OpenShift Container Platform on Z: Performance, Quality & Best Practices

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Linux on IBM z Performance

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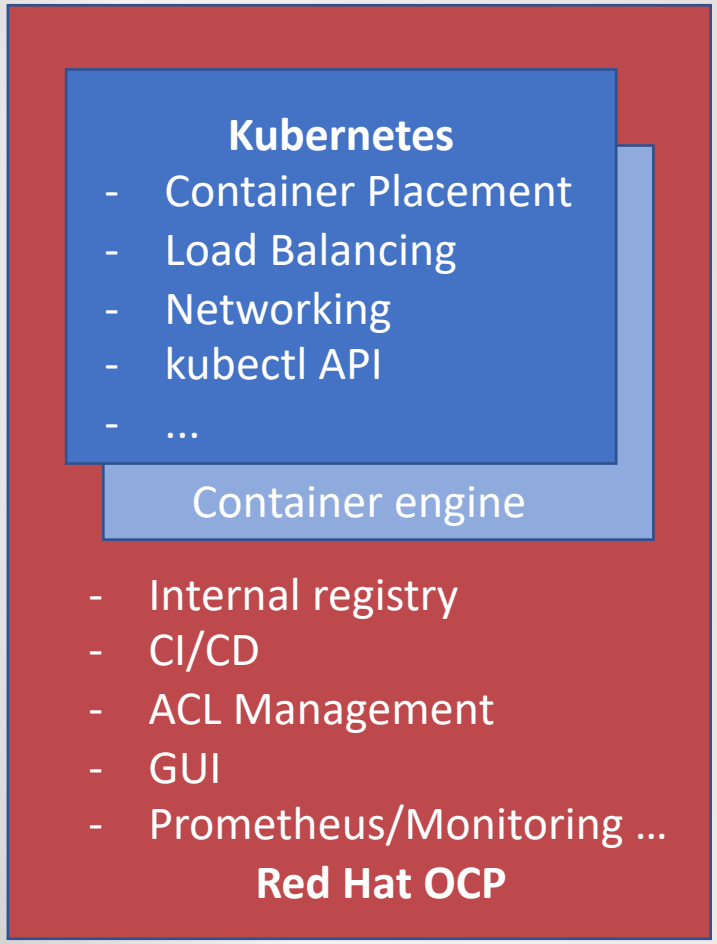
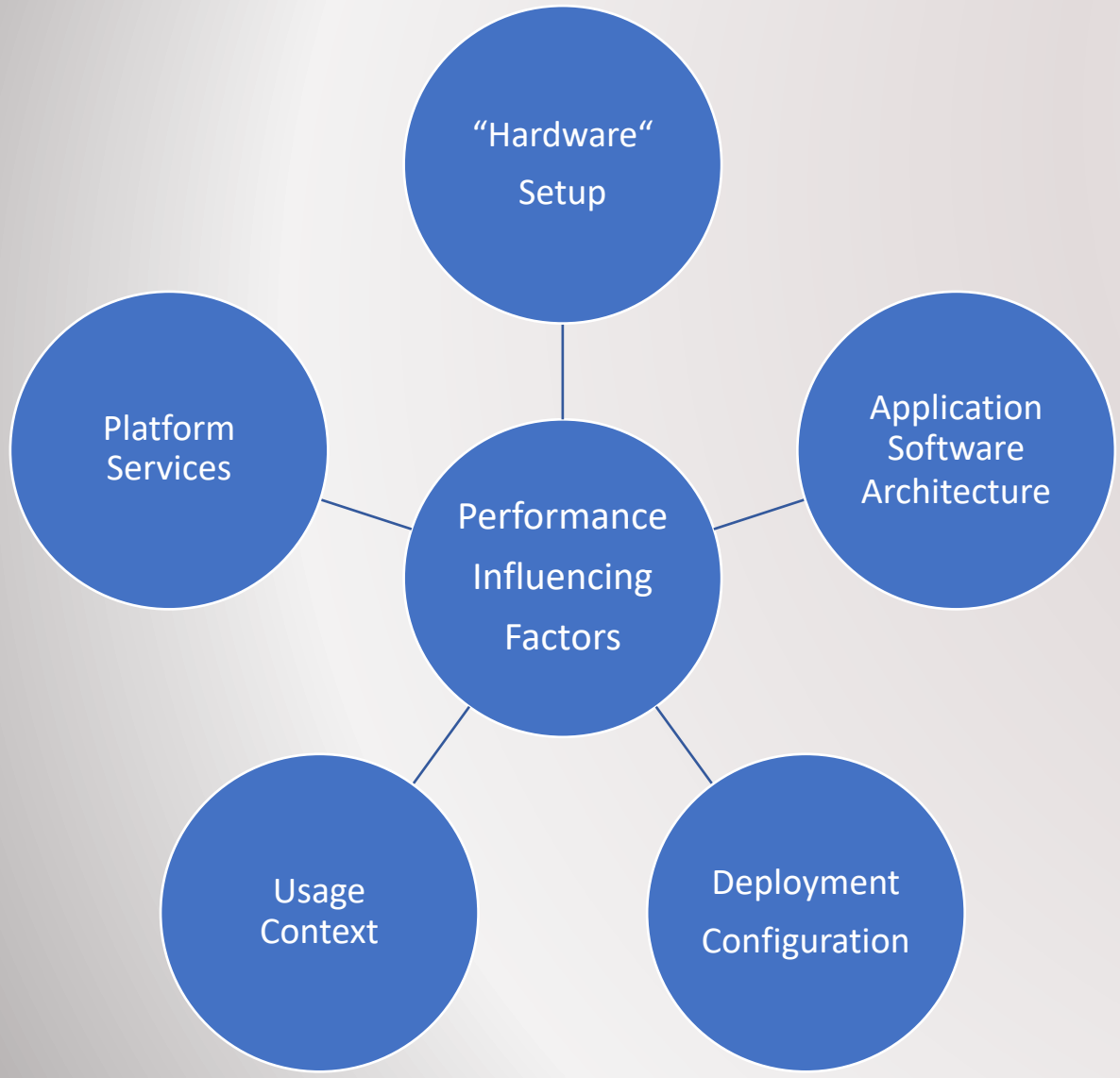
OpenShift container platform in a nutshell



- Kubernetes-based automated container orchestration platform
- Supports DevOps for more efficient digital transformation
  - Tools for agile development of software
  - Automated build and deployment pipeline
- Monitoring stack and security features
- Can be run on physical, virtual and cloud infrastructures

- Kubernetes core features
- Additional tools that can make life easier for daily work of developers
- Supports modern (agile) software development processes

Why do we talk about (OCP) performance?



- CPU/memory/.. resources
- Hypervisor, i.e. z/VM, KVM,…

- Monolythic Application
- Service oriented
- Microservices

- Trade-off decision for deployment
- High locality vs. high distribution

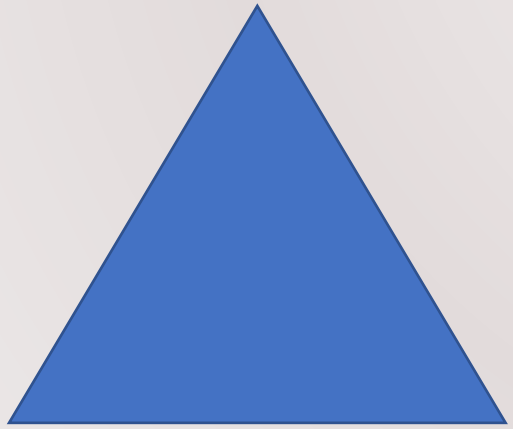
- Workload pattern
- # concurrent users
- Data amount

- OpenShift Layers/Operators
- Software defined network
- Prometheus
- etcd,…

Performance as one of many attributes…

- Requirements often competing
- More requirements = more trade-off decisions

Performance



Cost

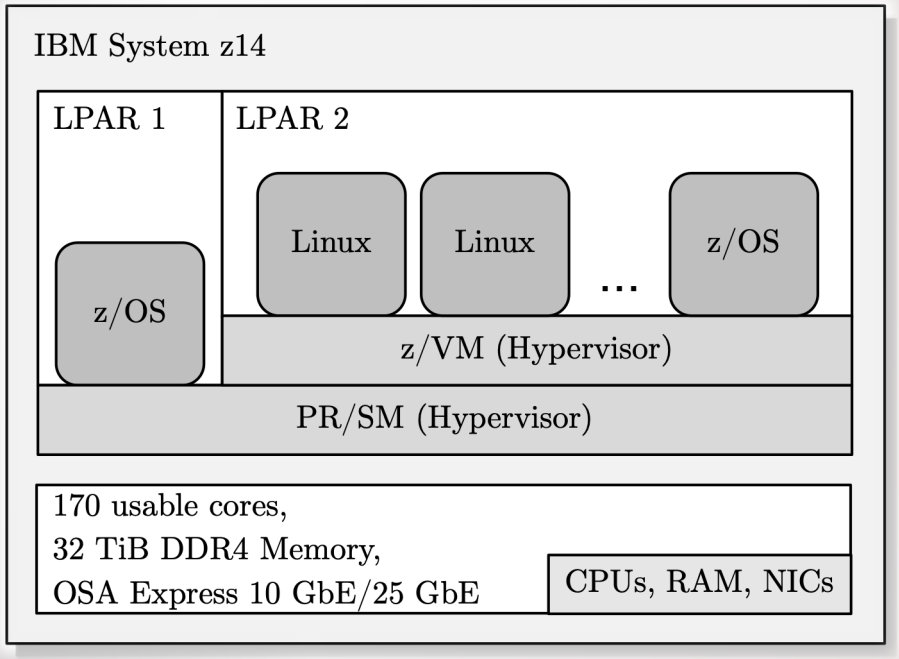
Security

… many more

Based on *Roger Atkinson - Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria, International Journal of Project Management, 1999*

