SEAPATH Tests and CI

Test proposal

The following document describes the test cases which must meet the following objectives:

- Ensuring the hardware meets the required performance for substation grade protection regarding latency, jitter, interoperability and reliability
- Ensuring the software platform meets the required performance for substation grade protection regarding latency, jitter, interoperability and reliability
- Provide system characteristics/benchmarks
- Provide indications on scalability

`seapath.pptx`

Documentation

The documentation is available directly on github.

Here is the main documentation to build a SEAPATH image: https://github.com/seapath/yocto-bsp/blob/master/README.adoc

Build machine

The Yocto project requires a powerful Linux based machine.

In order to build efficiently the SEAPATH project, we recommend not to use Virtual Machine. The Yocto project will ensure to multi-thread your build, so try to use a build machine with many CPU cores.

Here is a discussion on the Yocto Project mailing list: https://lists.yoctoproject.org/g/yocto/topic/72047879#48815

Here is for instance, a build configuration (~1500 euros) used:

CPU	AMD RYZEN 9 3900X WRAITH PRISM LED RGB (3.8 GHZ / 4.6 GHZ)
Cooling	NOCTUA NH-U14S
MotherBoard	ASUS PRIME X570-P
Chipset	Intel C612
PowerSupply	SEASONIC PRIME ULTRA 650 W GOLD
RAM	G.SKILL FLARE X SERIES 32 GO (2 X 16 GO) DDR4 3200 MHZ CL14
SSD (SATA)	SAMSUNG SSD 860 EVO 500 GO
SSD (NVME)	CORSAIR FORCE MP600 1 TO
GPU	ASUS RADEON R7 240 R7240-2GD3-L
Case	PHANTEKS ENTHOO PRO

Tips for building

- About 250GB is needed for building SEAPATH.
- A USB attached storage may be too slow to be practical for a successful build.
- Ensure you use an ext 2/ ext3 / ext4 filesystem for the build directory. NTFS will not work.
- Watch out with only manually deleting the /tmp/work directory. Instead delete the whole tmp directory.
- When deleting the tmp, it may take a very long time, and might cause `rm -rf` to fail with an error. `find . -delete` will work better, as it will not try to index all files before deleting them.

Test Bench/Reference hardware

This is the reference hardware for the Seapath project and supported out of the box. It might cost significant time to support other hardware (e.g. AMD processors). Some integration is available with a dedicated Yocto layer: https://git.yoctoproject.org/cgit/cgit.cgi/meta-amd/

Specification

Parts	Specifications
Motherboard	ASMB823
Chipset	Intel C612
CPU	XEON 2.4G 35M 2011P 14CORE E52680V4
Memory	2x 8G RDDR42400 1.2V1GX8 HYX
Disk	SQF 2.5 SATA SSD 830 512G MLC (40~85°C)
NIC	INTEL I210 NIC 10/100/1000M PCIEx4 2PORT(G)

Tests results

Real time

Tests

With the previous test bench hardware, a couple of tests were used.

We used *cyclictest:*

"Cyclictest accurately and repeatedly measures the difference between a thread's intended wake-up time and the time at which it actually wakes up in order to provide statistics about the system's latencies. It can measure latencies in real-time systems caused by the hardware, the firmware, and the operating system." (source: https://wiki.linuxfoundation.org/realtime/documentation/howto/tools/cyclictest/start).

The following arguments were provided:

```
cyclictest -l100000000 -m -Sp90 -i200 -h400 -q >output
```

This test is very long (~5 hours).

You can then plot the latency graph:

```
./yocto-bsp/tools/gen_cyclic_test.sh -i output -n 28 -o output.png
```

- *output* is the output file generated by cyclictest
- *28* match the amount of CPU used.
- *output.png* is the latency graph file.

