LINUTRONIX

Continuous Integration: Jenkins, Libvirt & Real Hardware

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ELCE 2017 - Prague

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What's next?

1. Overview
2. The challenge: control real HW
3. Solution - r4d
4. Libvirt connection
5. Jenkins
6. Future extensions

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1. Overview

- ★ RTL project
- ★ CI-RT
- ★ Jenkins
- ★ Libvirt

RTL project

- Linuxfoundation collaborative project
- first announced in October 2015
- funds Linux Kernel PREEMPT_RT patch set ...
  - mainlining
  - maintenance
  - documentation
    (new RT Wiki: https://wiki.linuxfoundation.org/realtime/start)
  - establishing community - required for long term maintenance
  - CI-RT

CI-RT

- PREEMPT_RT Linux kernel tests on different machines (HW & VM)
  - Power control machines
  - Retrieve bootlog even if kernel crashes and doesn't boot into user-space
  - Schedule different tests on a machine

Jenkins

- De facto standard for CI
- Is able to distribute tests on different machines

available Jenkins plugins to control machines via

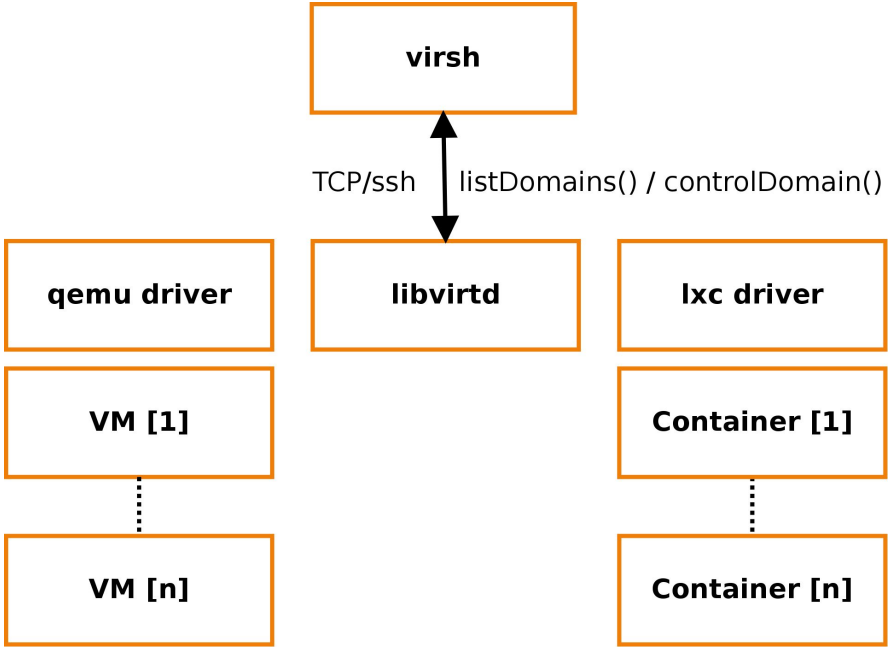
- docker
- libvirt

Libvirt

- Supports different hypervisors (via drivers)
- Standardized interface to enumerate and control VMs
- Graphical frontends like 'virt-manager' and CLI like 'virsh' available

BUT:

Can't interact with real HW



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2. The challenge

- ★ We want to use ....
- ★ Vision

M

We want to use … libvirt

- Restart node on kernel-crash
- Tests on VM behave like tests on real HW
- Nodes that are not used are powered off