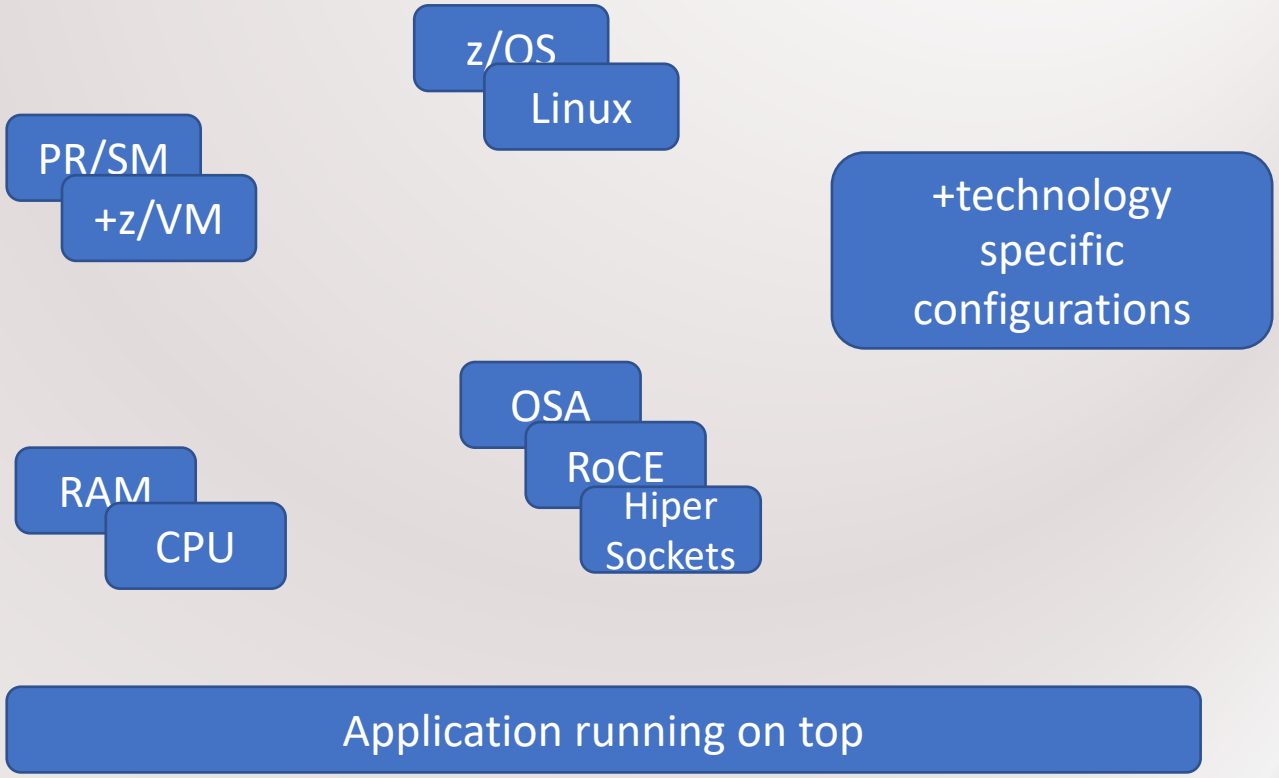
… and what is different to what we do since decades?

IBM z14 as an example:

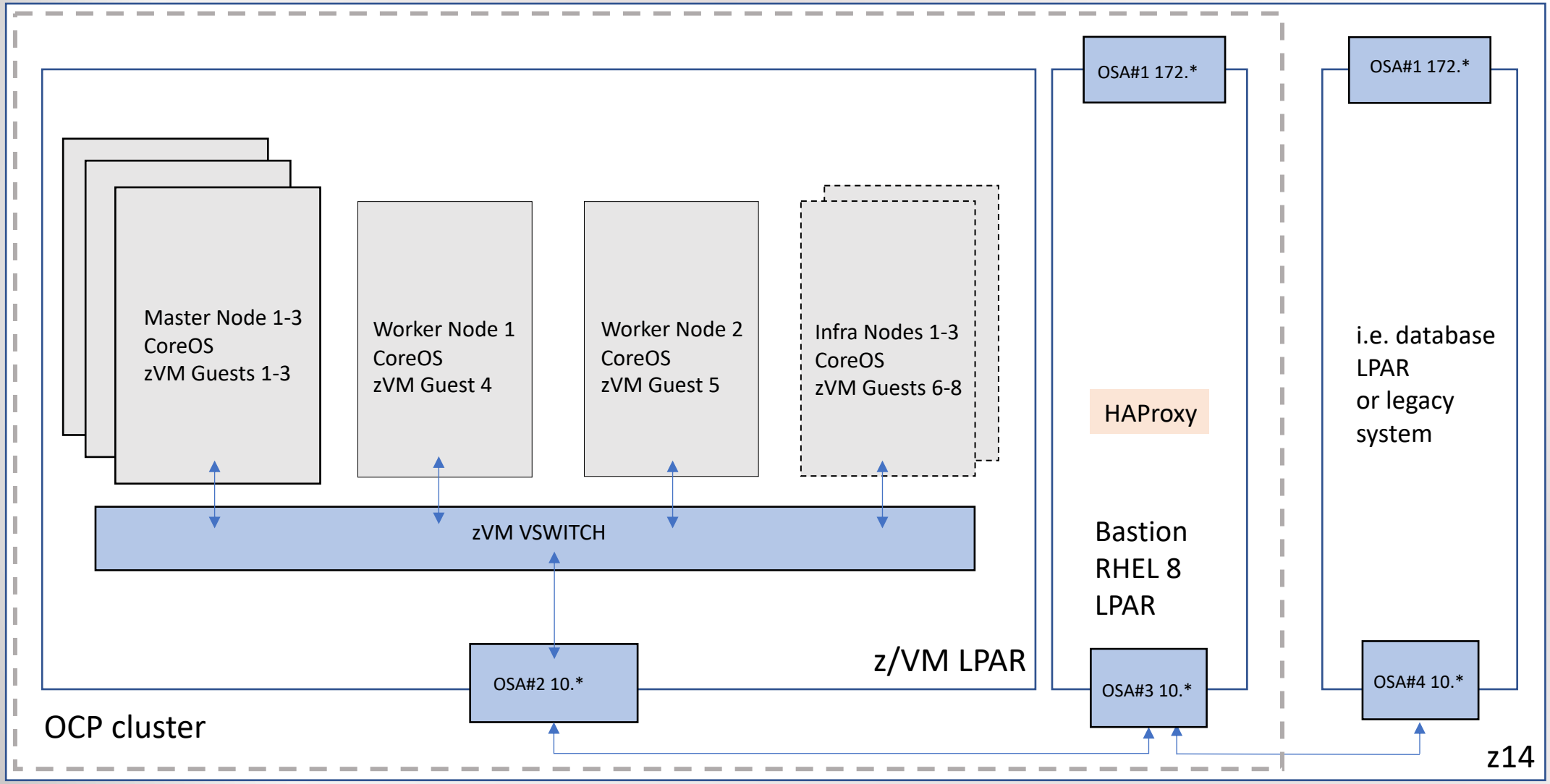


Degree of freedom space

Configuration options



OpenShift (on Z) Container Platform: System Architecture example



Again: what is different to what we do since decades?

Before:
- Choose if you want to run a monolythic application
- Create shortcuts to increase speed
- Disable (or just do not enable) logging to decrease CPU consumption

Deciding whether to optimize a quality attribute at the expense of others

Now: OCP prevents to make these decisions in a way that protects other quality attributes, such as
- Maintainability
- Security
- Reliability

But: Quality by design of OCP introduces other degrees of freedom
- Node types, i.e. master, worker, infra nodes
- Operator placement
- Network tunings, i.e. Receive packet steering, receive flow steering, node port,…

And now? More degrees of freedoms? More decisions to be made? Less flexibility?

