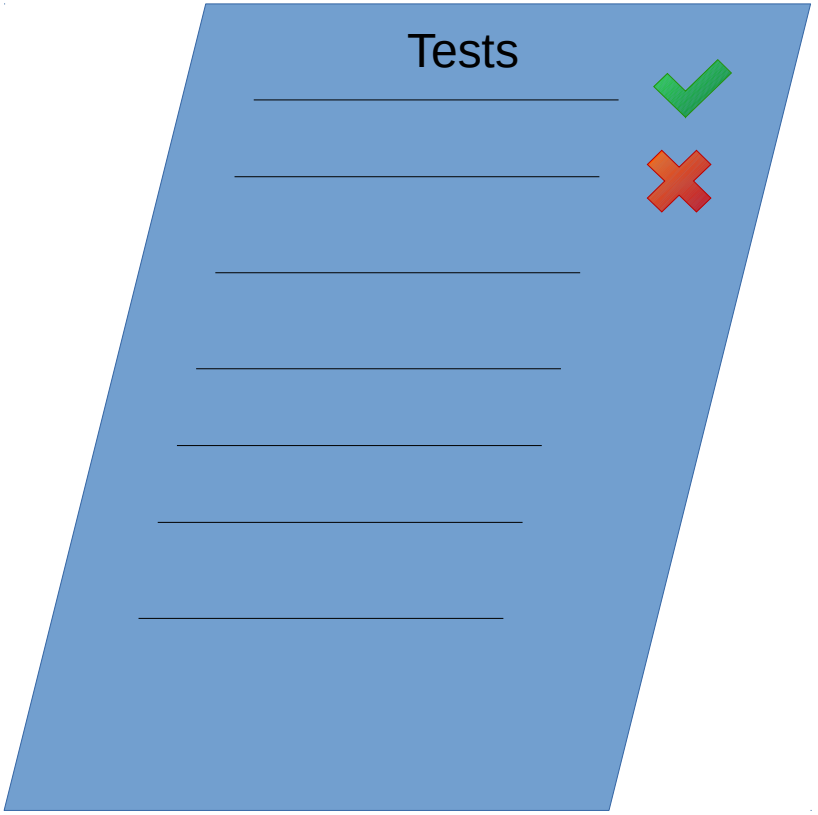
What is Kselftest?





Kselftest Evolution ...

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- Kernel developer/user regression test suite
- Authors: Kernel developers, users
- Users: Kernel developers, users, automated test rings (Kernel CI, 0-day)
- Gets run in stable and mainline release cycles

Kselftest Framework ...

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- Common infrastructure for:
  - Building, Running, reporting
- Makefile, lib.mk – abstracts common code for Makefile targets:
  - run_tests, install etc.
- kselftest.h – abstracts TAP13 reporting
- kselftest_harness.h – test harness used in some tests

Kselftest Tools ...

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- Install and packaging:
  - kselftest_install.sh
  - gen_kselftest_tar.sh

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Kselftest reporting results ...

Kselftest results ...

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- TAP13 compliant test reporting

TAP13 format ...

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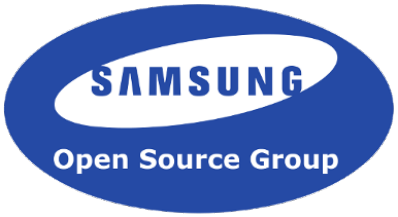
- Simple text based interface
- Aids in detecting run-to-run differences
- Makes it easier for external tools to parse the results
- TAP13 - Test Anything Protocol

Kselftest use-cases ...