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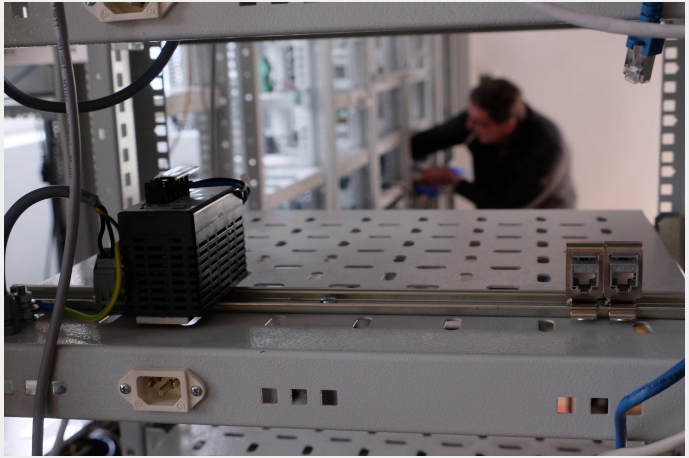
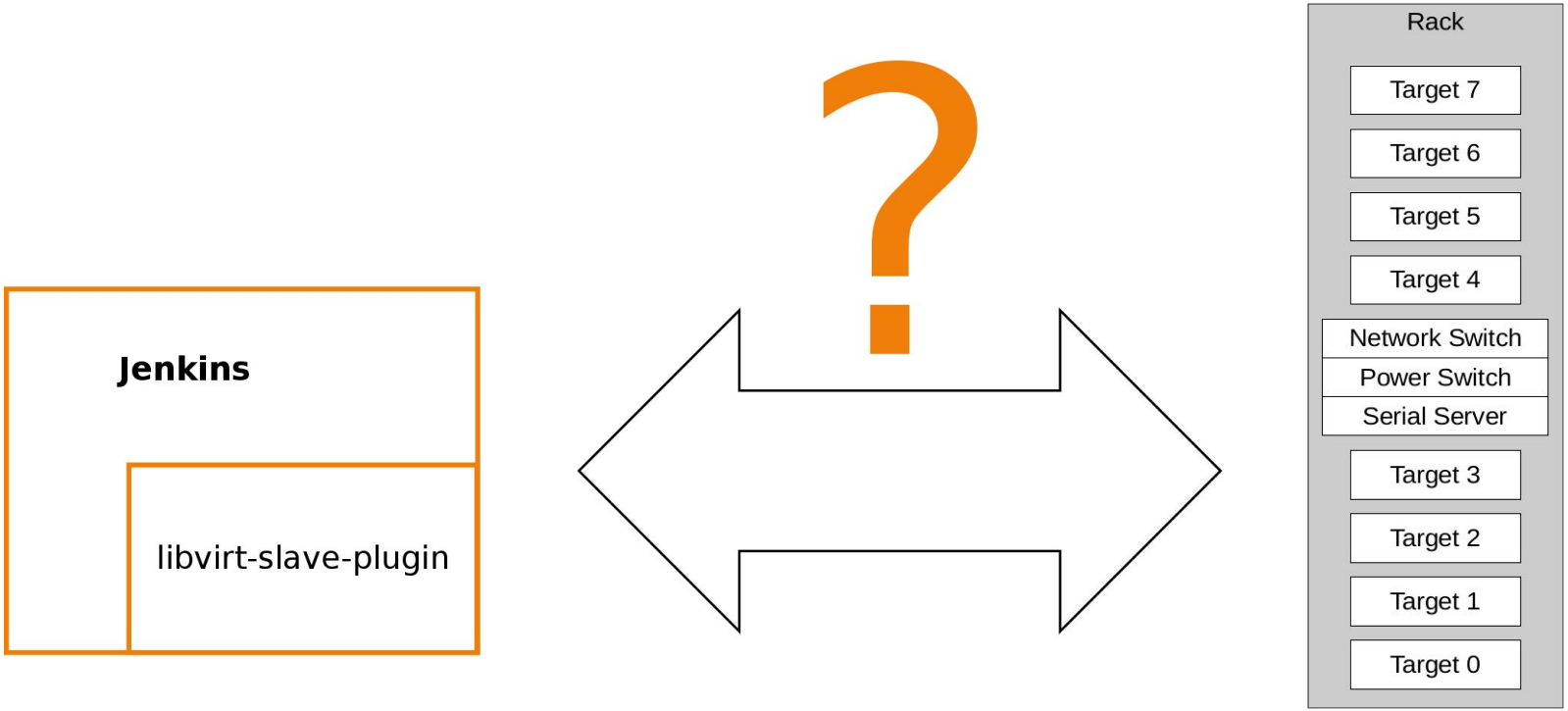
We want to use … existing racks