OCP tends to guide you to **make decisions more thoughtfully**
You **still can optimize** things

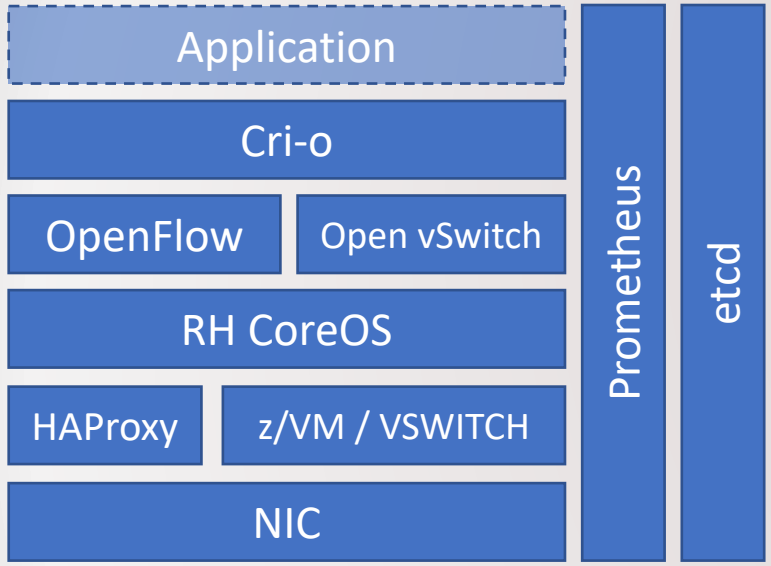
- Optimize the size of nodes and cluster (more workers/bigger workers)
- Optimize network throughput and latency by consuming some CPU cycles
- Define storage, e.g. NFS, OCS/Ceph,…

But it is **harder to accidentally bypass the fundamental quality by design** architecture principles by

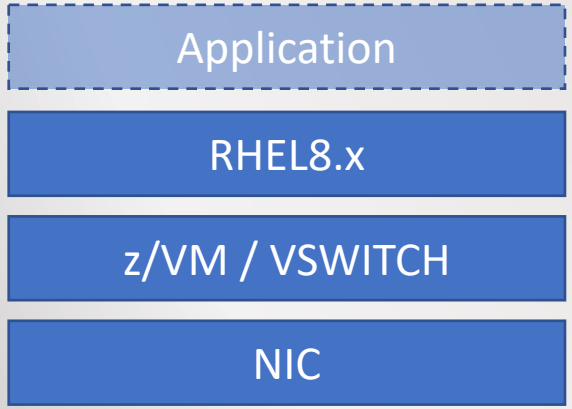
- avoiding to bypass the entire security architecture
- Prometheus logging stack always activated

Comparing what cannot be compared: steady state load of OCP vs. z/VM+RHEL8.1 installation

OCP



RHEL8.x



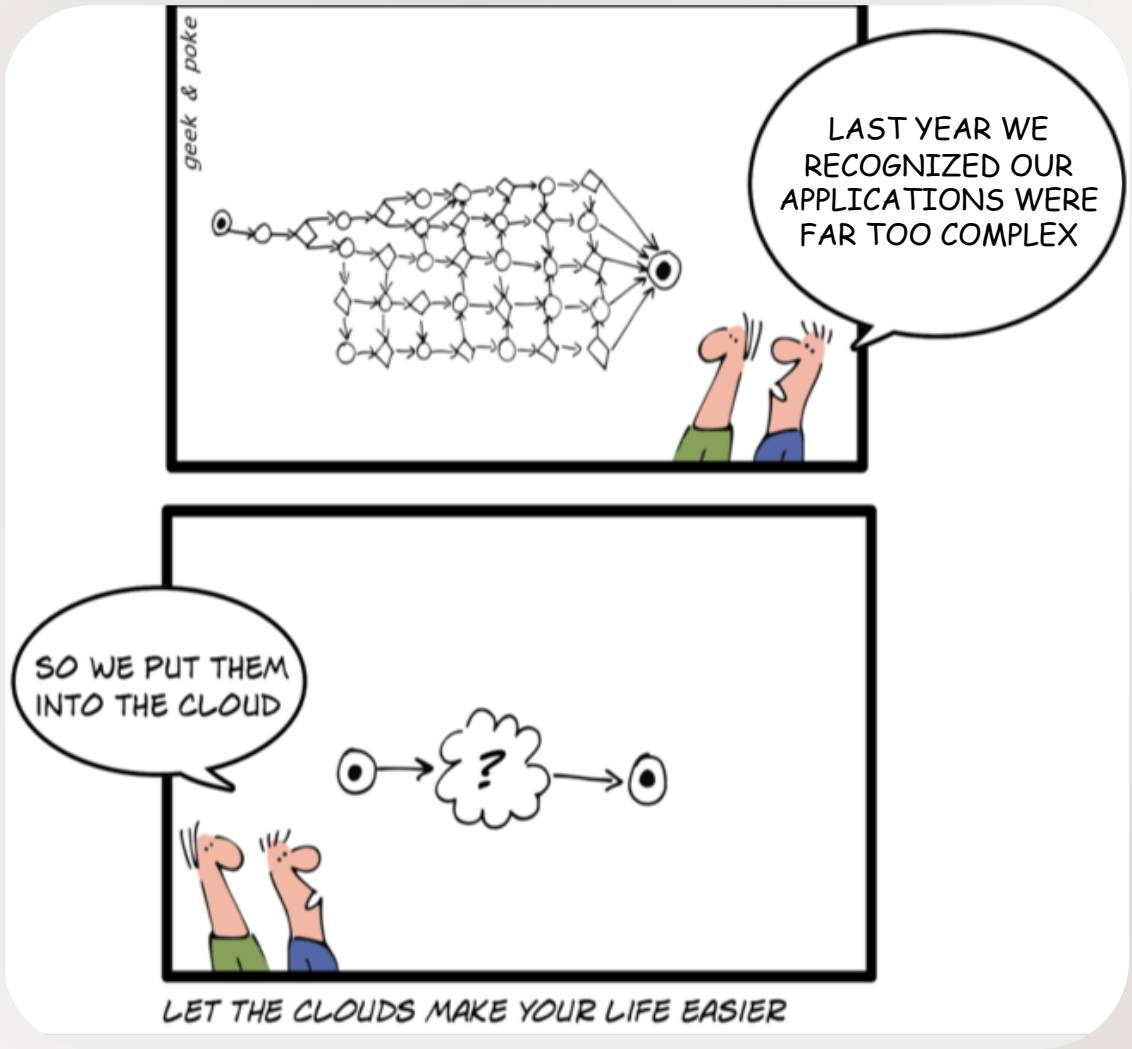
NAMESPACE	NAME
openshift-monitoring	prometheus-k8s-1
openshift-kube-apiserver	kube-apiserver-master-0.boet4244ocp.lnxne.boe
openshift-kube-apiserver	kube-apiserver-master-1.boet4244ocp.lnxne.boe
openshift-monitoring	prometheus-k8s-0
openshift-etcd	etcd-master-0.boet4244ocp.lnxne.boe
openshift-etcd	etcd-master-1.boet4244ocp.lnxne.boe
openshift-marketplace	certified-operators-9lgv5
openshift-operator-lifecycle-manager	packageserver-86598d8494-lk2cn
openshift-marketplace	redhat-operators-jjsw8
openshift-operator-lifecycle-manager	packageserver-86598d8494-25qfg
openshift-etcd	etcd-master-2.boet4244ocp.lnxne.boe
openshift-marketplace	community-operators-2cqtl
openshift-kube-apiserver	kube-apiserver-master-2.boet4244ocp.lnxne.boe

Top consumers:

- **openshift-monitoring**
- **openshift-kube-apiserver**
- **openshift-etcd**

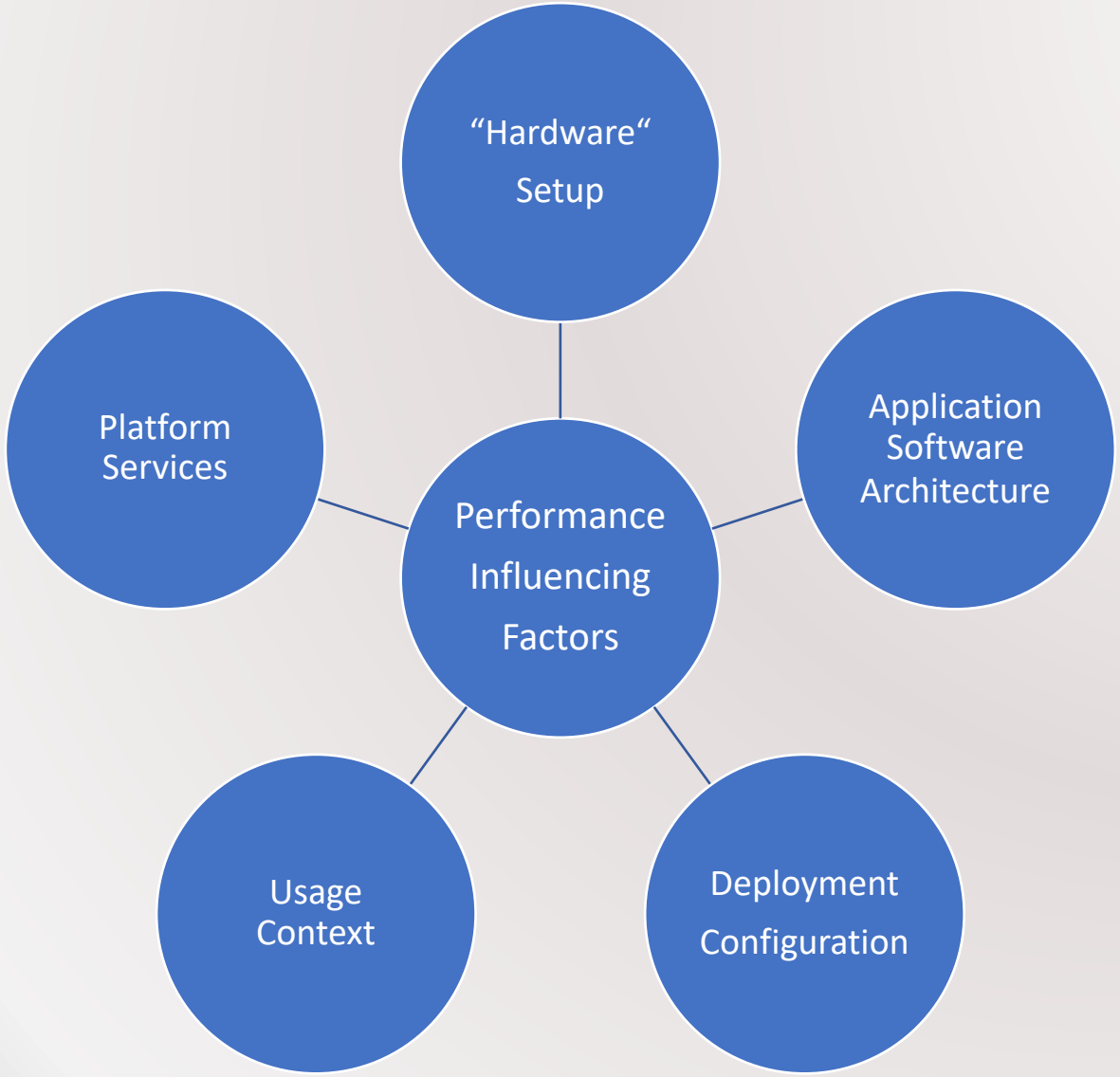
Operators for Reliability, Security, Logging… Keeping service quality high