Kselftest from same Linux 4.18 git repo

Linux 4.18 kernel

Kselftest from mainline latest

Stable release

Install and run Kselftest on a target

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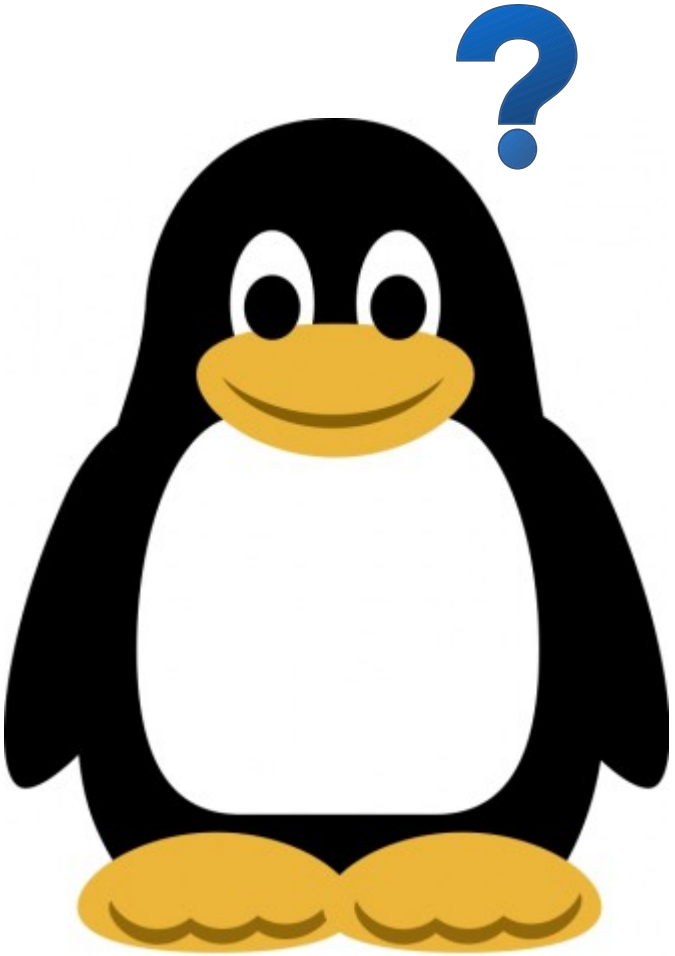
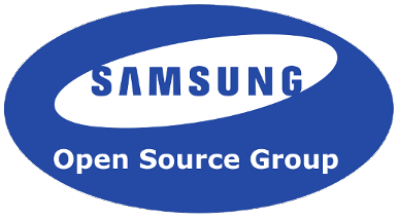
Kselftest source ...

Where are the tests?

- tools/testing/selftests



Kselftest git



- Kselftest git hosted on kernel.org
- Branches:
  - fixes: contains fixes to current rc's
  - next: contains content for upcoming merge window.
  - devel: contains experimental patches
- linux-kselftest git
- Patchwork - linux-kselftest

References ...

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- ../Documentation/dev-tools/kselftest.rst
- My blogs ...
  - Kselftest for Linux 4.14 to Add Support For Test Object Relocation
  - Kselftest for Linux 4.13 to Include TAP13
  - An Introduction to Testing the Linux Kernel with Kselftest

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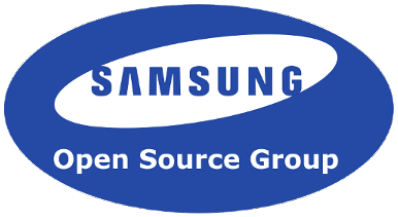
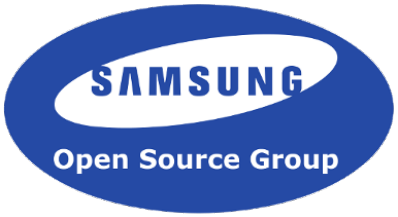
Building tests ...

Building tests ...



- make –silent -C tools/testing/selftests
  - Builds all tests
- make –silent -C tools/testing/selftests/timers
  - Builds timers tests

Building tests – cross compile ...



- make –silent -C ARCH=arm64 CROSS_COMPILE=aarch64-linux-gnu- tools/testing/selftests
  - Builds all tests
- make –silent -C ARCH=arm64 CROSS_COMPILE=aarch64-linux-gnu- tools/testing/selftests/timers
  - Builds timers tests

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Running tests ...

Running tests ...

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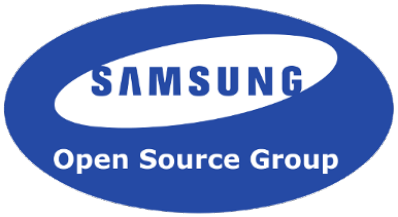
- make –silent kselftest
  - Kernel Makefile kselftest target - Builds and runs all TARGETS in tools/selftests/Makefile
- make –silent -C tools/testing/selftests run_tests
  - Builds and runs all TARGETS in tools/selftests/Makefile
- make –silent TARGETS=timers kselftest
  - Kernel Makefile kselftest target - Builds and runs all non-destructive tests in tools/selftests/timers
- Note that some tests require root privileges to run.

Running tests - TARGETS var ...



- Run tests for a single or multiple sub-systems using TARGETS variable
- Run tests for multiple sub-systems:
  - make –silent TARGETS="size timers" kselftest
- Run tests for a single sub-system:
  - make –silent TARGETS="size" kselftest

Running tests – make O=dir ...