- 19” industrial rack with 8 slots
- 8 port power control switch
- 8 port serial device server
- network switch



Vision


Jenkins
libvirt-slave-plugin
?
Rack
Target 7
Target 6
Target 5
Target 4
Network Switch
Power Switch
Serial Server
Target 3
Target 2
Target 1
Target 0

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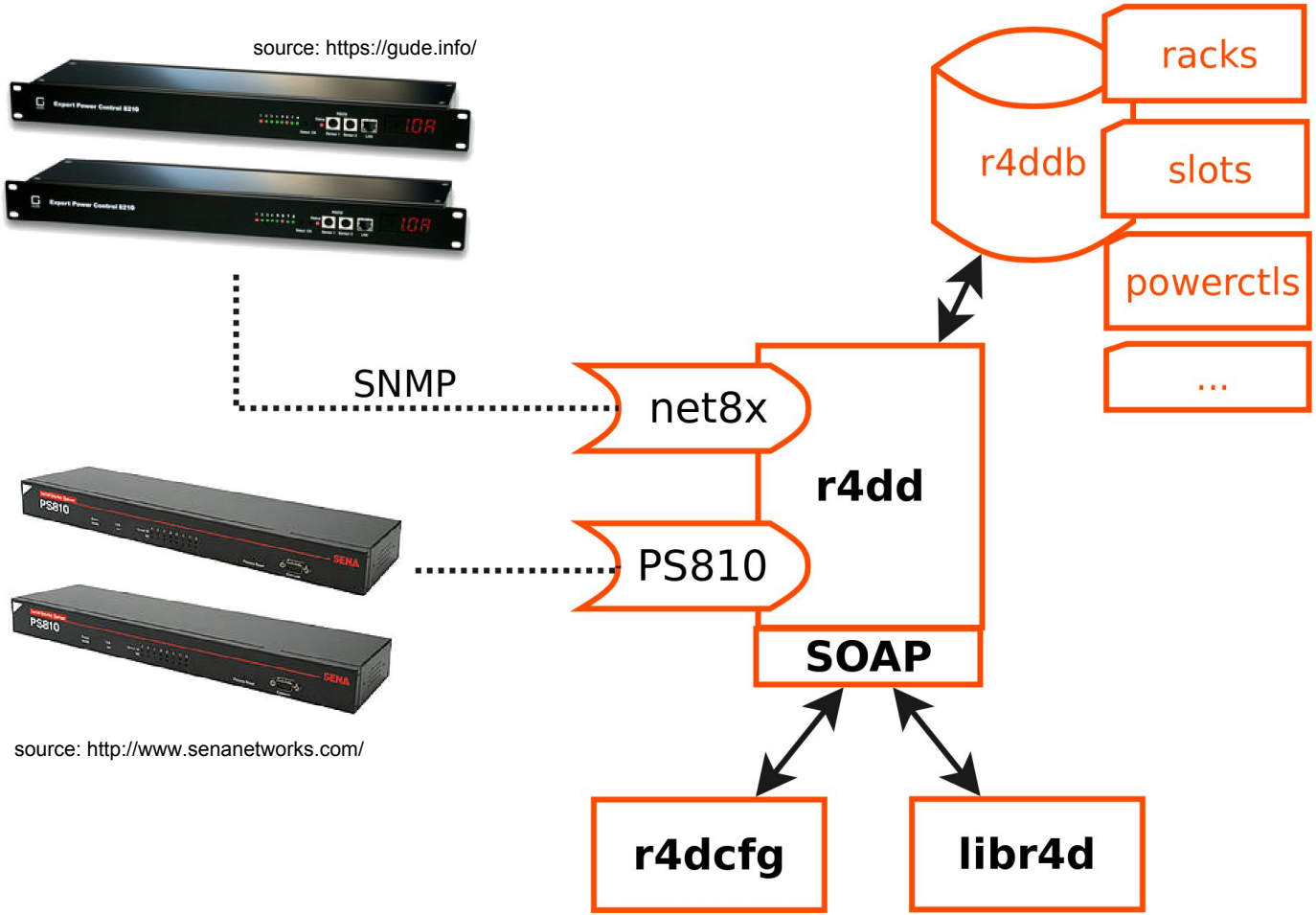
3. Solution - r4d