Cloud Complexity

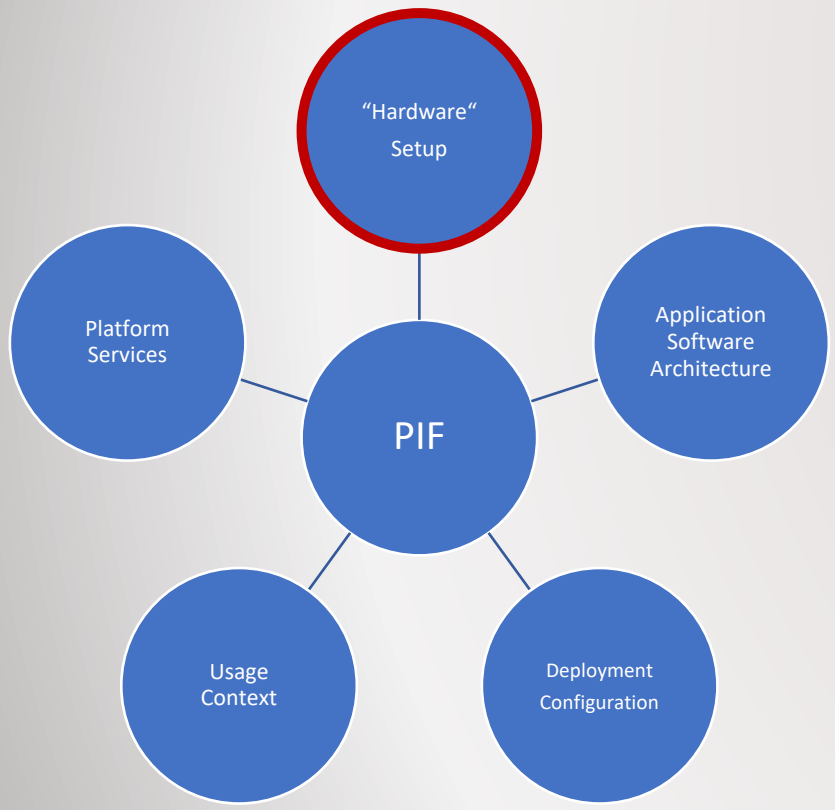


http://geek-and-poke.com/

Tunings addressing performance influencing factors



Tunings addressing performance influencing factors (1)



HyperPAV

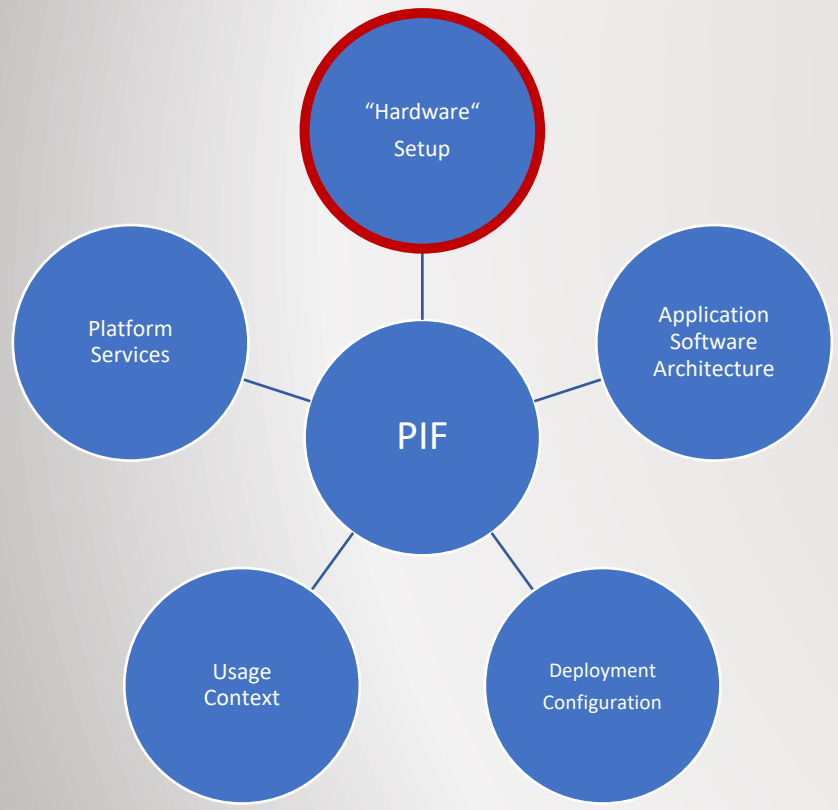
- DASD/ECKD devices
- Useful if workload has many parallel disk accesses
- OCP operators do have many parallel disk accesses
  - Prometheus
  - etcd
- If workloads access overlay filesystem of containers in parallel

- Channel subsystem processes one I/O operation per device
- HyperPAV devices allow parallel processing of I/O operations

- We recommend 5-8 HPAV devices per node

J. Doelle - Scaling HyperPAV alias devices on Linux guests on z/VM

Tunings addressing performance influencing factors (2)

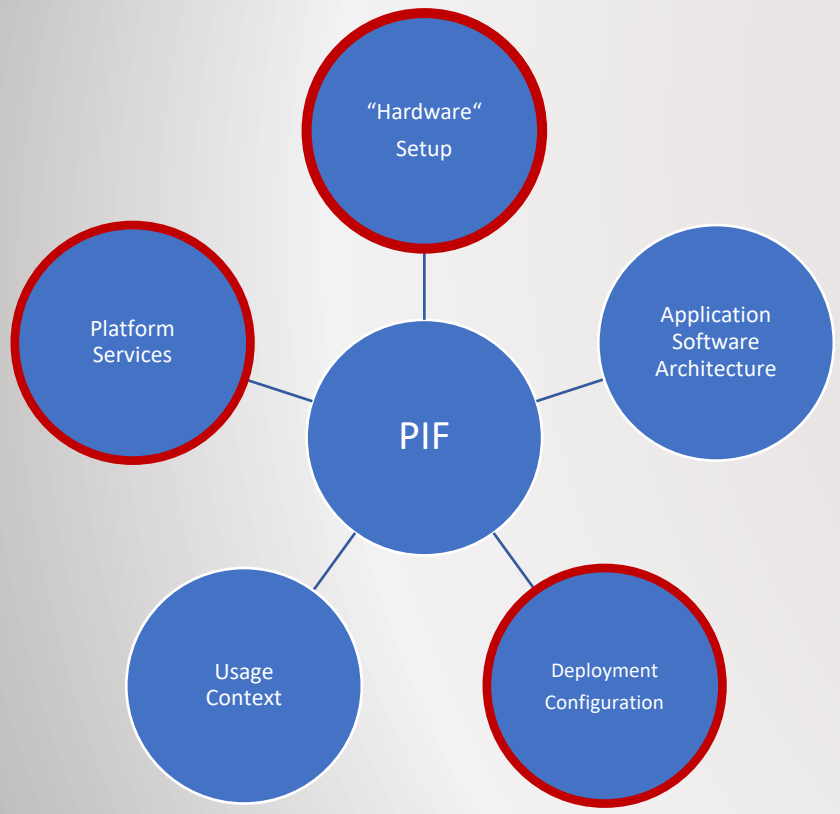


z/VM CPU SHARE

- Control the percentage of processor time a user receives
- With z/VM, a virtual machine receives its proportion of processor time according to its SHARE setting
- Some nodes might need more CPU proportion than others

- Adjusting can improve response time and throughput of workloads

Tunings addressing performance influencing factors (3)

