Deploying On-Prem Kubernetes Cluster - Lessons Learnt

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AGENDA

- Cloud Native Stack
- High Level requirements
- Details

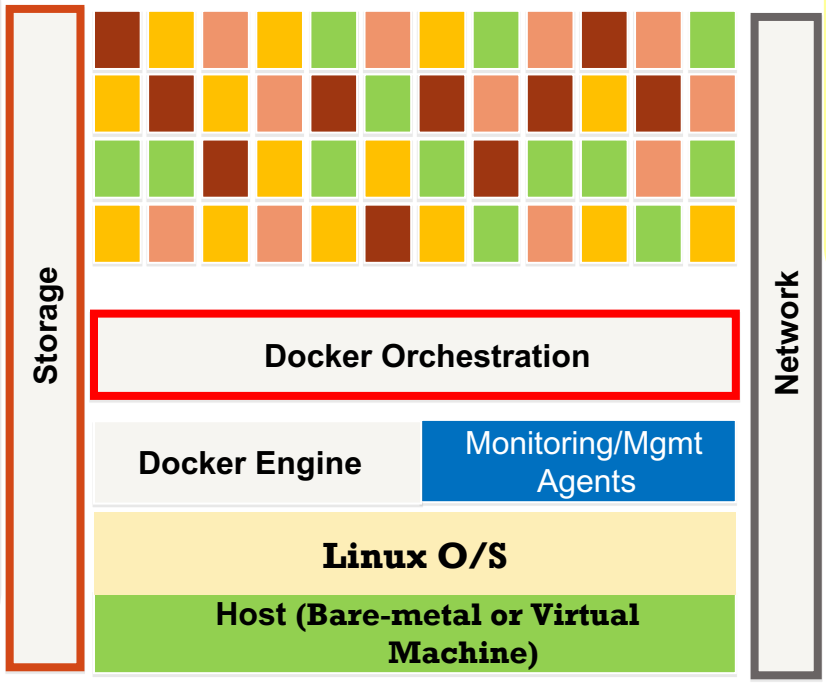
WHAT IT IS NOT

- Whether to Dockerize ?
- Which orchestration tool to use?

TYPICAL CLOUD NATIVE STACK

Operations

- *LifeCycle Management of Host and Containers*
- *Cluster Management*
- *Network Management*
- *Storage Management*
- *Monitoring & Alerting*
- *User Management*
- *Logging*
- *Security*
- *HA*
- *Backup and Disaster Recovery*



DevOps:

- *CI/CD Pipeline Tooling*
- *Build Service*
- *Trusted & Secure Registry*
- *Image Scanning & Integrity*
- *App & Image Governance*
- *PaaS*

Misc

- *Firewall*
- *Load Balancer*
- *Service Discovery*
- *DNS*
- *Proxy*
- *Ingress*
- *…*