- ★ Architecture
- ★ Features
- ★ Usage

Architecture



Features

- multiple DB backends supported (sqlalchemy)
- Plugin interface to support different power controls and serial device servers
- CLI tool to ...
    - add new racks, power-control, serial device servers and boards
    - move board into another rack/slot
    - switch board on/off
    - dump whole DB or only parts of it

Usage - basic setup

```
$ 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
```

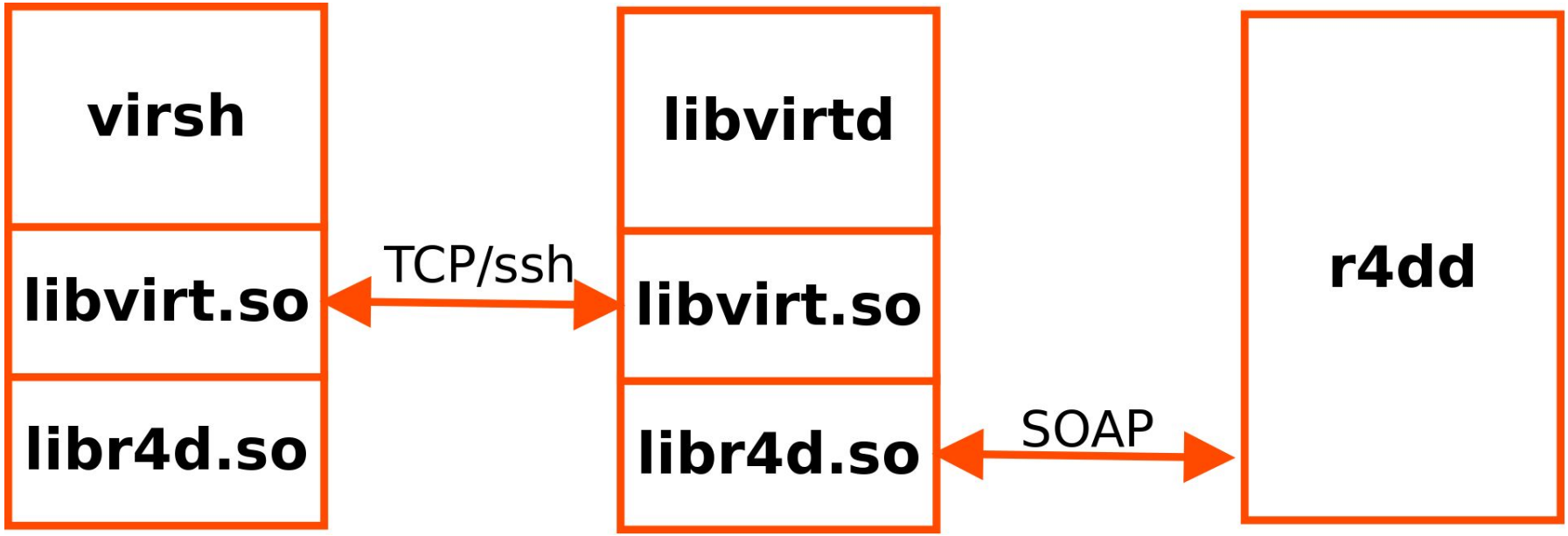
Usage - list-boards

```
$ r4dcfg --list-boards
ID[1]: guycGj4ypFe+ZpW+3Hr1eQ==
        Name: iommu     Rack: ci-rt-1   Port: 2 serial: ds-ci-rt-1.lab.linutronix.de:7002
ID[1]: gPgmvDJ1p16BVs3FUBTOwA==
        Name: phyflex-imx6      Rack: ci-rt-1   Port: 3 serial: ds-ci-rt-1.lab.linutronix.de:7003
ID[1]: 65aIrZAWGlCnyD6NDRU93g==
        Name: juno64    Rack: ci-rt-1   Port: 4 serial: ds-ci-rt-1.lab.linutronix.de:7004
ID[1]: PSWttE4u2lOkIufpknSSXQ==
        Name: roborio   Rack: ci-rt-1   Port: 5 serial: ds-ci-rt-1.lab.linutronix.de:7005
ID[1]: rubBbUBGeVmvD2V/V2SJPw==
        Name: seattle   Rack: ci-rt-1   Port: 6 serial: ds-ci-rt-1.lab.linutronix.de:7006
```