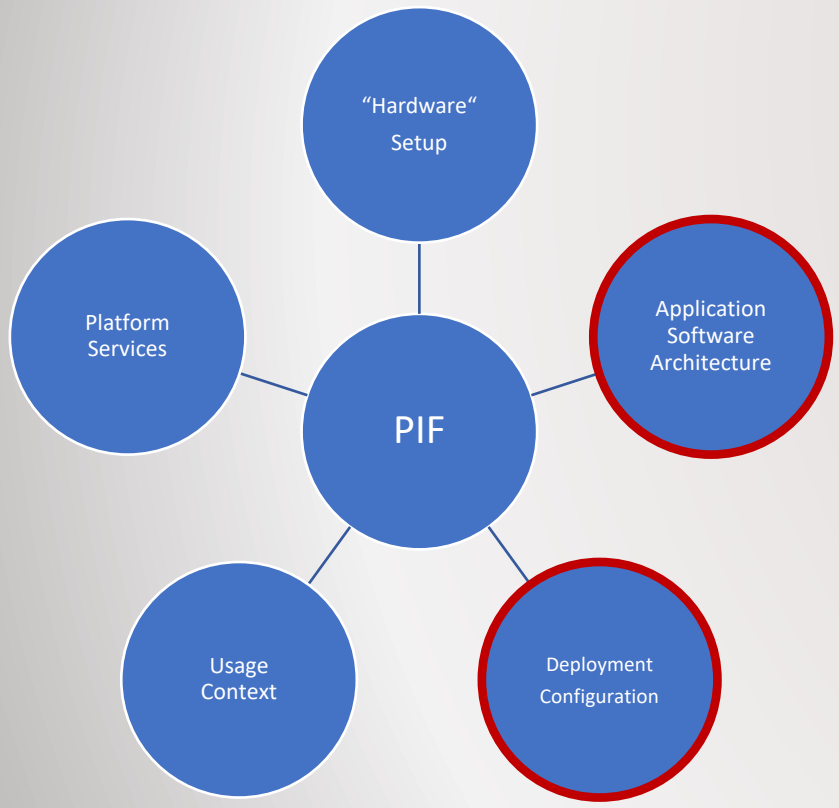


Cluster size #workers

- Trade-off decision between
  - number of workers
  - number of cpus per worker
  - amount of steady state load
- To what extent OCP can schedule pods on workers
- Scalability in high load scenarios (performance)
- Re-deployment in downtime scenarios of single nodes (reliability)

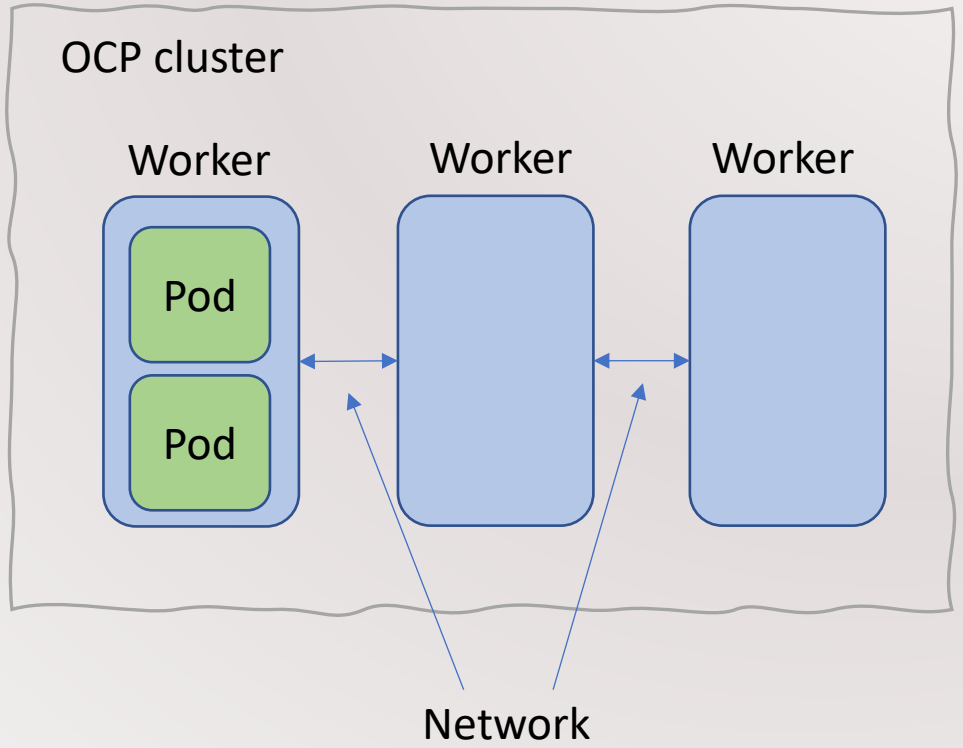
- Both, more workers and more cpus per worker increase steady state load
  - More logging effort
  - More network traffic between nodes

Tunings addressing performance influencing factors (4)

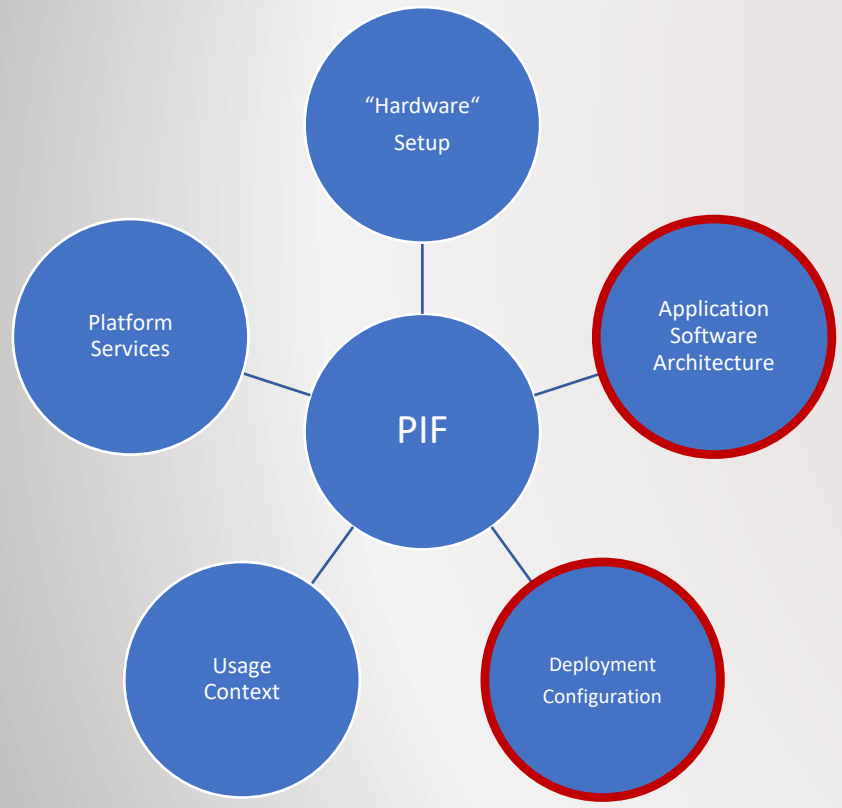


Service locality

1. Co-located

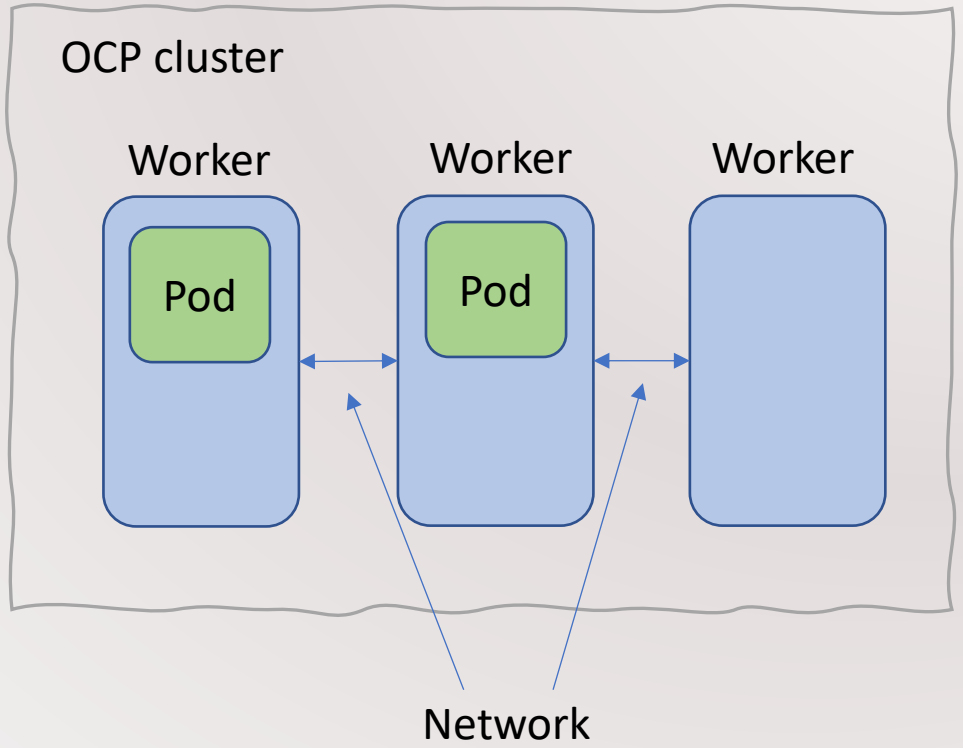


Tunings addressing performance influencing factors (4)

