LAVA External Device Monitoring
This document describes how to execute automated LAVA tests controlling resources external to the DUT across a network implementing a LAVA parallel pipeline job.

**Test Cases**

The approach proposed in this document will help to address test cases like:

- Executing a test in the DUT where certain power states are simulated (for example a power loss) during specific test actions using a programmable PSU external to the DUT.
- Executing a test in the DUT simulating SD card insertion and removal using an external device.

The only assumption, in both scenario, proposed in this document is that the external device (either a programmable PSU or SD-card simulator) can be accessed through the network using SSH.

**LAVA Features**

LAVA offers the following features that can be combined to implement a solution for the test cases mentioned in this document:

- LXC to deploy required software and tools to access the external device.
- MultiNode to communicate data between jobs actions.
- Secondary connections for executing tests through SSH.
LXC

LAVA supports LXC containers both as a standalone device type and as dynamic transparent environments in order to interact with external devices. In either case the LXC Protocol\(^1\) is used.

MultiNode

The MultiNode Protocol\(^2\) allows data to be shared between actions, including data generated in one test shell definition being made available over the protocol to a deploy or boot action of jobs with a different role.

Synchronisation is done using the MultiNode API, specifically the `lava-send` and `lava-wait` calls.

Secondary Connections

LAVA allows Secondary Connections\(^3\) to open network connections to external devices using MultiNode submissions.

Approach Overview

The main idea is to create a LXC container device associated to the DUT responsible to execute the automated test, then opens a SSH connection to an external device, and use the MultiNode API in order to synchronize both devices and pass data between them with the LXC container serving like a coordinator of the different LAVA tests actions.

In this way, a server-client layout is setup that will help to execute tests in a board attached to LAVA (server side) with intervention of external devices (client side).

LAVA Job Connection Layout

The LXC container is deployed directly from the LAVA dispatcher and coordinate the execution of the parallel pipeline between the DUT and the external device (secondary connection) from there.

The layout model would be something like:

```
------------------- DUT
    / MultiNode
LAVA (LXC)
```

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\(^1\)https://lava.collabora.co.uk/static/docs/v2/actions-protocols.html#lxc-protocol-reference
\(^2\)https://lava.collabora.co.uk/static/docs/v2/actions-protocols.html#multinode-protocol
\(^3\)https://lava.collabora.co.uk/static/docs/v2/pipeline-writer-secondary.html
Test Job

This section shows the basics proposed in this document using a LAVA job file example.

The following steps describe the main flow of the job:

1 - Create two types of roles host and guest. The host role will contain the LXC container and the DUT, the guest role will label the SSH connection for the external device. This creates two groups (host and guest) that can communicate using the MultiNode API, so messages can be sent between the LXC and Device as the server and the secondary connection as the client.

2 - Label both types of roles in the protocols section of the job.

3 - Deploy and boot the LXC container (host).

4 - Execute a test in the LXC container using the MultiNode API to send the \texttt{lava\_start} message, so the deploy action for the external device can start, and waits for remaining clients to start using the \texttt{lava\_sync} call.

5 - Deploy the DUT (host).

6 - Deploy the external device (guest), which is waiting for the LXC \texttt{lava\_start} message to start deployment. Once this message is received, the guest device is deployed.

7 - Boot DUT.

8 - Boot external device.

9 - Execute a test in the DUT sending the \texttt{lava\_sync} call.

10 - Execute a test in the external device sending the \texttt{lava\_sync} call.

11 - Once all clients are synchronized (the LXC, DUT and external device), start executing tests.

12 - Tests executed in the DUT and external device needs to use the MultiNodeAPI\textsuperscript{4} in order to pass data between them.

As the LXC is deployed and booted first, the LXC can run a test shell before deploying the device, before booting the device, before the test shell action on the device which starts the secondary connection guests or at any later point (AddingTestsActions\textsuperscript{5}).

\textsuperscript{4}\url{https://lava.collabora.co.uk/static/docs/v2/multinodeapi.html#multinode-api}

\textsuperscript{5}\url{https://lava.collabora.co.uk/static/docs/v2/writing-multinode.html#adding-test-actions}
**Job File Example**

job_name: LXC and Secondary connection with a Device

timeouts:
  job:
    minutes: 30
  action:
    minutes: 3
  connection:
    minutes: 5

priority: medium
visibility: public

protocols:
  lava-lxc:
    host:
      name: lxc-ssh-test
      template: debian
      distribution: debian
      release: stretch

lava-multinode:
  # expect_role is used by the dispatcher and is part of delay_start
  # host_role is used by the scheduler, unrelated to delay_start.
  roles:
    host:
      device_type: beaglebone-black
  guest:
    # protocol API call to make during protocol setup
    request: lava-start
    # set the role for which this role will wait
    expect_role: host
    timeout:
      minutes: 15
    # no device_type, just a connection
    connection: ssh
    count: 3
    # each ssh connection will attempt to connect to the device of role 'host'
    host_role: host

actions:
- deploy:
  role:
  - host
    namespace: probe
timeout:
  - minutes: 5
to: lxc
  # authorize for ssh adds the ssh public key to authorized_keys
  authorize: ssh
packages:
  - usbutils
  - procps
  - lsb-release
  - util-linux
  - ntpdate
  - openssh-server
  - net-tools

