Primer: Testing Your Embedded System - What is a ptest, Lava, Fuego, KernelCI and...?

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Overview / Scope
Frameworks to test your embedded...

- Yocto Project / ptest
- Fuego
- LAVA
- KernelCI
- labgrid
- r4d
- of course there are more

Image: public domain
Yocto Project's ptest
Name: ptest
Project: The Yocto Project (www.yoctoproject.org)
URL: https://wiki.yoctoproject.org/wiki/Ptest
TLDR: Packaging and Execution of 'make test' style testsuites on the DUT
ptest

- ptests are
  - sub-packages (foo-ptest)
  - a output format ("$RESULT: <testname>")
    - PASS/FAIL/SKIP
  - convention to call them ( run-patest script )
    - ptest-runner on the target to start them
from zlib_1.2.11.bb:
SRC_URI += "file://run-ptest"
inherit ptest
do_compile_ptest() {
  oe_runmake test
}
do_install_ptest() {
  install ${B}/Makefile   ${D}${PTEST_PATH}
  install ${B}/example    ${D}${PTEST_PATH}
  install ${B}/minigzip   ${D}${PTEST_PATH}
  install ${B}/examplesh  ${D}${PTEST_PATH}
  install ${B}/minigzipsh ${D}${PTEST_PATH}

  # Remove buildhost references...
  sed -i -e "s,--sysroot=${STAGING_DIR_TARGET},,g" \
    -e 's|${DEBUG_PREFIX_MAP}||g' \
    ${D}${PTEST_PATH}/Makefile
}
RDEPENDS_${PN}-ptest += "make"
To add package testing to your build, set the `DISTRO_FEATURES` and `EXTRA_IMAGE_FEATURES`:

- `DISTRO_FEATURES_append = "ptest"
- `EXTRA_IMAGE_FEATURES += "ptest-pkgs"`
ptest

+ supports cross-compilation of the test-suite ahead of time
+ well integrated into the bitbake procedures
+ can be combined with the "testimage" class
- large log output, full run takes quite long
- Result visualization needs postprocessing
• References:
  – https://wiki.yoctoproject.org/wiki/Ptest
  – http://bit.ly/2S5JNtA
Fuego – Fact sheet

- Name: Fuego
- Project: Fuego Test System
- URL: http://fuegotest.org/
- TLDR: automated testing of embedded targets from a host system with 100 pre-packaged tests
Fuego

- Fuego is
  - a Jenkins instance preloaded with
    - a lot of tests (ranging from LTP to )
    - scripts to compile the test for the target
    - upload and run on the target
    - grab the results and parse them
    - partially visualize the results
Fuego

+ Large set of tests out of the box !!
+ No prerequisites on the target beside ssh
+ Result parsers so graphing is possible

- Assumes board is local (ssh)
- Assumes board is deployed with filesystem
- Each board needs a separate configuration
Fuego

- References:
  - http://fuegotest.org/wiki/FrontPage
• **Name:** LAVA
• **Project:** LAVA Software Community Project
• **URL:** http://www.lavasoftware.org/

• **TLDR:** Device automation and test execution framework
LAVA

LAVA does

- manage deployment of the filesystem
- power-on & booting & test exec on the DUT
- support multiple devices of the same type
- have templates for >= 150 types of boards
- support devices to be remote (master/worker)
# All Devices