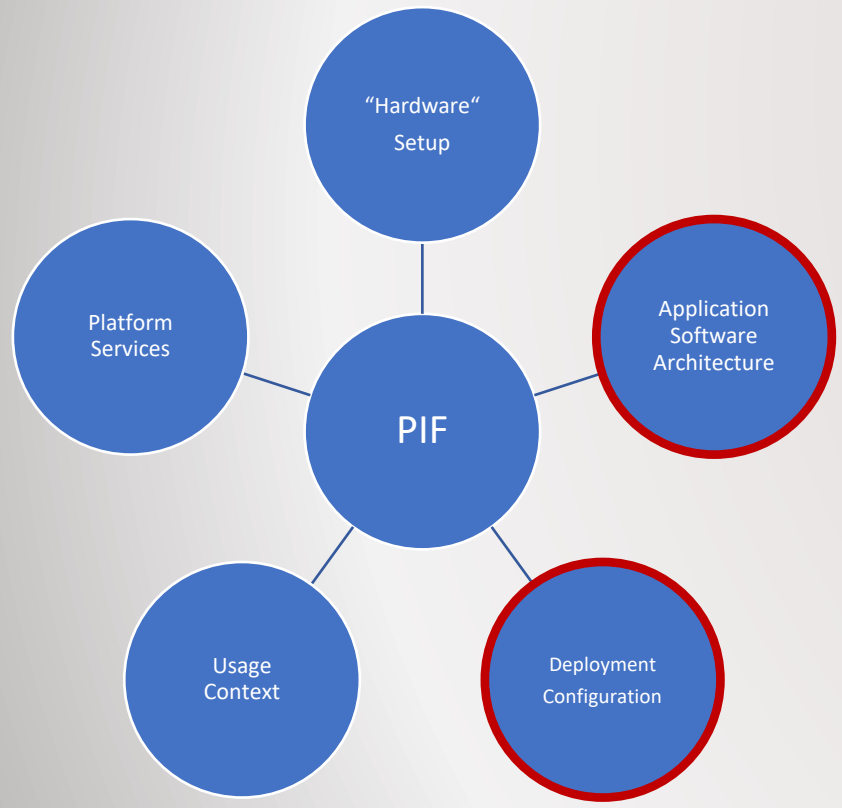


Service locality

2. Non-colocated

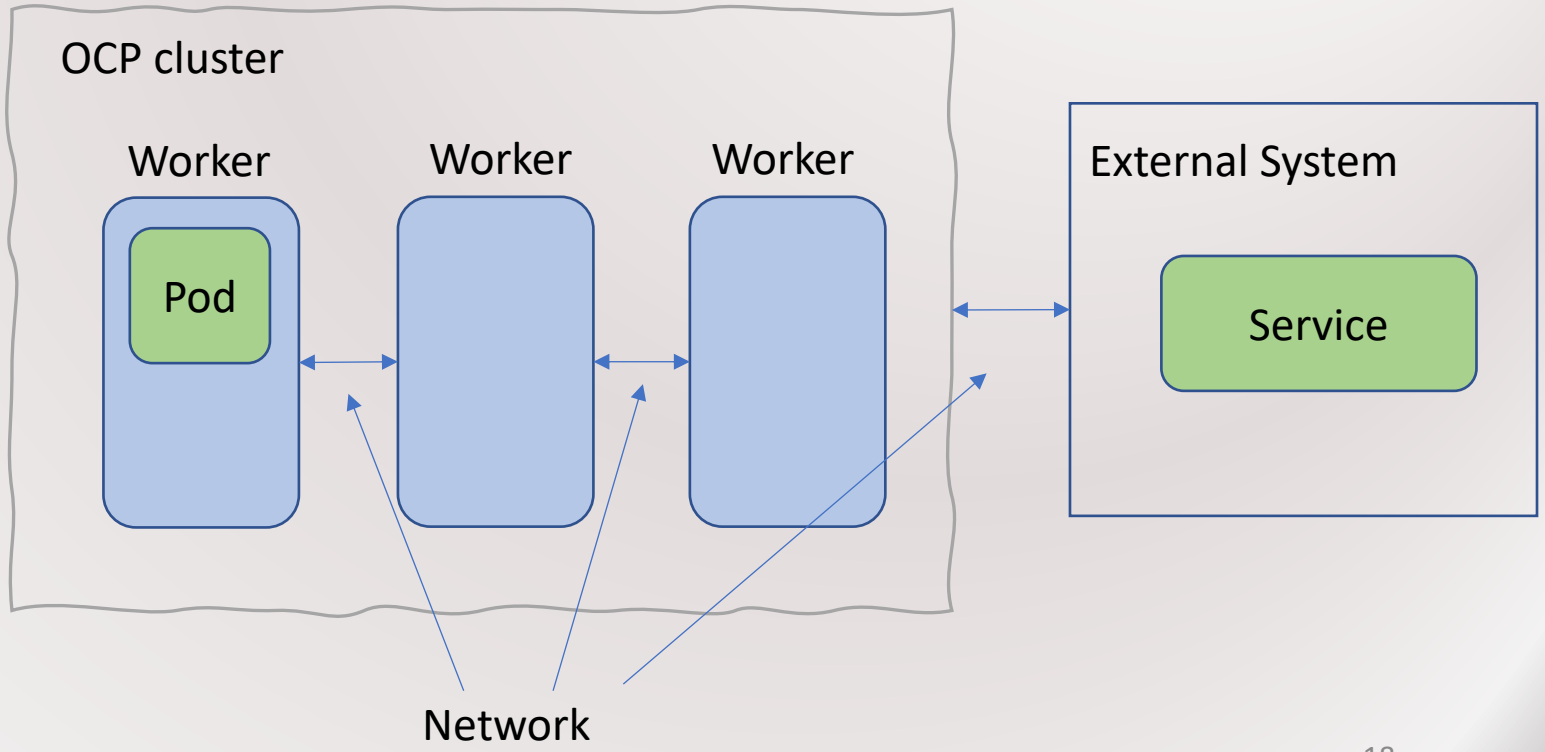


Tunings addressing performance influencing factors (4)