4. Libvirt connection

- ★ Architecture
- ★ Code changes
- ★ Usage

Architecture



Code changes

```
$ diffstat add-r4d-support.patch
 configure.ac                  |   28 +
 include/libvirt/virterror.h   |    1
 src/Makefile.am               |   23 +
 src/libvirt.c                 |    7
 src/libvirt_r4d.syms          |    8
 src/r4d/r4d_driver.c          |  642 ++++++++++++++++++++++++++++++++++++++++++++
 src/r4d/r4d_driver.h          |   37 ++
 src/util/virerror.c           |    3
 8 files changed, 748 insertions(+), 1 deletion(-)
```

Code changes

r4d_driver.c

r4dConnectOpen()	open connection to r4dd 'hypervisor'
r4dConnectClose()	close connection and drop handle
r4dConnectNumOfDefinedDomains()	get number of boards configured in r4d
r4dConnectListDefinedDomains()	list all boards configured in r4d
r4dDomainCreate()	power a board
r4dDomainDestroy()	power off a board
r4dDomainGetState()	returns current power state of a board
r4dDomainOpenConsole()	open a serial console stream

Usage

```
manut@castellum:~$ virsh -c r4d://localhost
Welcome to virsh, the virtualization interactive terminal.

Type:  'help' for help with commands
       'quit' to quit

virsh # list
 Id    Name                           State
----------------------------------------------------
 0     iommu                          running
 1     phyflex-imx6                   running
 2     juno64                         running
 3     roborio                        running
 4     seattle                        running

virsh #
```

```
manut@castellum:~$ virsh -c r4d://localhost console --domain roborio
Connected to domain roborio
Escape character is ^]
Debian GNU/Linux 8 roborio ttyS0

roborio login:
```

5. Jenkins

- ★ Code changes
- ★ Add a new node
- ★ Control the node

Code changes

Entry for hypervisor in libvirt-slave-plugin:

```
src/main/java/hudson/plugins/libvirt/Hypervisor.java
@@ -503,6 +503,7 @@ public String getUsername() {
             types.add("LXC+SSH");
             types.add("BHYVE");
             types.add("BHYVE+SSH");
+            types.add("R4D");
             return types;
         }
     }
```

Jenkins ▸ configuration

Cloud

Hypervisor (via libvirt)

Hypervisor Type: R4D

Hypervisor Host: varus

Username:

SSH Port: 8008

URI parameters:

Concurrent Slaves Capacity: 1

Use Native Java libvirt client ☐

Native Credentials: jenkins (jenkins@servus by password) | Add

Test Connection

Delete cloud

Add a new hypervisor

Hypervisor (via libvirt)

Hypervisor Type: QEMU+SSH

Save | Apply

Add a new node

Jenkins | search | Manuel Traut | log out

Jenkins ▸ Nodes ▸ phyflex-imx6

- Back to List
- Status
- Delete Agent
- **Configure**
- Build History
- Load Statistics
- Script Console
- Log
- System Information
- Disconnect

