

Enabling an OpenStack-based cloud on top of RISC-V hardware



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Abstract



The European Union's technological sovereignty strategy centers around the RISC-V Instruction Set Architecture, with the European Processor Initiative leading efforts to build production-ready processors. Focusing on realizing a functional RISC-V cloud ecosystem, the Vitamin-V European project developed an OpenStack cluster utilizing genuine hardware. In this poster, we detail the efforts done in porting and setting up the cluster and the many software services required by OpenStack to properly run on real hardware. In this poster, we detail our efforts on building an minimal viable prototype OpenStack cluster using real hardware. The cluster is almost functional, and we expect it to be complete in the next few months.

Introduction



Figure 1. Vitamin-V Cloud Setups

The RISC-V Instruction Set Architecture (ISA) is at the core of the European Union's technological sovereignty plans. One key initiative in this direction is the European Processor Initiative (EPI) [Kovač 2019], which aims to produce processors ready for mass production based on the RISC-V open-source ISA. These processors are intended to be used in various applications, including cloud computing and data centers.

The omics sciences require big-data processing infrastructures. Thus, supercomputers and

Experimental Platform



Figure 2. Lichee PI 4A cluster running OpenStack

As the hardware platform, we are using a RISC-V development board by Sipeed, the Lichee PI 4A owing to their balanced pricing and capabilities. More specifically, the utilized development platform provides a TH1520 RISC-V CPU (4 Threads), 16GB of RAM, and 128GB of storage. In addition, it also provides a dual Gigabit Ethernet a feature particularly interesting when building an OpenStack cluster.

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datacenters are an essential requirement [Eisenstein 2015]. However, most current computing architectures are proprietary and closed-source technologies such as x86 and ARM, which creates concerns about the reliability of privacy and security.

In this poster, we explain our work to enable an OpenStack-based cloud environment on top of RISC-V using the Lichee PI 4A boards [SiPeed n.d.]. Enabling such an environment allows us to demonstrate a functional cloud on RISC-V and evaluate how well traditional cloud workloads perform on top of it.

OpenStack

Due to the novelty of both RISC-V chips and OS (Linux), building the cluster from scratch presented several challenges at different levels: operating system, distribution, and packages. OpenStack consists of numerous software services, each exhibiting varying levels of maturity for the RISC-V architecture. While some components worked seamlessly on RISC-V, others necessitated an intricate setup process due to the absence of essential libraries. These often had to be constructed from source code.



[370.178840]	systemd[1]: Finished systemd-modules-load.service - Load Kernel Modules.
[370.423352]	systemd[1]: dev-ttyS0.device: Job dev-ttyS0.device/start timed out.
[370.508567]	systemd[1]: Timed out waiting for device dev-ttyS0.device - /dev/ttyS0.
[370.724497]	systemd[1]: Dependency failed for serial-getty@ttyS0.service - Serial Getty on ttyS0.
[370.862396]	systemd[1]: serial-getty@ttyS0.service: Job serial-getty@ttyS0.service/start failed with result 'dependency'.
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Figure 3. Linux boot on VM

We have currently already booted a Linux kernel on top of an OpenStack instantiated VM using qemu as hypervisor.

Future Work

Currently, we have been able to run the basic OpenStack dashboard and we can identify the hardware resources available in the cluster as well as to instantiate VMs. This dashboard is shown in figure 4. Next steps include having multiple VMs inside a single node as well as to demonstrate a multi-board OpenStack managed cloud. As future work we will evaluate its performance running Vitamin-V targeted workloads on top of it.

Services Network Agents							
Displaying 6 items							
Name	Service	Region	Endpoints				
Identity Service	identity	RegionOne	Admin http://10.0.0.1:5000/v3 Internal http://10.0.0.1:5000/v3 Public http://192.168.10.18:5000/v3				
Placement Service	placement	RegionOne	Admin http://10.0.0.1:8778 Internal http://10.0.0.1:8778 Public http://192.168.10.18:8778				
Orchestration Service	orchestration	RegionOne	Adminhttp://10.0.0.1:8004/v1/332f0702092741ff8e12ee4658a33c09Internalhttp://10.0.0.1:8004/v1/332f0702092741ff8e12ee4658a33c09Publichttp://10.0.0.1:8004/v1/332f0702092741ff8e12ee4658a33c09				
glance	image	RegionOne	Admin http://10.0.0.1:9292 Internal http://10.0.0.1:9292 Public http://192.168.10.18:9292				
Compute Service V2.1	computev21	RegionOne	Admin http://10.0.0.1:8774/v2.1 Internal http://10.0.0.1:8774/v2.1 Public http://192.168.10.18:8774/v2.1				
Network Service	network	RegionOne	Admin http://10.0.0.1:9696 Internal http://10.0.0.1:9696 Public http://10.0.0.1:9696				
Displaying 6 items							

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MCIN/AEI/10.13039/ 501100011033/FEDER and PID GA PID2019-107255GB-C21, and the Generalitat de Catalunya (AGAUR) under grant agreements 2021-SGR-00478, 2021-SGR-01626 and "FSE Invertint en el teu futur".

Figure 4. OpenStack Dashboard

References

SiPeed (n.d.). Sipeed Liche Pi4A. https://sipeed.com/licheepi4a. Accessed: 2024-01-25.
Kovač, M. (2019). "European Processor Initiative: The Industrial Cornerstone of EuroHPC for Exascale Era". In: Proceedings of the 16th ACM International Conference on Computing Frontiers. CF '19. Alghero, Italy: Association for Computing Machinery, p. 319. ISBN: 9781450366854. DOI: 10.1145/3310273.3323432. URL: https://doi.org/10.1145/3310273.3323432.
Eisenstein, M. (Nov. 2015). "Big data: The power of petabytes". In: Nature 527.7576, S2–S4. ISSN: 1476-4687. DOI: 10.1038/527S2a. URL: https://doi.org/10.1038/527S2a.

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