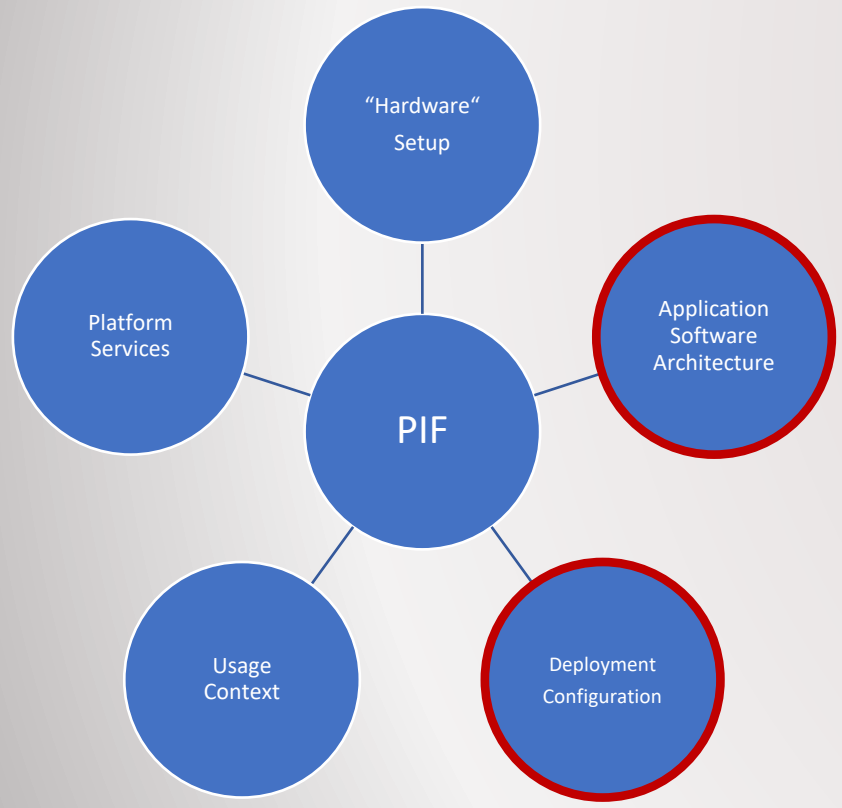


Service locality

3. External service



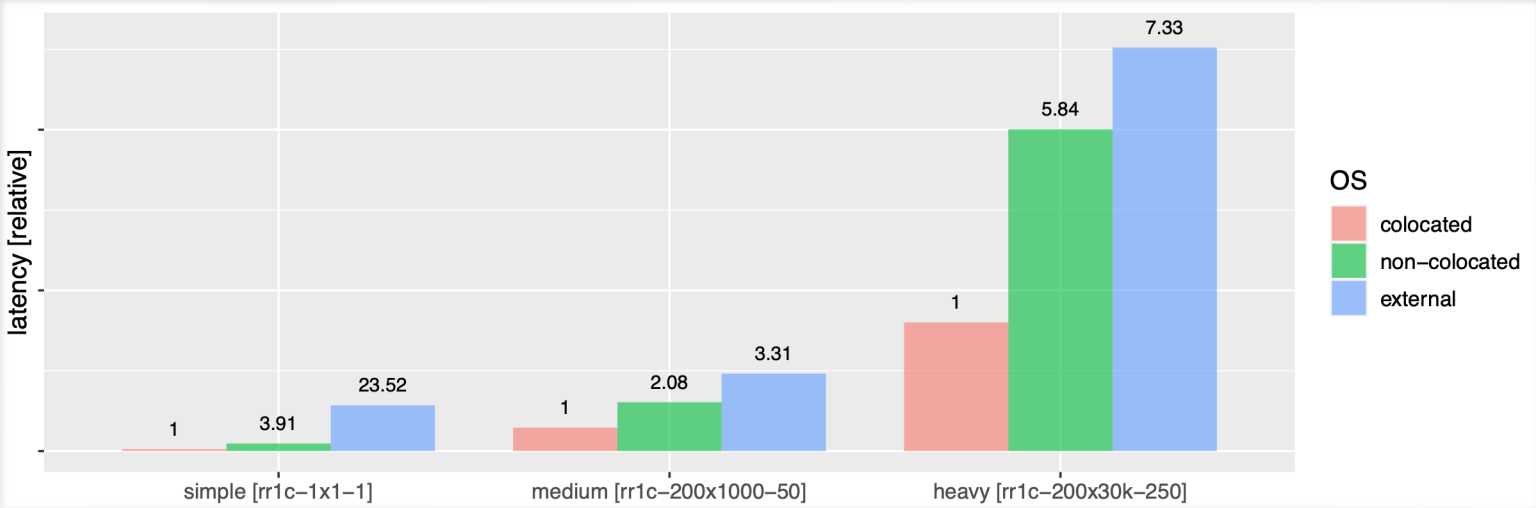
Tunings addressing performance influencing factors (4)



Service locality

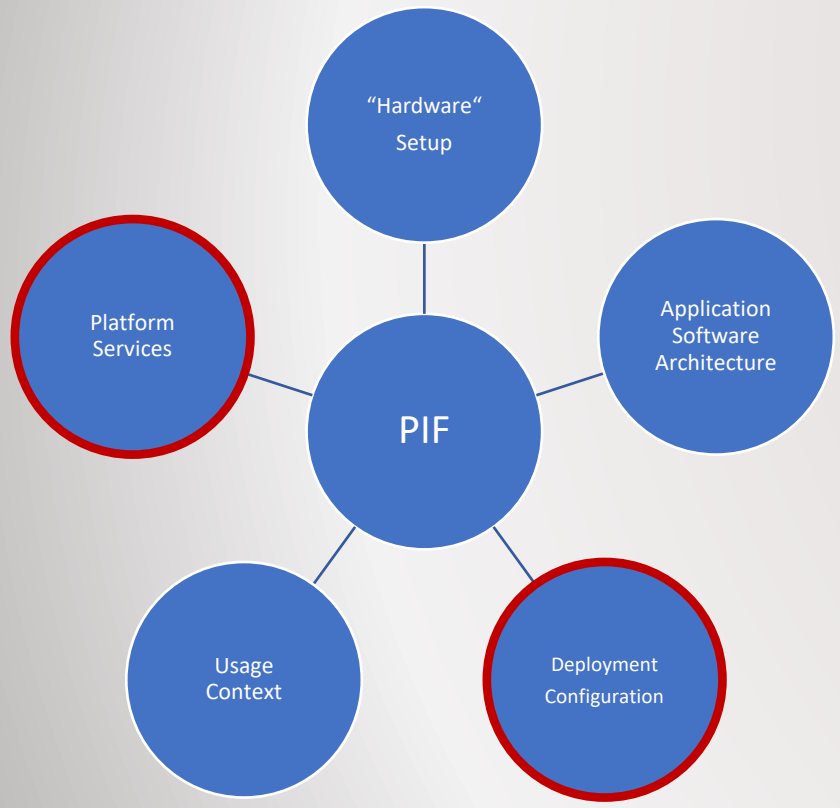
- Assumption: Service-oriented architecture/microservice architecture
- Each deployment strategy comes with different performance

- Longer network distances can impact both, latency and throughput



- Deploy services with frequent interaction locally
- Again trade-off decision required between CPU demand and locality

Tunings addressing performance influencing factors (5)



Nodes and node types

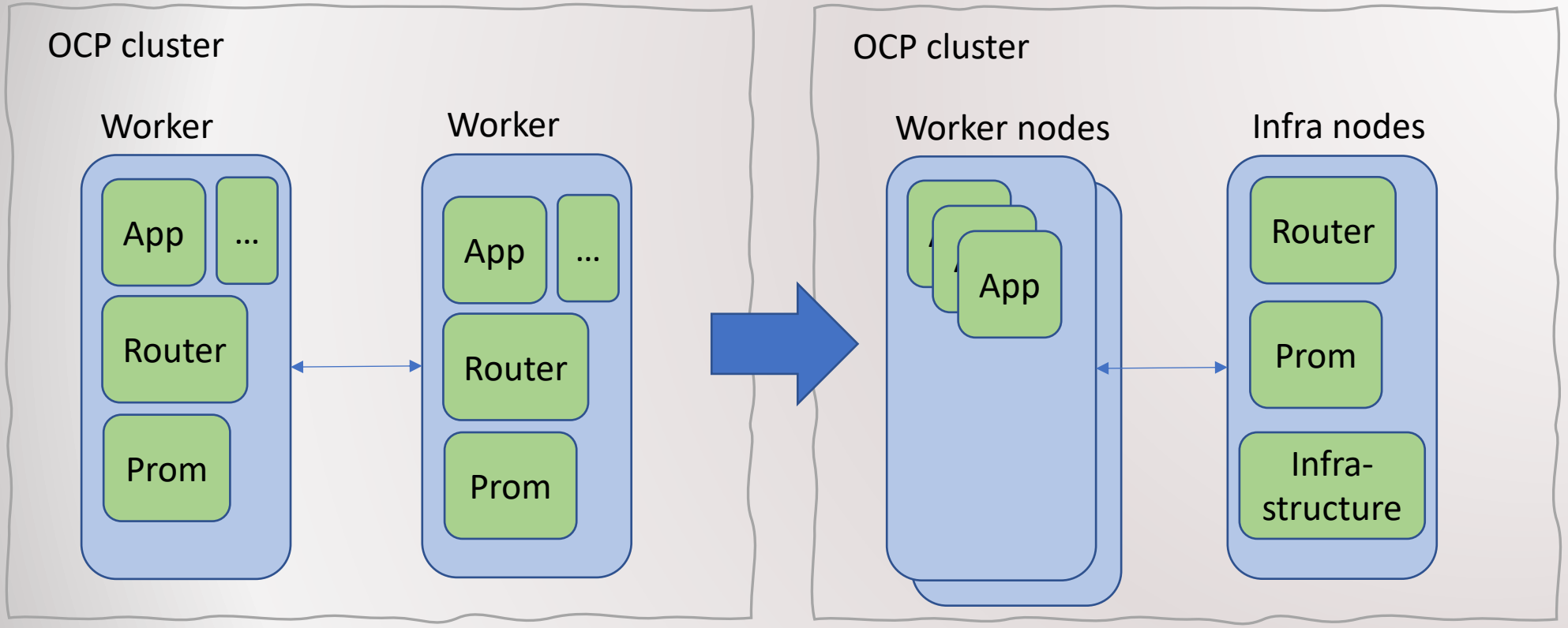
- Infrastructure nodes optional node types in OCP
- Can be used to offload worker nodes from infrastructure pods
  - Cluster monitoring
  - Ingress-router

- Using infra nodes and moving pods can lead to more stable workload performance
- Infrastructure pods consume cycles
- Can influence workload performance noticable
- Per default deployed on workers randomly

- Drawback: Less worker nodes available

How to setup infra nodes:

Tunings addressing performance influencing factors: Infra nodes (1)