Single System View

HIGH LEVEL REQUIREMENTS

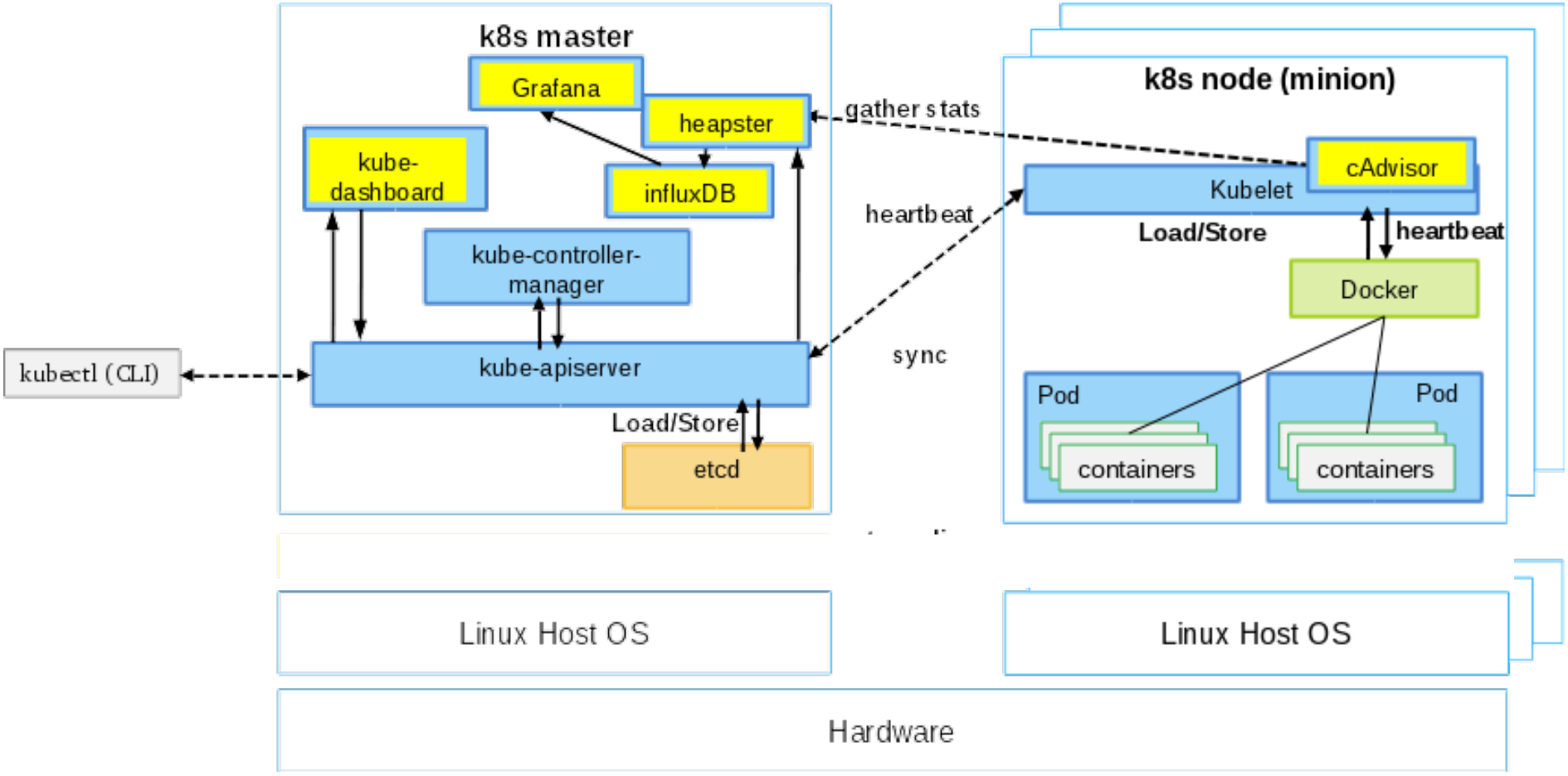
- **Docker Host**
  - VM/baremetal
  - Lifecycle management of hosts ?
- **Docker Storage** for Containers and Volumes?
- **Network** for Host and Docker Containers?
- **Docker Orchestration**
  - Handling user authentication & authorization
  - How to expose services ?
  - How to access legacy backends ?
  - How to handle resource management for different users and teams ?
  - Handling HA, backup & restore
- **Docker Image Build & Distribution**
  - Where to get the base images ?
  - How to handle multi-arch builds ?
  - How to scan the images for any existing vulnerabilities ?
  - Should the images be stored on public registry or private registry ?
- **Configuration management**
  - How to manage keys, secrets and runtime configuration of containers?
- **Logging**
  - What logging mechanism to use for containers and host ?
  - Should we use same or different logging mechanism for containers and host ?
- **Monitoring**
  - How to monitor host & containers ?
  - How to integrate into existing enterprise wide monitoring solution ?

DETAILS

DOCKER ORCHESTRATION

- Every orchestration s/w (Kubernetes, Docker swarm, Mesos-marathon) is opinionated when it comes to describing a containerized application (pattern)
- Developers and Operators need to be in agreement.
- This session is mostly focused on Kubernetes

KUBERNETES COMPONENTS



DOCKER STORAGE (CONTAINERS)

- **Key Points to Remember**
  - AUFS is not supported by any Linux Distribution
  - OverlayFS is a good choice – check support statement
  - Devicemapper with Direct-LVM is a decent (& supported) option
    - https://docs.docker.com/engine/userguide/storagedriver/device-mapper-driver/
- **Storage sizing depends on the role of the host**
  - Building Docker images requires significantly more storage

DOCKER PERSISTENT STORAGE (VOLUMES)

- **NFS**
- **HostPath**
  - Use a specific directory or file on the host
  - The directory can be from local storage or external storage (eg. SAN)
- Many more options in Kubernetes - Gluster, Ceph, etc.
- **NFS and HostPath are good options for on-prem Kubernetes deployments**

DOCKER NETWORKING

- Overlay (eg. Flannel)
  - Easier maintenance
  - Has performance overheads
- Flat
  - Maintenance overheads (manual partitioning and management of IP address space)
  - Better performance
- Layer-3 (eg. Calico)
  - Easier maintenance
  - Better performance
  - Provides network policy config
- **Calico is a good choice for Docker Networking with Kubernetes**
- Calico/Flannel comparison Ref: http://chunqi.li/2015/11/15/Battlefield-Calico-Flannel-Weave-and-Docker-Overlay-Network/