Build Executor Status

1 Idle

Name	phyflex-imx6
Hypervisor	r4d://localhost:8008
Virtual Machine	roborio
Revert Snapshot	
Before Job Snap	
Description	
Startup Idle	60
Times to Retry Startup	5
# of executors	1
Remote FS root	/home/jenkins
Labels	phyflex-imx6
Shutdown Method	destroy
Reboot this slave after each build	☐
Usage	Only build jobs with label expressions matching this node

- iommu
- juno64
- phyflex-imx6
- roborio
- seattle

Save

Add a new node

Jenkins ▸ Nodes ▸ phyflex-imx6

Remote FS root: /home/jenkins

Labels: phyflex-imx6

Shutdown Method: destroy

Reboot this slave after each build ☐

Usage: Only build jobs with label expressions matching this node

Secondary launch method: Launch slave agents on Unix machines via SSH

Host: phyflex-imx6

Credentials: jenkins | Add

Advanced...

Availability: Take this agent online when in demand, and offline when idle

In demand delay: 1

Idle delay: 1

Node Properties

☐ Environment variables

☐ Prepare jobs environment

☐ Tool Locations

Save

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Control node

```
[..]

try {
    timeout(time: 10, unit: 'MINUTES') {
        node("phyflex-imx6") {
            sh "cyclictest.sh"
        }
    }
}
catch(err) {
    println("Timeout for running cyclictest reached")
    currentBuild.result = "UNSTABLE"
}

[..]
```

