Open Source QA - What will it take to get to the next level?

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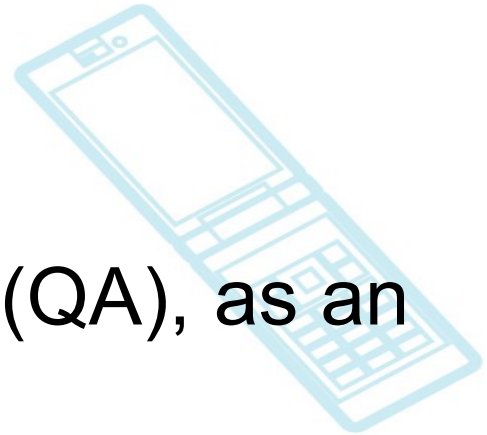
Problem

- We can do better with Linux Quality Assurance (QA), as an industry and community

~~Problem~~ Opportunity

- We can do better with Linux QA, as an industry and community
- Not saying we're doing something wrong
  - Lots of great projects and efforts
- I think that we're missing opportunities to do better

Outline

Attributes of Open Source
Status of Open Source QA
Obstacles to Sharing
Solutions and Next Steps

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Attributes of Open Source

- Openly available
- Easy to contribute to
- Generalized
  - Applies to a broad range of uses
- Has a development community
- Community effect
  - Build on the work of others
  - As contributor pool increases, better ideas are found
  - Feedback loops
- The essence of Open Source is “exchange” or sharing

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Status of Open Source QA

- Software Landscape
  - Tools
  - Tests
- Hardware
- Industry QA efforts
  - In-house
  - Ad-hoc solutions
- Result = lots of unshared stuff

What tools in QA are Open Source

- Systems:
  - Buildbot, Jenkins, LAVA, LKFT, Fuego, KernelCI, CKI
- Lab/board management: LAVA, Labgrid, SLAV, libvirt, r4d
- Harnesses: pytest, ptest (Yocto Project), ktest
- Services: 0-day, Phoronix, CKI?
- Tests suites: LTP, kselftest
- Tests
  - See next page

Open Source tests

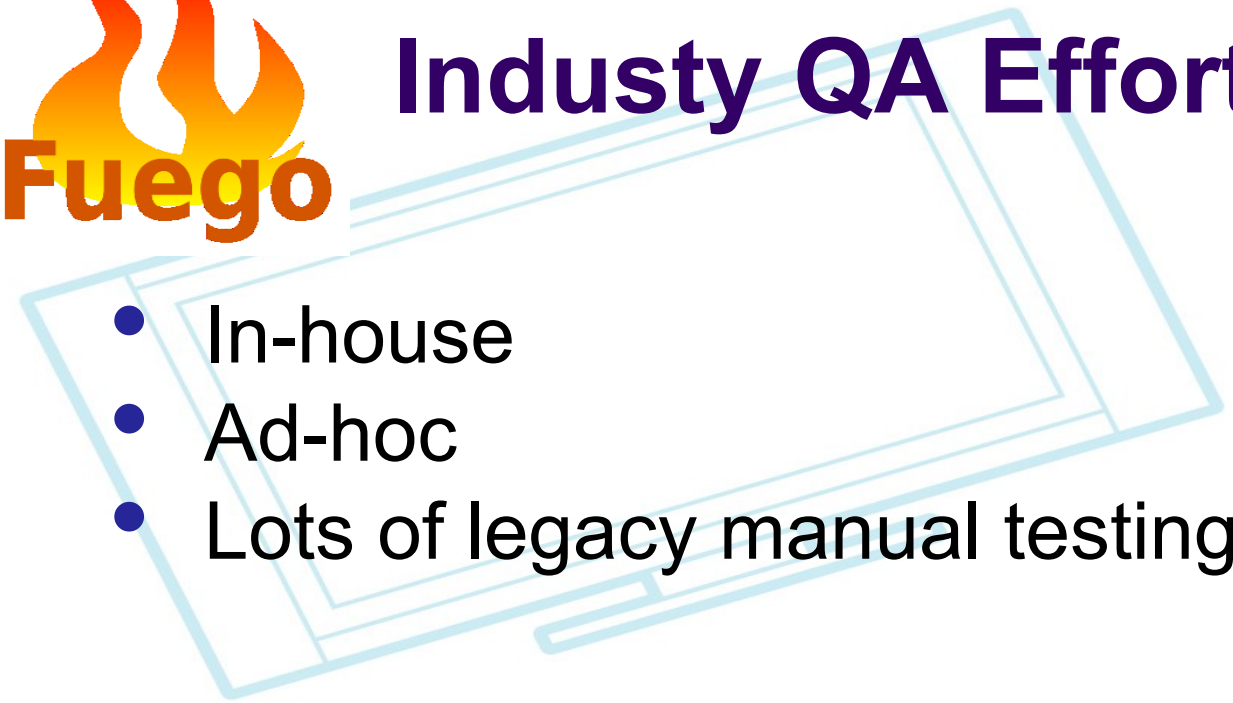
- kernel testing
  - LTP – actually multiple test suites
  - sysbench, unixbench, hackbench, dhrystone, etc.
- system testing:
  - lsb-test, yocto ptest, debian autopkgtest
- filesystem – iozone, xfstest, bonnie, dbench
- realtime – cyclictest, pitest
- network – iperf, netperf
- security – vuls
- vertical tests – Android Compatibility Test Suite (CTS)?