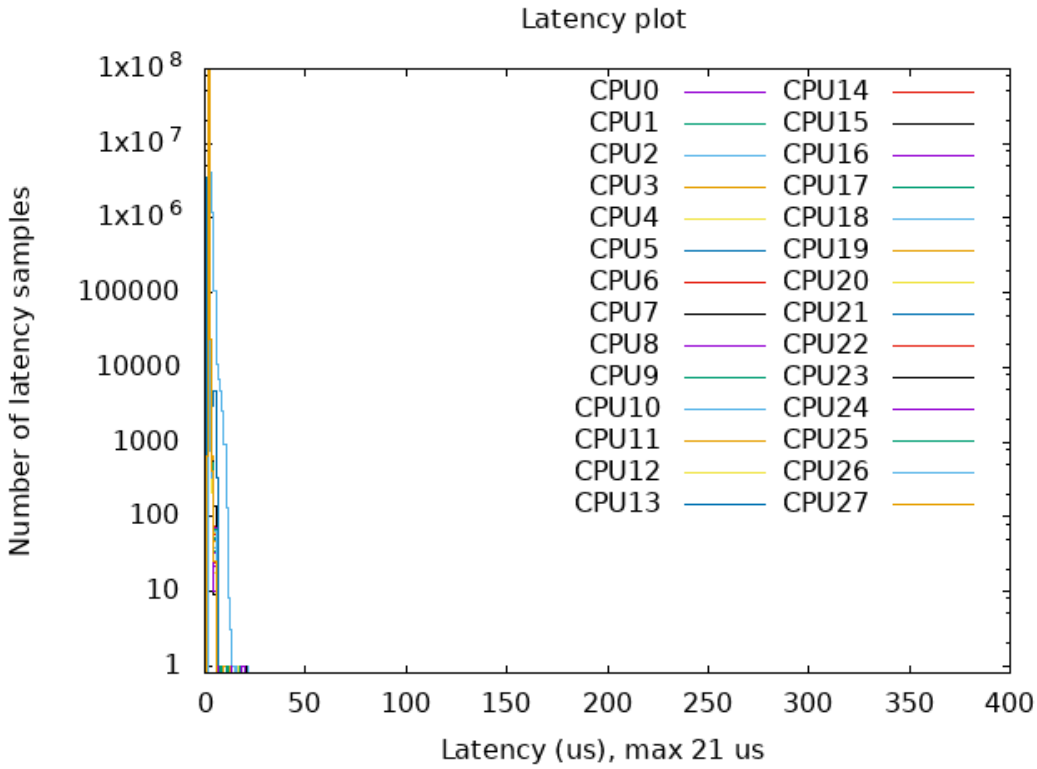
Note:

1. we used the same arguments than used by OSADL (https://www.osadl.org/Latency-plots.latency-plots.0.html)
2. We created a script to plot the latency graph as done by OSADL

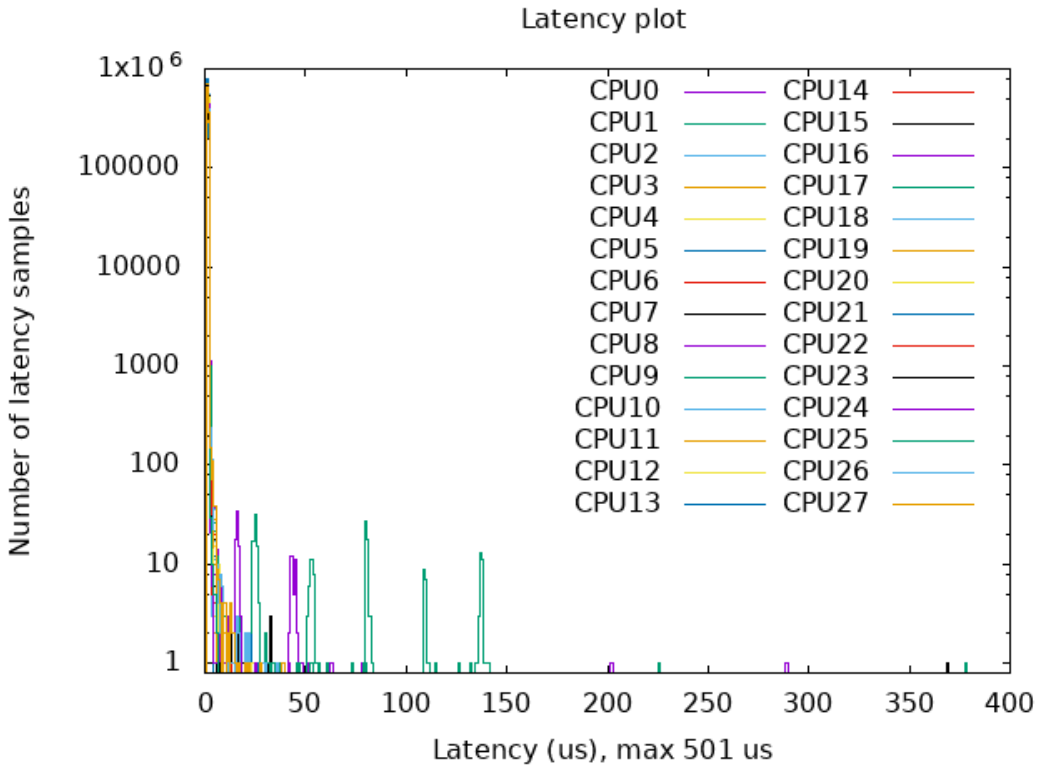
Results

Hypervisors

- With Kernel RT Full Preempt (CONFIG_PREEMPT_RT_FULL=y)



- Without Kernel RT Full Preempt (CONFIG_PREEMPT_NONE=y)



Virtual machines

All Yocto images include the ability to run guest Virtual Machines (VMs).