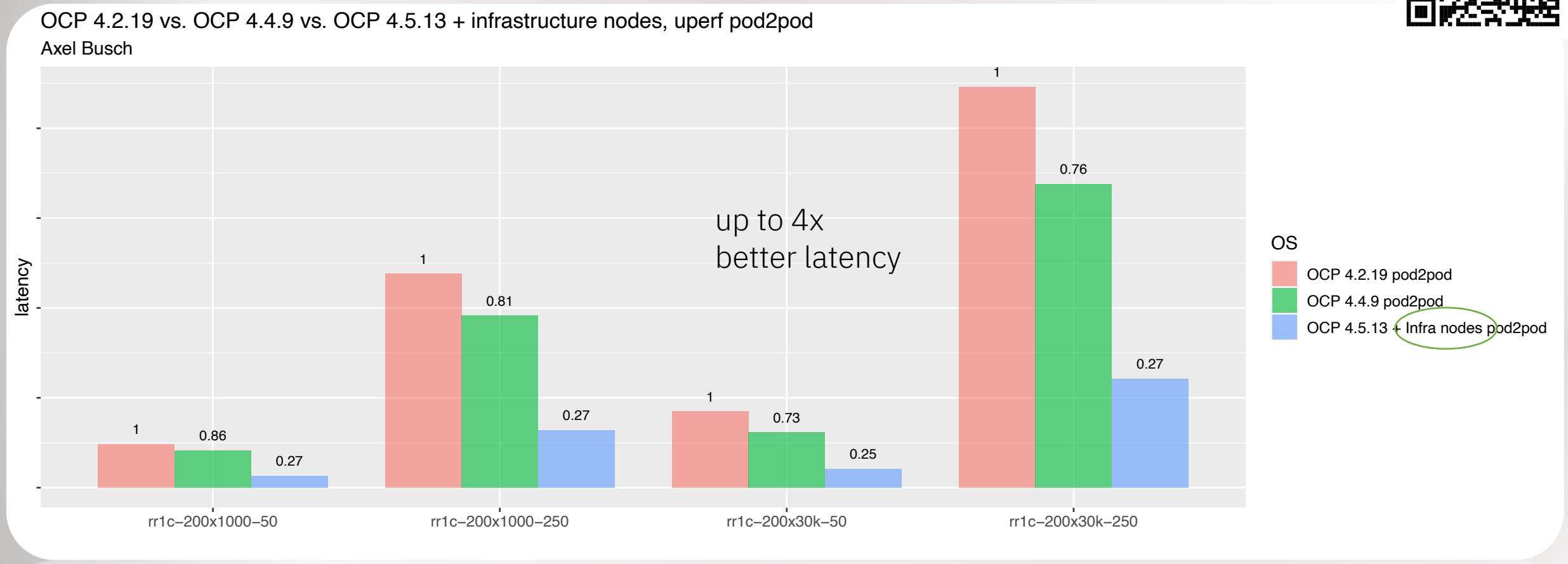


- OCP services, such as monitoring-solutions (e.g. Prometheus) and router run on worker nodes per default
- Consume resources of worker and slow down applications
- Move all infrastructure services to infrastructure nodes to keep workers for application workloads exclusively
- Can improve performance significantly

https://www.linkedin.com/pulse/boosting-performance-using-infrastructure-nodes-your-cluster-miranda/

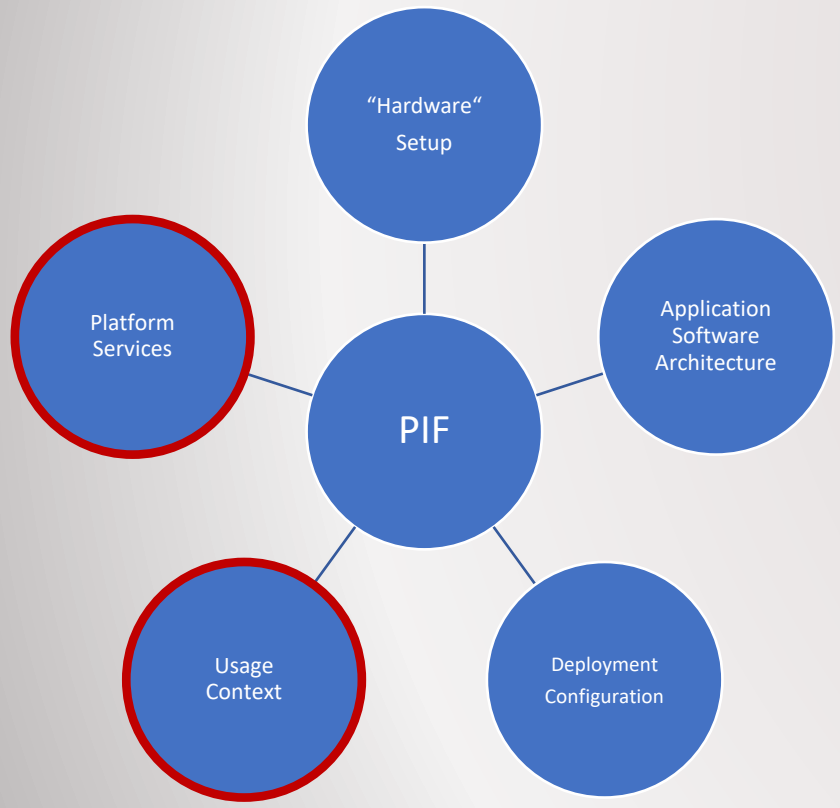
How to setup infra nodes:

Tunings addressing performance influencing factors: Infra nodes (2)



How to setup RFS:

Tunings addressing performance influencing factors (6)



RPS & RFS

- Receive Packet Steering (RPS) & Receive Flow Steering (RFS)
- Prevents hardware queue of network card beeing bottleneck
  - ksoftirq/0
  - ksoftirq/1
  - …
- Directs packets to specific CPUs
- Implemented on software level (kernel)

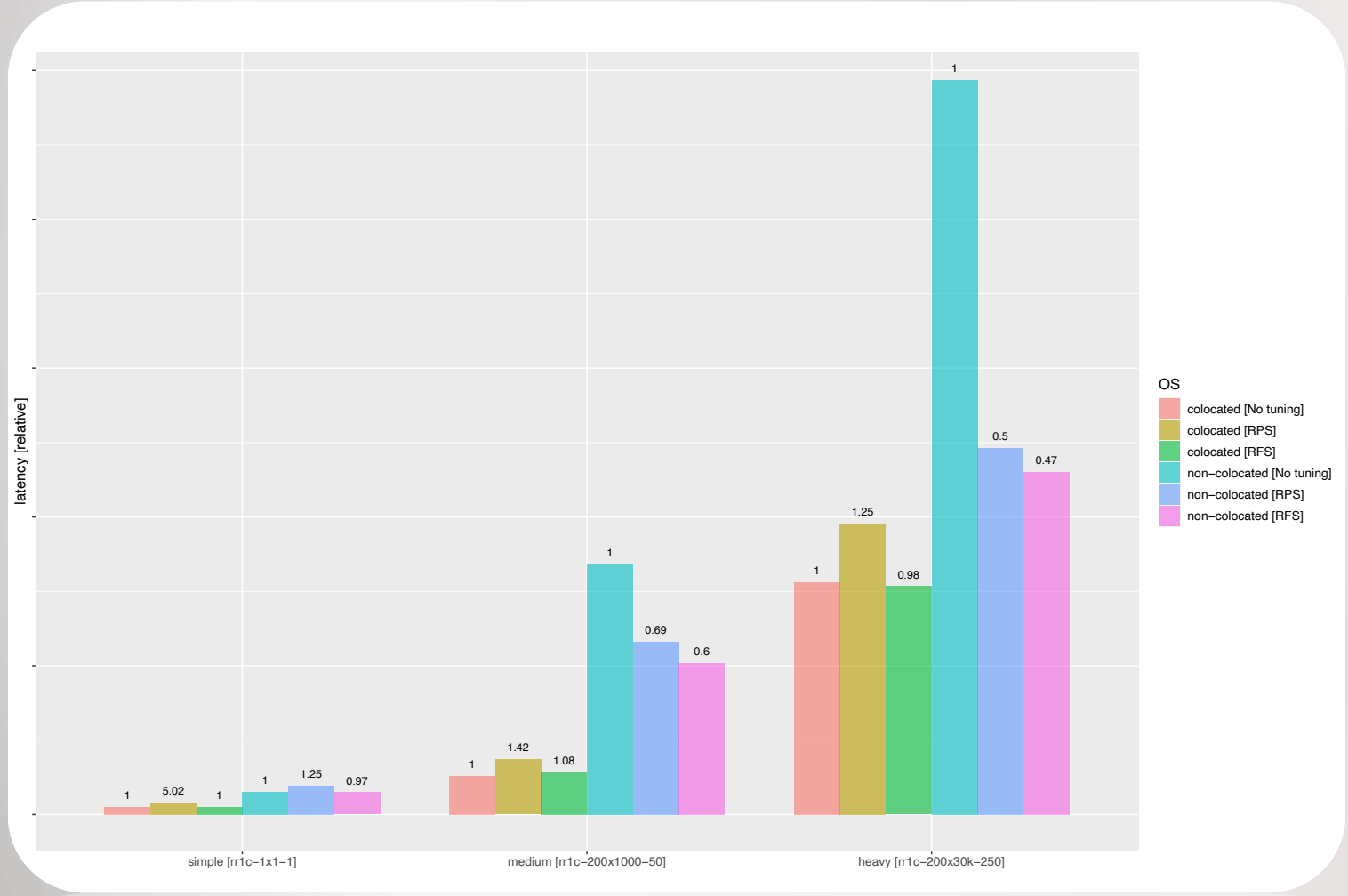
- Can improve latency and throughput
- Especially in high load networking scenarios

- Consumes CPU cycles
- Depends on workload whether to use or not

https://developer.ibm.com/components/ibmz/tutorials/red-hat-openshift-on-ibm-z-tune-your-network-performance-with-rfs/

How to setup RFS:

Tunings addressing performance influencing factors: Results



- RFS seems to outperform RPS (at least in our scenarios)
- RFS beneficial in non-colocated scenarios
- RPS can be harmful in co-located scenarios

RFS can improve performance up to 2x

Summary

Quality

Performance

Trade-off decisions to be made

Performance Influencing Factors

Tunings

RPS & RFS

infra nodes

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Thank you!

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Linux on IBM z Performance