Test hardware

- Some off-the shelf components:
  - PDUs (power distribution units)
  - Commercial multi-function boards: ACME
  - Video capture: Numato Opsis, Lenking LKV373a HDMI extender
- Some open hardware:
  - Multi-function boards: ACME, MuxPi, Sony debug board
  - Analyzers: Sigrok-based boards (eg. BeagleLogic)
- Different labs use different combinations of things
  - Often manually manage the hardware
- Companies have lots of in-house custom hardware solutions
  - e.g. Sony debug board has custom USB switching capability

Industy QA Efforts

- In-house
- Ad-hoc
- Lots of legacy manual testing



Unshared

- Many QA artifacts are not even tangible
  - Knowledge specific to the QA objectives
    - What tests to run?
    - Dependencies
    - Expected values – How to interpret results?
    - What metrics are important?
- Hardware testing is extremely silo-ed
  - Each test harness is different
- Exceptions:
  - KernelCI is defacto lab standard for kernel build/boot testing
    - They have something like 10 labs now
  - Vendor-provided: Android compliance testing (CTS)

An analogy:

Today's QA software = Yesterday's RTOS

Embedded OS landscape 20 years ago

- Fragmented
- In-house
- Ad-hoc
- Unshared
- Some exceptions:
  - Commercial offerings: VxWorks, pSOS
  - Regional industry standard: µItron

Open Source Software vs. Testing

- Samsung, LG, Sony all produce TV sets
- 80% of software stacks in TVs are Open Source
- What percentage of QA software is Open Source?
- Which of these companies:
  - Contribute to Open Source test projects?
  - Share their TV functionality tests?

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Obstacles to sharing

- Custom hardware
- Unique lab configurations
- Dependency on test framework (different APIs)
- Unique software
- Different product use cases
- Different testing goals
- Organizational inertia
- Licensing

Fragmentation of Test hardware API

- No consistent API for lab hardware with similar functionality
- Example: PDUs
  - There are many different ways to control power to a board in a lab
    - Serial-controlled power devices
      - APC devices
      - YKush
    - Network-controlled power switches
      - Digital Loggers web power switch
      - Devantech devices
      - Custom-built network relays
    - USB-controlled power devices
      - Sony debug board
      - PowerUSB
- Example: power measurement hardware
  - There is no standard

Specialization: Lab configuration

- Even with off-the-shelf hardware, labs use different hardware
  - Everyone seems to have a different PDU (Power Distribution Unit)
  - Different external power measurement devices
- Labs mix-and-match equipment
- Each lab ends up with unique combinations
- Tests written for one lab don't work in another

Specialization: Test Framework

- Different test frameworks have different APIs, test models

	Fuego	LAVA	Yocto Project
test driven from	host	target	target
target lifecycle	multiple tests per boot	re-provision every test	n/a
languages	host: bash, python, yaml, json target: sh	sh, awk, yaml	python
APIs	*X*	*Y*	*Z*
dependencies	permission, kconfig, mem, storage	permission, packages	packages

Specialization: Unique software

- Vendors have different software stacks above their Open Source layers
  - e.g. Samsung's TV stack doesn't look like Sony's TV stack
- More and more software is open source, and therefore common
  - For many products, 80% of the software is Open Source (estimated)
- Lots of legacy test software
- Target distribution may have different installed software
  - e.g. may or may not have 'expect', 'awk', 'sed', or even 'grep'.

Fragmentation: Different use cases

- Different products have different testing needs
  - Ex: Enterprise database server vs. mobile phone
- Big difference in hardware and usage, but...
- Both need to test:
  - syscalls
  - IPC performance
  - filesystems
  - networking
- Can they use the same tests?