Jenkins ▸ kernel ▸ utilities ▸ cyclictest-runner ▸ #260

See Fingerprints

Build Artifacts As Maven Repository

Previous Build

Next Build

Timestamps View as plain text

- (•) System clock time
  - [ ] Use browser timezone
- ( ) Elapsed time
- ( ) None

```
build number 84
19:13:55      originally caused by:
19:13:55       Started by upstream project "kernel/compiletest" build number 84
19:13:55       originally caused by:
19:13:55        Started by upstream project "kernel/CI-RT-scheduler" build number 85
19:13:55        originally caused by:
19:13:55         Started by upstream project "kernel/CI-RT/bigeasy%2Fcurrent-development" build number 67
19:13:55         originally caused by:
19:13:55          Started by upstream project "kernel/Trigger" build number 77
19:13:55          originally caused by:
19:13:55           Started by remote host 10.100.30.5
19:13:55 [EnvInject] - Loading node environment variables.
19:13:56 Building remotely on phyflex-imx6 (arm-unknown+check_lsb_release_installed
unknown+check_lsb_release_installed-unknown+check_lsb_release_installed arm-unknown+check_lsb_release_installed-
unknown+check_lsb_release_installed unknown+check_lsb_release_installed arm) in workspace /home/jenkins/workspace
/kernel/utilities/cyclictest-runner
19:13:56 [WS-CLEANUP] Deleting project workspace...
19:13:56 [WS-CLEANUP] Done
19:13:56 No emails were triggered.
19:13:58 Copied 2 artifacts from "kernel ? utilities ? environment" build number 85
19:13:58 [EnvInject] - Injecting environment variables from a build step.
19:13:58 [EnvInject] - Injecting as environment variables the properties file path 'cyclictest/phyflex-imx6/hackbench'
19:13:58 [EnvInject] - Variables injected successfully.
19:13:58 [EnvInject] - Injecting environment variables from a build step.
19:13:58 [EnvInject] - Injecting as environment variables the properties file path 'environment.properties'
19:13:59 [EnvInject] - Variables injected successfully.
19:13:59 [cyclictest-runner] $ /bin/bash -xe /tmp/hudson6935871306594910369.sh
19:14:00 + set -e
19:14:00 + echo 'while true; do hackbench 100; done'
19:14:00 + cat
19:14:00 + bash histogram.sh
19:14:00 Running in process mode with 10 groups using 40 file descriptors each (== 400 tasks)
19:14:00 Each sender will pass 100 messages of 100 bytes
19:14:00 WARN: Running on unknown kernel version...YMMV
19:14:06 Time: 5.866
19:14:07 Running in process mode with 10 groups using 40 file descriptors each (== 400 tasks)
19:14:07 Each sender will pass 100 messages of 100 bytes
19:14:13 Time: 5.932
19:14:13 Running in process mode with 10 groups using 40 file descriptors each (== 400 tasks)
19:14:13 Each sender will pass 100 messages of 100 bytes
19:14:21 Time: 6.273
```

```
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ID[1]: guycGj4ypFe+ZpW+3Hr1eQ==
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ID[1]: gPgmvDJ1p16BVs3FUBTOwA==
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ID[1]: 65aIrZAWGlCnyD6NDRU93g==
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ID[1]: PSWttE4u2lOkIufpknSSXQ==
       Name: roborio   Rack: ci-rt-1   Port: 5 serial: ds-ci-rt-1.lab.linutronix.de:7005
ID[1]: rubBbUBGeVmvD2V/V2SJPw==
       Name: seattle   Rack: ci-rt-1   Port: 6 serial: ds-ci-rt-1.lab.linutronix.de:7006
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```
manut@castellum:~$ virsh -c r4d://localhost
Welcome to virsh, the virtualization interactive terminal.

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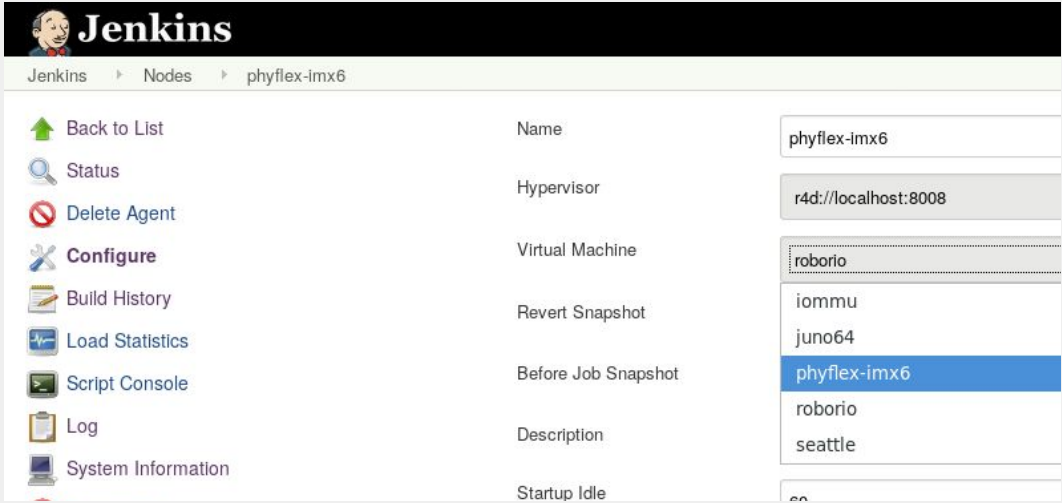
       'quit' to quit

virsh # list
 Id    Name                           State
----------------------------------------------
 0     iommu                          runnin
 1     phyflex-imx6                   runnin
 2     juno64                         runnin
 3     roborio                        runnin
 4     seattle                        runnin

virsh #
```



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Future Extensions

- ★ Various improvements
- ★ r4d Testbox

Various improvements

- Soft power off
- Authentication
- Post libvirt and jenkins-libvirt-slave-plugin patches
- ...

r4d Testbox

- Redirect USB serial
- GPIO to control power buttons
- Interface tests for e.g. CAN
- Could serve as an all in one: serial device server and power control server

References

CI-RT

https://ci-rt.linutronix.de

R4D

https://github.com/ci-rt/r4d

https://github.com/ci-rt/libr4d

Libvirt

https://github.com/ci-rt/libvirt-debian

Jenkins

https://github.com/ci-rt/libvirt-slave-plugin

Thanks

Benedikt Spranger

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