<table>
<thead>
<tr>
<th>Hostname</th>
<th>Worker Host</th>
<th>Device Type</th>
<th>state</th>
<th>Health</th>
<th>Submissions restricted to</th>
<th>Tags</th>
</tr>
</thead>
<tbody>
<tr>
<td>arndale01</td>
<td>dispatcher01.lavlab</td>
<td>arndale</td>
<td>Retired</td>
<td>Retired: no submissions possible.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>arndale02</td>
<td>dispatcher02.lavlab</td>
<td>arndale</td>
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<td></td>
</tr>
<tr>
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<td>dispatcher03.lavlab</td>
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<td></td>
</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>arndale05</td>
<td>dispatcher05.lavlab</td>
<td>arndale</td>
<td>Retired</td>
<td>Retired: no submissions possible.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b2260-01</td>
<td>dispatcher01.lavlab</td>
<td>b2260</td>
<td>Bad</td>
<td>Health check failed: no test jobs will be scheduled.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b2260-02</td>
<td>dispatcher02.lavlab</td>
<td>b2260</td>
<td>Idle</td>
<td>Good</td>
<td>group kernel-ci</td>
<td></td>
</tr>
<tr>
<td>beaglebone-black01</td>
<td>dispatcher01.lavlab</td>
<td>beaglebone-black</td>
<td>Idle</td>
<td>Good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>beaglebone-black02</td>
<td>dispatcher01.lavlab</td>
<td>beaglebone-black</td>
<td>Idle</td>
<td>Good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>beaglebone-black03</td>
<td>dispatcher02.lavlab</td>
<td>beaglebone-black</td>
<td>Idle</td>
<td>Good</td>
<td></td>
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<td>dispatcher02.lavlab</td>
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<td>beaglebone-black</td>
<td>Retired</td>
<td>Retired: no submissions possible.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Starting test lava.0_smoke-tests-lxc (1895547_1.8.4.1)
Enabling test definition pattern '([^<test_case_id>.]*\s+)?([^<result>(PASS|pass|FAIL|fail|SKIP|skip|UNKNOWN|unknown)]?([^<result>(PASS|pass|FAIL|fail|SKIP|skip|UNKNOWN|unknown)]?)'
Enabling test definition fixup {'FAIL': 'fail', 'PASS': 'pass', 'SKIP': 'skip', 'UNKNOWN': 'unknown'}

< LAVA_SIGNAL_STARTTC linux-linaro-ubuntu-pwd
/lava-1895547/0/tests/0_smoke-tests-lxc
< LAVA_SIGNAL_ENDTC linux-linaro-ubuntu-pwd
Received signal: <STARTTC> linux-linaro-ubuntu-pwd
Received signal: <ENDTC> linux-linaro-ubuntu-pwd
< LAVA_SIGNAL_TESTCASE TEST_CASE_ID=linux-linaro-ubuntu-pwd RESULT=pass
+ lava-test-case linux-linaro-ubuntu-uname --shell uname -a
Received signal: <TESTCASE> TEST_CASE_ID=linux-linaro-ubuntu-pwd RESULT=pass
case: linux-linaro-ubuntu-pwd
case_id: 33785876
definition: 0_smoke-tests-lxc
result: pass
< LAVA_SIGNAL_STARTTC linux-linaro-ubuntu-uname
Received signal: <STARTTC> linux-linaro-ubuntu-uname
Linux lxc-db410c-test-1895547 4.9.0-7-amd64 #1 SMP Debian 4.9.110-3+deb9u1 (2018-08-03) x86_64 GNU/Linux
< LAVA_SIGNAL_ENDTC linux-linaro-ubuntu-uname
Received signal: <ENDTC> linux-linaro-ubuntu-uname
< LAVA_SIGNAL_TESTCASE TEST_CASE_ID=linux-linaro-ubuntu-uname RESULT=pass
Received signal: <TESTCASE> TEST_CASE_ID=linux-linaro-ubuntu-uname RESULT=pass
case: linux-linaro-ubuntu-uname
case_id: 33785877
definition: 0_smoke-tests-lxc
result: pass
+ lava-test-case linux-linaro-ubuntu-vmstat --shell vmstat
< LAVA_SIGNAL_STARTTC linux-linaro-ubuntu-vmstat
Received signal: <STARTTC> linux-linaro-ubuntu-vmstat
procs memory swap io system cpu
  r b swpd free buff cache si so bi bo in cs us sy id wa st
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
LAVA