Fragmentation: Different test goals

- Developers and testers with different roles:
  - System software developers (Kernel developers)
  - Distribution developers (e.g. AGL, Android, CIP, other stacks)
  - Product developers (hardware/software integrators)
- Testing to:
  - Find software regressions
  - Find integration problems
  - Meet criteria for shipping
- Interested in different parts of the system
- Different threshold of sensitivity to bugs
- Focus on local remediation vs. upstream reporting and fixing

Organizational inertia

- QA department is not yet interacting with OSS community
  - Some companies still working to have their software teams learn to interact with OSS communities
- There's a learning curve going from using to contributing
- Testing has not historically been an open activity
  - Concern that tests reveal product info prematurely

Licensing

- License may not require sharing
- Requirement to publish is not invoked
  - QA software is not distributed by a company
  - There's no trigger for license publication requirement

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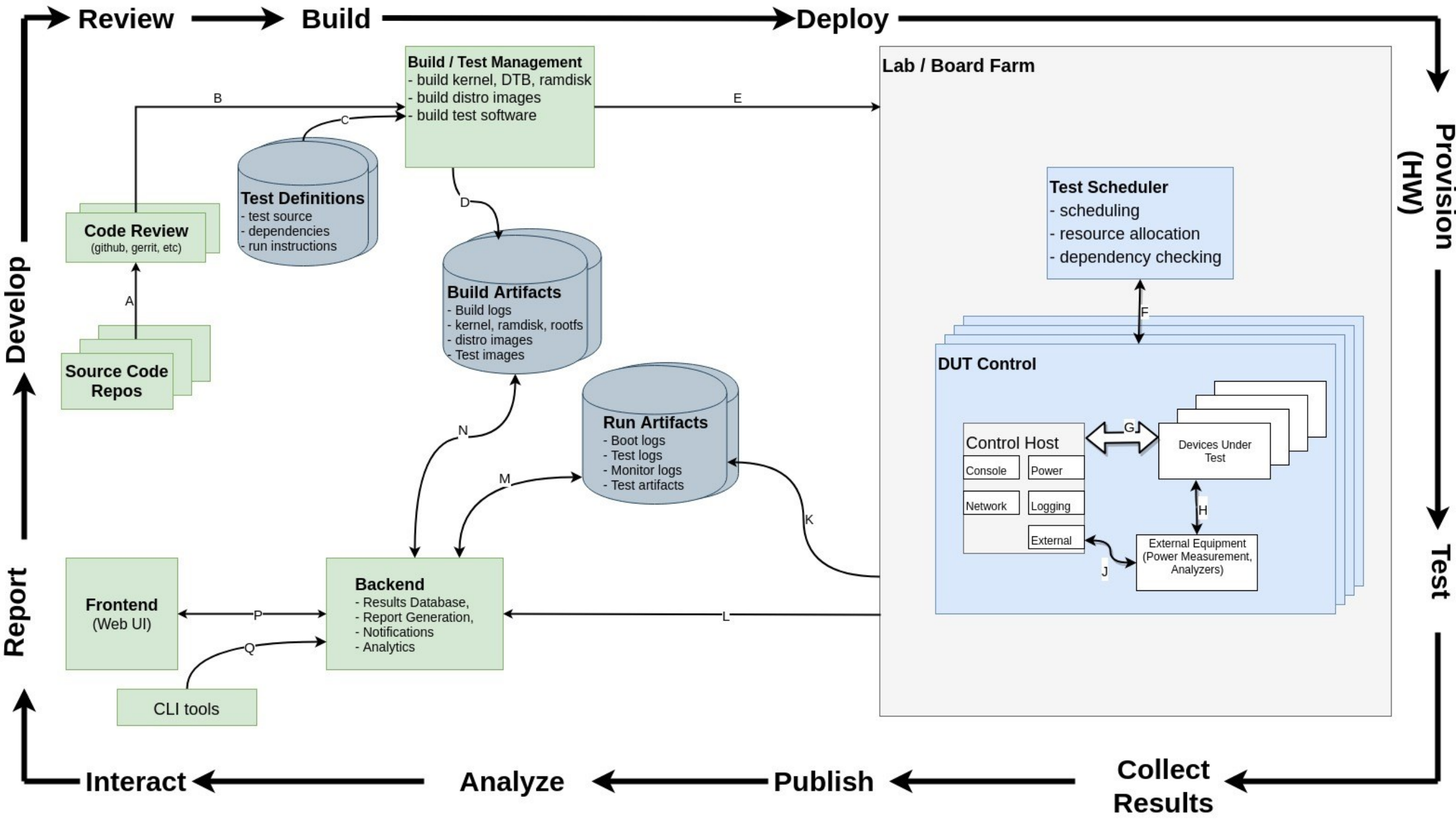
Solutions

- Create objects that can be shared
  - Common CI reference model
  - Standardize test definitions
    - Common APIs
    - Common languages
  - Standardize APIs to lab hardware
- Create ways to share dis-similar objects
  - Translation layers or converters
- Create places where objects can be shared
- Support test customization