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- make –silent O=/tmp/kselftest kselftest
  - Builds and runs all TARGETS in tools/selftests/Makefile
  - Executables are created in O=/tmp/kselftest/test directories
- make –silent TARGETS=timers O=/tmp/kselftest kselftest
  - Builds and runs all non-destructive tests in tools/selftests/timers
  - Executables are created in O=/tmp/kselftest/timers

Running individual tests ...

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- make –silent -C tools/testing/timers run_tests
- make –silent -C tools/testing/breakpoints run_tests
- make –silent -C tools/testing/kcmp run_tests

Run kcmp test ...

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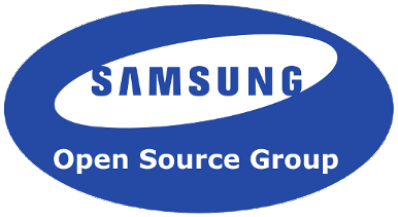
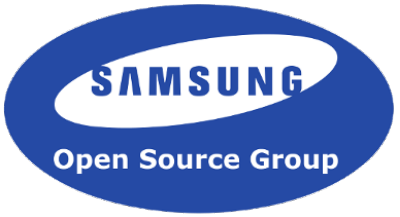
- make –silent TARGETS=kcmp kselftest
- make –silent TARGETS=kcmp O=/tmp/kselftest
- make –silent -C tools/testing/kcmp run_tests

Default vs. stress testing ...



- hotplug (cpu and memory), pstore tests support stress and default modes.
- Kselftest test runs them in default mode.

Stress test runs ...



- run the test on all hot-pluggable cpu and memory modules.
  - make –silent -C tools/testing/selftests run_hotplug
- pstore run crash test:
  - make –silent -C tools/testing/selftests run_pstore_crash
- timers
  - make –silent -C tools/testing/selftests/timers run_destructive_tests

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Test results ...

Detailed vs. summary ...

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- Kselftest reports detailed results in default mode
  - Includes messages from individual tests.
- Supports summary option for just the pass/fail/skip counts
  - make –silent summary=1 kselftest

Code Slide

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```
make --silent -C tools/testing/selftests/sync run_tests
TAP version 13
selftests: sync: sync_test
========================================
1..0 # Skipped: Run Sync test as root.
not ok 1..1 selftests: sync: sync_test [SKIP]
```

Code Slide

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```
make --silent -C tools/testing/selftests/sync/ run_tests summary=1
TAP version 13
selftests: sync: sync_test
========================================
not ok 1..1 selftests: sync: sync_test [SKIP]
```

Code Slide

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```
sudo make --silent -C tools/testing/selftests/sync run_tests
TAP version 13
selftests: sync: sync_test
=======================================
# [RUN]  Testing sync framework
ok 1 [RUN]    test_alloc_timeline
ok 2 [RUN]    test_alloc_fence
ok 3 [RUN]    test_alloc_fence_negative
ok 4 [RUN]    test_fence_one_timeline_wait
ok 5 [RUN]    test_fence_one_timeline_merge
ok 6 [RUN]    test_fence_merge_same_fence
ok 7 [RUN]    test_fence_multi_timeline_wait
ok 8 [RUN]    test_stress_two_threads_shared_timeline
ok 9 [RUN]    test_consumer_stress_multi_producer_single_consumer
ok 10 [RUN]  test_merge_stress_random_merge
Pass 10 Fail 0 Xfail 0 Xpass 0 Skip 0 Error 0
1..10
ok 1..1 selftests: sync: sync_test [PASS]
```

Code Slide

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```
make --silent -C lib/ run_tests
TAP version 13
selftests: lib: printf.sh
====================================
printf: module test_printf is not found [SKIP]
not ok 1..1 selftests: lib: printf.sh [SKIP]
selftests: lib: bitmap.sh
====================================
bitmap: module test_bitmap is not found [SKIP]
not ok 1..2 selftests: lib: bitmap.sh [SKIP]
selftests: lib: prime_numbers.sh
====================================
prime_numbers: module prime_numbers is not found [SKIP]
not ok 1..3 selftests: lib: prime_numbers.sh [SKIP]
```

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Installing tests ...

Kselftest install ...

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- Run kselftest install tool in tools/testing/selftests
  - cd tools/testing/selftests
  - ./kselftest_install.sh [install_location]
- Default install location:
  - tools/testing/selftests/kselftest
- Specify install location:
  - ./kselftest_install.sh /tmp

Kselftest install run ...

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- Kselftest install creates run_kselftest.sh
- Run tests:
  - cd install_dir
  - ./run_kselftest.sh

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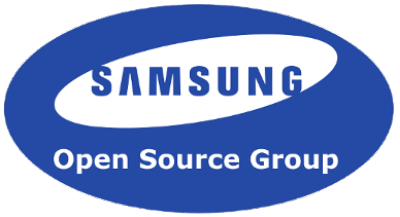
Kselftest package ...