+ Multiple instances for each DUT-type
+ Master/Worker split allows multiple labs
+ Scales up
- Initial setup (improved by lava-docker)
- Less detailed parsing and presentation of results compared to Fuego
• References
  • lava documentation:
    • https://validation.linaro.org/static/docs/v2/
  • lava-docker:
    • https://github.com/kernelci/lava-docker
KernelCI
KernelCI

- Name: KernelCI
- Project: KernelCI project
- URL: http://kernelci.org
- TLDR: Test aggregation and visualization
KernelCI

- KernelCI
  - is a database and webfrontend
  - lets you upload results in json
  - visualizes the results
Details for Tree «mainline» - v4.19-rc8-109-gc7b70a641df2

- **SoC**: omap2
- **Tree**: mainline
- **Git branch**: master
- **Git describe**: v4.19-rc8-109-gc7b70a641df2
- **Git URL**: http://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git
- **Git commit**: c7b70a641df26002e8f26e2b8122fcbe6a1d815a1
- **Date**: 2018-10-19

**Unique boards**: 5
**Unique SoCs**: 1
**Unique defconfigs**: 3 out of 199

### Conflicting Boot Reports

Boot report conflicts have been detected.

These are likely not failures since other boot labs are reporting a successful state: they need to be reviewed.

<table>
<thead>
<tr>
<th>Architecture</th>
<th>Defconfig</th>
<th>Board</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>arm</td>
<td>multi_v7_defconfig</td>
<td>omap3-beagle-xm</td>
<td>2</td>
</tr>
</tbody>
</table>

### Boards Tested

- **Lab «lab-baylibre»**: (6 – 2 / 4 / 0) (1 architecture / 2 boards / 1 SoC / 3 defconfigs)

- **dra7-evm omap2plus_defconfig - arm**
+ can aggregate results from multiple sources
+ multiple tools can upload results (LAVA/Fuego)
- setup (but kernelci-docker)
- UI adaptations not easy
KernelCI

• References:
  • https://github.com/kernelci/kernelci-docker
  • https://github.com/kernelci/kernelci-admin
  • http://powerci.org
labgrid
labgrid

- **Name:** labgrid
- **Project:** labgrid-project
- **URL:** https://labgrid.readthedocs.io/en/latest/
- **TLDR:** abstraction of the hardware control layer needed for testing of embedded systems
labgrid

- labgrid lets you
  - expose the DUT resources
    - to $TESTTOOL
    - to $DEVELOPER
  in a unified manner
labgrid

+ allows automated and developer access to the DUTs
+ abstracts the HW specifics
- integration with testtools (Lava/Fuego)
- setup
• References:
  • https://labgrid.readthedocs.io/en/latest/
  • https://github.com/labgrid-project
r4d
r4d

- **Name:** r4d
- **Project:** ci-rt (Real-Time LINUX)
- **URL:** https://github.com/ci-rt/r4d
- **TLDR:** infrastructure for power-control and console access that plugs into libvirt
r4d

Name: r4d
Project: ci-rt (Real-Time LINUX)
URL: https://github.com/ci-rt/r4d
TLDR: infrastructure for power-control and console access that plugs into libvirt
$ r4dcfg --add-rack ci-rt-1 room209

$ r4dcfg --add-power ci-rt-1 pc8210 pc-ci-rt-1.lab.linutronix.de

$ r4dcfg --add-serial ci-rt-1 PS810 ds-ci-rt-1.lab.linutronix.de

$ r4dcfg --add-board ci-rt-1 6 seattle
r4d

- r4d
  - will manage power/serial
  - will allow remote control
  - plugs into libvirt (Jenkins!)
+ libvirt (!)
+ small
- only selected serial/power switches supported
- libvirt patches not yet upstream (but debian pkgs)
Other
For all I missed ...

- There are of course more / other frameworks
- in the time we could just not cover all
- please speak-up in the Q/A and lets discuss
Wrap-up and Q/A
Wrap-up

• Different frameworks have different strengths
• But what is important:
  • Collaboration
  • Test Results
    • Aggregation, Evaluation, Visualization
  • More and more boards → LABs
• Questions ?
• Notes ?
End

- Thank you for joining!