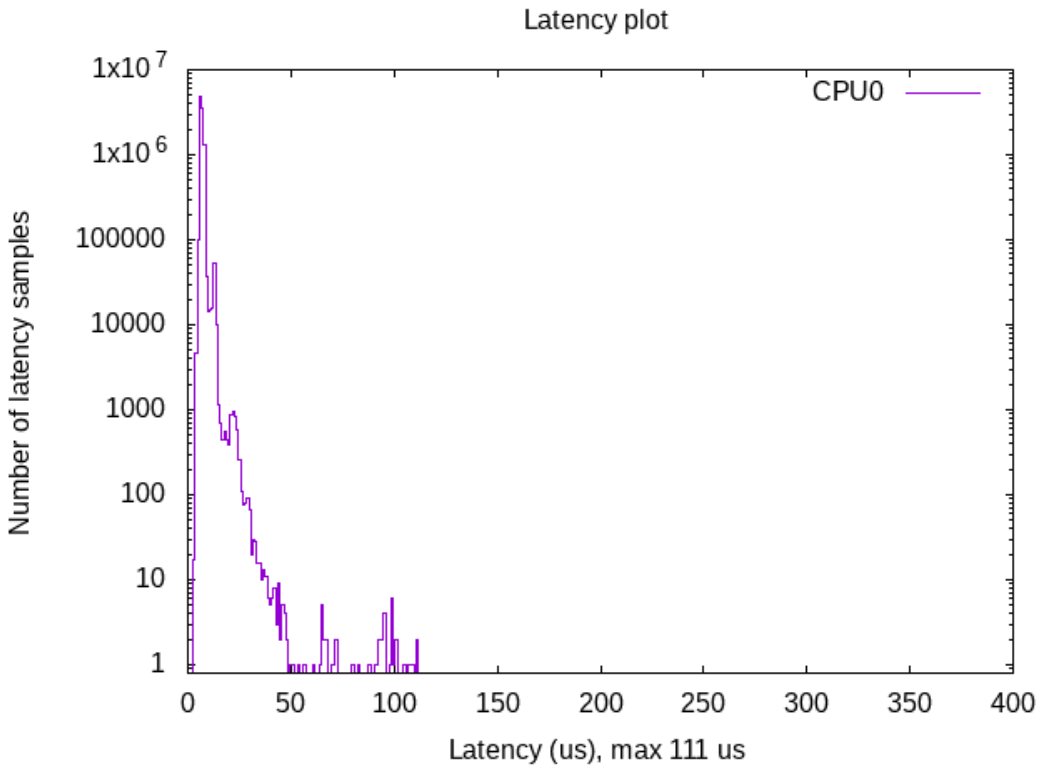
We used KVM and Qemu to run them. As we do not have any window manager on the host system,
VMs should be launched in console mode and their console output must be correctly set.

For testing purpose, we can run our Yocto image as a guest machine.
We do not use the *.wic* image which includes the Linux Kernel and the rootfs because
we need to set the console output.
We use two distinct files to modify the Linux Kernel command line:

- *bzImage*: the Linux Kernel image
- seapath-*test-image-votp.ext4*: the rte rootfs

Then run:

```
qemu-system-x86_64 -accel kvm -kernel bzImage -m 4096 -hda seapath-test-image-votp.ext4 -nographic -append
'root=/dev/sda console=ttyS0'
```