Generating kselftest tar-ball ...



- Run generate tar tool in tools/testing/selftests
  - cd tools/testing/selftests
  - ./gen_kselftest_tar.sh [tar | targz | tarbz2 | tarxz]
- Tool supports uncompressed tar, gz, bz, and xz compression formats.
- Default is .gz

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Helpful Tips and Hints ...

Tips and hints ...

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- Use make –silent to silence makefile specific output.
- Running as root increases coverage.
- Beware of tests that could be disruptive – might require reboot.
- Running Kselftest from mainline kernel on Stable releases is recommended.

Tips and hints ...

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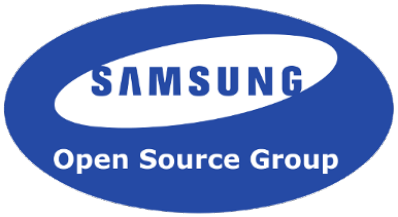
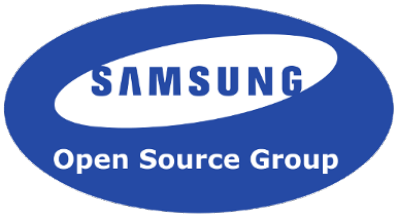
- Running tests from the latest release on stable releases:
  - Works.
  - Offers better regression testing.
- Comparing results from run to run helps detect regressions.
- Save old results and compare with the new rc results.

Contributing new tests



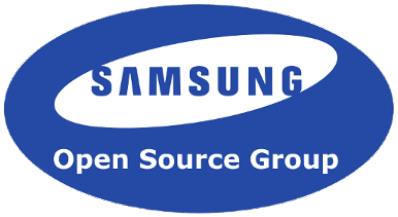
- Report pass and fail conditions.
- When run as non-root, try testing the parts that can be tested without being root.
- Ensure build doesn't break on any architecture.
- Ensure “make kselftest” doesn't break if feature is not supported.
- Ensure test exits gracefully with ksft_skip code when test can’t run due to unmet dependencies.

Contributing new tests



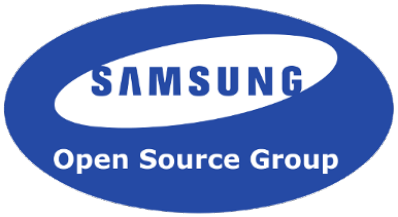
- Avoid regressions in Kselftest use-cases

Framework nuts and bolts ...



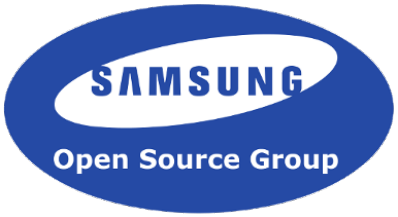
- How to hook into framework
  - Add a new target to selftests Makefile
  - Leverage common framework make targets: all, run_tests, install, emit_tests, clean etc.
  - Avoid overriding the common targets (unless it is absolutely necessary)
  - Add a “config” file for Kernel Config dependencies under the test directory. e.g: tools/testing/selftests/android/config

Framework - variables



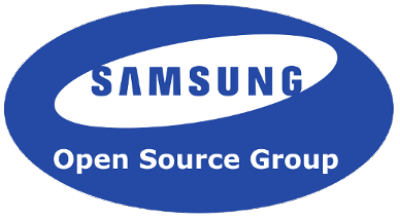
- TEST_GEN_PROGS – primary test
- TEST_CUSTOM_PROGS – primary test
- TEST_GEN_PROGS_EXTENDED - run by primary tests
- TEST_GEN_FILES - run by primary tests

Framework - variables



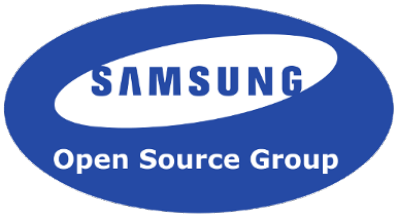
- TEST_PROGS – primary test shell scripts
- TEST_PROGS_EXTENDED – shell scripts run by primary tests
- TEST_FILES – data files used during test run

Framework – build



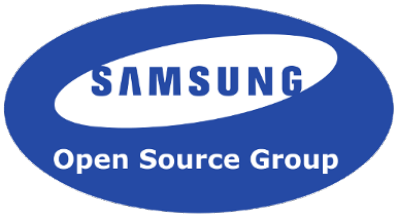
- What is built by lib.mk common compile rules?
  - TEST_GEN_PROGS
  - TEST_GEN_PROGS_EXTENDED
  - TEST_GEN_FILES