Common CI reference model

- Like protocol stack
  - Define discrete entities and interfaces
- Organizes operations and responsibilities into layers or modules
- Standard interfaces allow for interchangeable implementations
- At recent Automated Testing Summit, we produced a draft reference model


Review
Build
Deploy
Provision (HW)
Test
Collect Results
Publish
Analyze
Interact
Report
Develop
Build / Test Management
- build kernel, DTB, ramdisk
- build distro images
- build test software
Test Definitions
- test source
- dependencies
- run instructions
Code Review
(github, gerrit, etc)
Source Code Repos
Build Artifacts
- Build logs
- kernel, ramdisk, rootfs
- distro images
- Test images
Run Artifacts
- Boot logs
- Test logs
- Monitor logs
- Test artifacts
Lab / Board Farm
Test Scheduler
- scheduling
- resource allocation
- dependency checking
DUT Control
Control Host
Console
Power
Network
Logging
External
Devices Under Test
External Equipment (Power Measurement, Analyzers)
Backend
- Results Database,
- Report Generation,
- Notifications
- Analytics
Frontend
(Web UI)
CLI tools
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q

Sharable objects

- Create sharable objects
  - Test definitions usable in multiple frameworks
  - Sharable pass criteria
  - Sharable results
    - In a format that would be mineable

Test definitions

- Meta-data and instructions for a running a test
- Elements:
  - Pre-requisites and dependencies
  - Information about a test
  - Instructions for test execution
  - Customizations (knobs and dials)
  - Output parsing or conversion
  - Results analysis
  - Visualization control

Define standards for lab environment

- Board control (power, bus control, multiplexing)
- Multi-machine tests (servers, peers, simulators)
- External hardware (monitors, analyzers)
- API above and below lab controller entities
- Goal is to create ecosystems of plug-and-play modules

Place to share objects

- Project neutral site for collecting/disseminating objects
- or...
- Agreement to consolidate tests in one repository
- Possible uses:
  - Peer-to-peer test sharing
    - Eliminate gatekeeping for collaboration in testing community
  - Allow customization and enhancement of ad-hoc tests
    - For diagnosing problems
  - Apply tests to board that have hardware needed for test
    - Give access to developer who does not have hardware

Test customization

- Allow generalization, by making tests customizable
- Ways to make a test customizable:
  - Skiplists (control of testcases)
    - Use dependencies to automate
  - Test variables
  - Expected values/Test outcomes (pass criteria)
    - Localized results interpretation
  - Data files for different use cases
    - e.g. filesystem workload - For example, dbench supports custom "loadfiles" which specify the set of operations to perform
- Preferably do automatic customization
  - e.g. Set benchmark value threshold based on previous results

Next steps

- Creating standards
- Cross-system interaction (interchange)
- Experimentation
- Continued communications
  - More face-to-face meetings

Next steps – Standards

- At ATS 2018:
  - Agreed to use pdudaemon as standard Power controller
    - Is the first lab API to be standardized
      - There is work in progress to document and standardize the API
- Working towards standardizing:
  - Test definitions
  - Results formats
  - Backend API – KernelCI vs. Squad
  - Board management API
    - pdudaemon is just a start

Next steps – Interchange

- Prototyping sharing of results
  - Between Fuego and Linaro projects (LAVA, LKFT, Squad)
    - Unified results format
  - Linaro proposal for shared results repository using Google BigQuery
    - See https://lists.yoctoproject.org/pipermail/automated-testing/2019-May/000417.html
- Prototyping cross-use of tests
  - Between Fuego and Linaro projects
    - Fuego running Linaro tests
    - LAVA running Fuego tests
  - Next target:
    - ptest (better integration), CKI?, PTS?, 0-day?

Next steps - Experimentation

- There are issues for which an approach has yet to be decided:
  - How to integrate different systems?
    - At the source level (if so, using what languages?)
    - As binary package level, containerized commands, network services?
  - Where does data live?
    - Does the user need to store information in multiple frameworks?
    - In multiple formats?
  - How to break apart currently monolithic systems?
  - What is the API between components
- Need to experiment with integration to see what approaches work

Next steps – More communication

- Using the Automated Testing mailing list
  - https://lists.yoctoproject.org/listinfo/automated-testing
- There is now a monthly call to discuss subjects
  - See https://elinux.org/Automated_Testing#Conference_call
- Face-to-face meetings
  - Plumbers “Testing and Fuzzing microconference”
    - September, Lisbon, Portugal
  - RedHat CKI Hackfest
    - September, Lisbon, Portugal
  - Automated Testing Summit 2019
    - October, Lyon, France (CFP is still open)

Vision – super high level

Do for testing
what open source
has done for coding

Promote the sharing of automated CI components, artifacts, and results, the way code is shared now

- Allow components to specialize
- Support collaboration between projects

Thanks

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