Docker

You can use docker check-config.sh to check that all necessary configurations of the host linux Kernel are set:

```
info: reading kernel config from /proc/config.gz ...

Generally Necessary:
- cgroup hierarchy: properly mounted [/sys/fs/cgroup]
- CONFIG_NAMESPACES: enabled
- CONFIG_NET_NS: enabled
- CONFIG_PID_NS: enabled
- CONFIG_IPC_NS: enabled
- CONFIG_UTS_NS: enabled
- CONFIG_CGROUPS: enabled
- CONFIG_CGROUP_CPUACCT: enabled
```

```
- CONFIG_CGROUP_DEVICE: enabled
- CONFIG_CGROUP_FREEZER: enabled
- CONFIG_CGROUP_SCHED: enabled
- CONFIG_CPUSETS: enabled
- CONFIG_MEMCG: enabled
- CONFIG_KEYS: enabled
- CONFIG_VETH: enabled
- CONFIG_BRIDGE: enabled
- CONFIG_BRIDGE_NETFILTER: enabled
- CONFIG_NF_NAT_IPV4: enabled
- CONFIG_IP_NF_FILTER: enabled
- CONFIG_IP_NF_TARGET_MASQUERADE: enabled
- CONFIG_NETFILTER_XT_MATCH_ADDRTYPE: enabled
- CONFIG_NETFILTER_XT_MATCH_CONNTRACK: enabled
- CONFIG_NETFILTER_XT_MATCH_IPVS: enabled
- CONFIG_IP_NF_NAT: enabled
- CONFIG_NF_NAT: enabled
- CONFIG_NF_NAT_NEEDED: enabled
- CONFIG_POSIX_MQUEUE: enabled

Optional Features:
- CONFIG_USER_NS: enabled
- CONFIG_SECCOMP: enabled
- CONFIG_CGROUP_PIDS: enabled
- CONFIG_MEMCG_SWAP: enabled
- CONFIG_MEMCG_SWAP_ENABLED: enabled
    (cgroup swap accounting is currently enabled)
- CONFIG_LEGACY_VSYSCALL_EMULATE: enabled
- CONFIG_BLK_CGROUP: enabled
- CONFIG_BLK_DEV_THROTTLING: enabled
- CONFIG_IOSCHED_CFQ: enabled
- CONFIG_CFQ_GROUP_IOSCHED: enabled
- CONFIG_CGROUP_PERF: enabled
- CONFIG_CGROUP_HUGETLB: enabled
- CONFIG_NET_CLS_CGROUP: enabled
- CONFIG_CGROUP_NET_PRIO: enabled
- CONFIG_CFS_BANDWIDTH: enabled
- CONFIG_FAIR_GROUP_SCHED: enabled
- CONFIG_RT_GROUP_SCHED: missing
- CONFIG_IP_NF_TARGET_REDIRECT: enabled
- CONFIG_IP_VS: enabled
- CONFIG_IP_VS_NFCT: enabled
- CONFIG_IP_VS_PROTO_TCP: enabled
- CONFIG_IP_VS_PROTO_UDP: enabled
- CONFIG_IP_VS_RR: enabled
- CONFIG_EXT4_FS: enabled
- CONFIG_EXT4_FS_POSIX_ACL: enabled
- CONFIG_EXT4_FS_SECURITY: enabled
- Network Drivers:
  - "overlay":
    - CONFIG_VXLAN: enabled
      Optional (for encrypted networks):
      - CONFIG_CRYPTO: enabled
      - CONFIG_CRYPTO_AEAD: enabled
      - CONFIG_CRYPTO_GCM: missing
      - CONFIG_CRYPTO_SEQIV: missing
      - CONFIG_CRYPTO_GHASH: missing
      - CONFIG_XFRM: enabled
      - CONFIG_XFRM_USER: enabled
      - CONFIG_XFRM_ALGO: enabled
      - CONFIG_INET_ESP: missing
      - CONFIG_INET_XFRM_MODE_TRANSPORT: missing
  - "ipvlan":
    - CONFIG_IPVLAN: enabled
  - "macvlan":
    - CONFIG_MACVLAN: enabled
    - CONFIG_DUMMY: missing
  - "ftp,tftp client in container":
    - CONFIG_NF_NAT_FTP: enabled
    - CONFIG_NF_CONNTRACK_FTP: enabled
    - CONFIG_NF_NAT_TFTP: missing
```

```
    - CONFIG_NF_CONNTRACK_TFTP: missing
- Storage Drivers:
  - "aufs":
    - CONFIG_AUFS_FS: missing
  - "btrfs":
    - CONFIG_BTRFS_FS: missing
    - CONFIG_BTRFS_FS_POSIX_ACL: missing
  - "devicemapper":
    - CONFIG_BLK_DEV_DM: enabled
    - CONFIG_DM_THIN_PROVISIONING: missing
  - "overlay":
    - CONFIG_OVERLAY_FS: missing
  - "zfs":
    - /dev/zfs: missing
    - zfs command: missing
    - zpool command: missing

Limits:
- /proc/sys/kernel/keys/root_maxkeys: 1000000
```