Framework – custom build



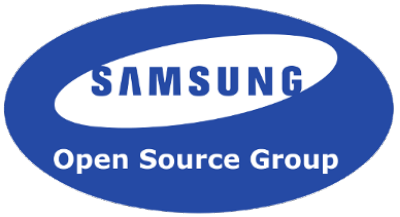
- Custom compile option - lib.mk doesn’t build these:
  - TEST_CUSTOM_PROGS

Framework - run_tests



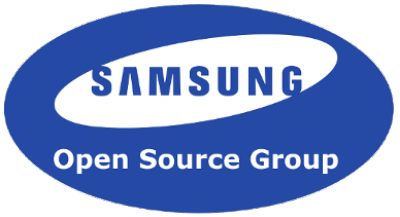
- What gets run by lib.mk run_tests?
  - TEST_GEN_PROGS
  - TEST_PROGS (shell scripts)
  - TEST_CUSTOM_PROGS
- In object relocation case, installs TEST_PROGS, TEST_PROGS_EXTENDED, TEST_FILES to the target directory.

Framework - install



- What gets installed by lib.mk run_tests?
  - TEST_GEN_PROGS
  - TEST_GEN_PROGS_EXTENDED
  - TEST_CUSTOM_PROGS
  - TEST_GEN_FILES
  - TEST_PROGS
  - TEST_PROGS_EXTENDED
  - TEST_FILES

Framework - install



- run_kselftest.sh gets generated via emit_tests target

What's new in Linux 4.18 ...

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- Skip handling …
  - Kselftest framework reports skipped tests
  - Individual tests detect and return ksft_skip to framework
  - Several new tests

Tests as of 4.18 ...

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- android
- bpf
- breakpoints
- capabilities
- cgroup
- cpufreq
- cpu-hotplug
- drivers
- efivarfs
- exec
- filesystems
- firmware
- ftrace
- futex
- gpio
- ia64 (not a run_tests TARGET)

Tests as of 4.18 ...

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- intel_pstate
- ipc
- kcmp
- kmod
- kvm
- lib
- locking
- media_tests
- membarrier
- memfd
- memory-hotplug
- mount
- mqueue
- net
- networking (not a run_tests TARGET)
- nsfs

Tests as of 4.18 ...

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- ntb (not a run_tests TARGET)
- powerpc
- prctl
- proc
- pstore
- ptp
- ptrace
- rcutorture (not a run_tests TARGET)
- rseq
- rtc
- seccomp
- sigaltstack
- size
- sparc64
- splice
- static_keys

Tests as of 4.18 ...

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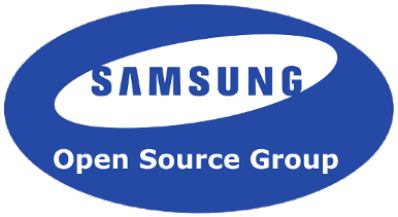
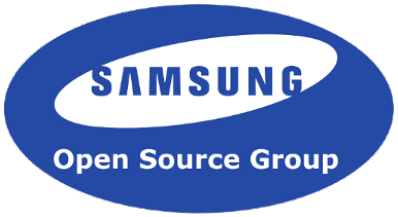
- sync
- sysctl
- tc-testing (not a run_tests TARGET)
- timers
- uevent
- user
- vDSO (not a run_tests TARGET)
- vm
- watchdog (not a run_tests TARGET)
- x86
- zram

Next Steps ...



- Run-time documentation
  - What does the test do?
- Improved skip reporting to include reasons:
  - destructive/intrusive/unsupported etc.

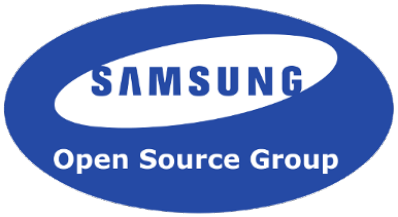
Next Steps ...



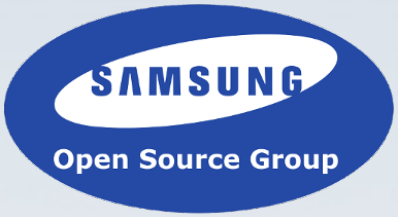
- Fix problems with O= relative paths don’t work
- Add support for pre-processor output from main Makefile (e.g: *.i)
- Consistent headers inclusion across tests

109 year old Alfie Date from Australia spends his time knitting sweaters for injured penguins!!

Help needed ...



- Review tests
- Run tests as a complement to existing tests
- Contribute new tests (driver area is weak)



Thank You!