- boot:
  role:
  - host
    namespace: probe
prompts:
  - 'root@(.*):/#'
timeout:
  - minutes: 5
method: lxc

- test:
  role:
  - host
    namespace: probe
timeout:
  - minutes: 5
definitions:
  - repository:
      metadata:
        format: Lava-Test Test Definition 1.0
        name: network
description: "Send message ID"
run:
  steps:
    - lava-test-case ntpdate --shell ntpdate-debian
    - lava-echo-ipv4 eth0
    - lava-send ipv4 ipaddr=$(lava-echo-ipv4 eth0)
    - lava-send lava_start
- lava-sync clients

from: inline
name: lxc-test
path: inline/lxc-test.yaml

# DUT actions
- deploy:
  role:
  - host
  namespace: device
  timeout:
    minutes: 5
to: tftp

  kernel:
  url: https://files.lavasoftware.org/components/lava/standard/debian/stretch/armhf/3/vmlinuz-4.9.0-4-armmp
  sha256sum: b6043cc5a07e2cead3f7f098018e7706ea7840eece2a456ba5fcfaddaf98a21e
type: zimage
  ramdisk:
  url: https://files.lavasoftware.org/components/lava/standard/debian/stretch/armhf/3/initrd.img-4.9.0-4-armmp
  sha256sum: 4cc25f499ae74e72b5d74c9c5e65e143de8c2e3b019f5d1781abbf519479b843
type: initrd
compression: gz
  modules:
  url: https://files.lavasoftware.org/components/lava/standard/debian/stretch/armhf/3/modules.tar.gz
  sha256sum: 10e6930e9282dd44905cfdf33a2d5a5058a1d400374af2b2619412554e1067d58
  compression: gz
  nfsrootfs:
  url: https://files.lavasoftware.org/components/lava/standard/debian/stretch/armhf/nfs.tar.gz
  sha256sum: 46dfd18f339ac973359e8ac5097e5258b620709add94cf5e09a85d936ace38f698
  compression: gz
dtb:
  url: https://files.lavasoftware.org/components/lava/standard/debian/stretch/armhf/3/dtbs/am335x-boneblack.dtb
  sha256sum: c4c461712bf52af7d020e78678e20fc946f1d9b9552ef26fd07ae8c5373e3e9

# Timeout for the ssh connection attempt
- deploy:
  role:
  - guest
  namespace: guest
  timeout:
    seconds: 30
to: ssh
connection: ssh
protocols:
lava-multinode:
  - action: prepare-scp-overlay
    request: lava-wait
    messageId: ipv4
    message:
      ipaddr: $ipaddr
      timeout: # delay_start timeout
      minutes: 5

  - boot:
    role:
    - host
      namespace: device
      timeout:
        minutes: 15
      method: u-boot
      commands: nfs
      auto_login:
        login_prompt: 'login:'
        username: root
      prompts:
        - 'root@stretch:'
      parameters:
        shutdown-message: "reboot: Restarting system"

  - boot:
    role:
    - guest
      namespace: guest
      timeout:
        minutes: 3
      prompts:
        - 'root@stretch:'
      parameters:
        hostID: ipv4
        host_key: ipaddr
        method: ssh
        connection: ssh

  - test:
    role:
    - host
      namespace: device
      timeout:
minutes: 30

definitions:
  - repository:
      metadata:
        format: Lava-Test Test Definition 1.0
        name: install-ssh
        description: "install step"
      run:
        steps:
          - df -h
          - free
          - lava-sync clients
      from: inline
      name: ssh-inline
      path: inline/ssh-install.yaml
    - repository: http://git.linaro.org/lava-team/lava-functional-tests.git
      from: git
      path: lava-test-shell/smoke-tests-basic.yaml
      name: smoke-tests
    - repository: http://git.linaro.org/lava-team/lava-functional-tests.git
      from: git
      path: lava-test-shell/single-node/singlenode02.yaml
      name: singlenode-intermediate
  - test:
    role:
      - guest
      namespace: guest
      timeout:
        minutes: 5
    definitions:
      - repository: http://git.linaro.org/lava-team/lava-functional-tests.git
        from: git
        path: lava-test-shell/smoke-tests-basic.yaml
        name: smoke-tests
        # run the inline last as the host is waiting for this final sync.
      - repository:
          metadata:
            format: Lava-Test Test Definition 1.0
            name: client-ssh
            description: "client complete"
          run:
          steps:
            - df -h
            - free
            - lava-sync clients
from: inline
   name: ssh-client
   path: inline/ssh-client.yaml

# Tests executed in the external device and DUT can be added here.
# They all need to use the MultiNode API.
#

# Execute test in the DUT
- test:
  role:
    - host
      namespace: device
      timeout:
        minutes: 10
      definitions:
        - repository: https://gitlab.apertis.org/tests/apertis-test-cases/
          from: git
          path: lava-test-shell/single-node/singlenode03.yaml
          name: singlenode-advanced

# Execute test in the external device (PSU, SD-card device)
- test:
  role:
    - guest
      namespace: guest
      timeout:
        minutes: 10
      definitions:
        - repository: https://gitlab.apertis.org/tests/apertis-test-cases/
          from: git
          path: lava-test-shell/single-node/singlenode03.yaml
          name: singlenode-advanced

QA Report

Once tests results are available at LAVA, and the test cases are enabled for the specific images from the test case repository, the results will be available from the QA Report App automatically.