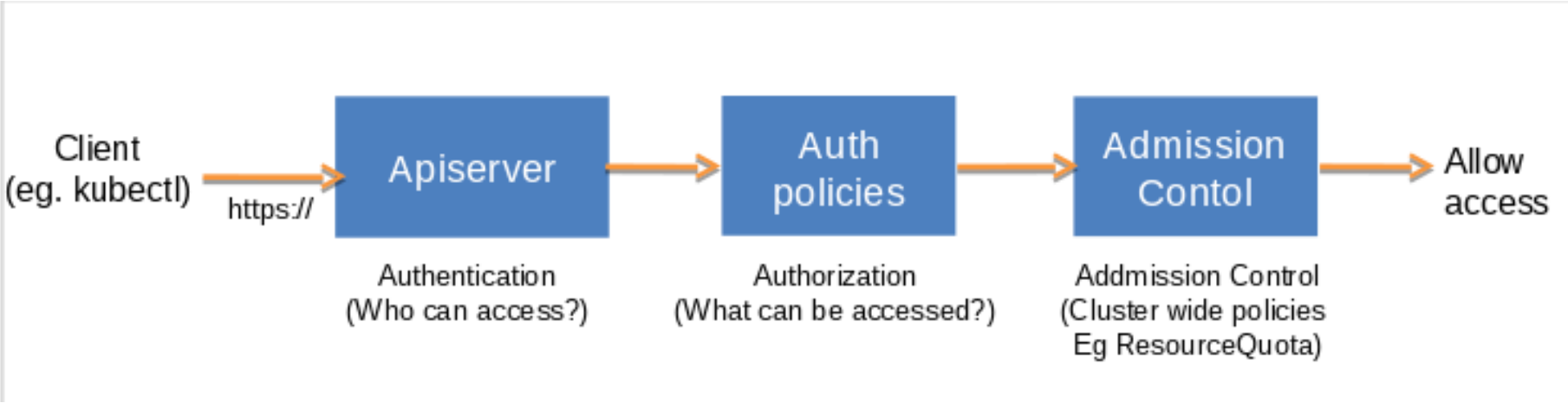
DOCKER IMAGES

- **Base Image**
  - From Public Registries like DockerHub
  - Create your own
- **Generic Best Practice**
  - Use layering
    - One layer for base, one for user configuration and one for application
  - Leverage 'USER' directive to run programs inside container as non-root.
  - Use environment variables for runtime configuration
  - Use volumes for storing application data
  - Ensure regular scanning of images
- **Multi-architecture Builds**
  - Use architecture emulators or native multi-arch build farms
  - Use fat (V2) image manifest or labels in the image name (ppc64le/mysql, mysql-ppc64le)
  - Example using arch emulator for multi-arch build - https://goo.gl/eU0Qbj

DOCKER REGISTRY

- Run your own private registry leveraging opensource docker distribution code (available with all Linux distributions)
- Commercial Docker orchestration tools ships with private registry (IBM Spectrum Conductor for Containers, RedHat OpenShift, Docker DataCenter etc)
- Standalone 3rd party solutions available as well
  - Docker Trusted Registry (DTR)
  - Artifactory
- Vulnerability Scanning of Docker Images
  - Integrated with 3rd party solutions
  - Setup your own (Clair, atomic-scan)
    - Example using Clair - https://goo.gl/Ff3ACw

USER MANAGEMENT



- **Authentication**
  - Static Password File
  - Certificate Based
  - Token Based
  - OpenID
  - **KeyStone** (required for LDAP/AD authentication)
- **Authorization**
  - **Role Based**
  - Attribute Based
- Example LDAP/AD authentication setup with Kubernetes - https://goo.gl/5qfy80

RESOURCE MANAGEMENT

- **Use Kubernetes Namespaces**
  - One namespace per user or group
  - Separate namespaces for Dev/Test/Staging/Build
  - Specify Resource Quota (cpu, mem, #pods, #services, #RCs, #PersistentVolumeClaims) for each namespace
- Use the same Kubernetes cluster for dynamic builds
  - Example Jenkins Build Pipeline Setup: https://goo.gl/OvHKm1

SECURITY POLICIES

- **Security Constraints**
  - Allowed/Disallowed container operations
    - Explicitly add/remove Linux capabilities from containers
    - Disable Linux system calls
  - Allow/Disallow container to run as root
  - Pod Security Policy
    - Governs what actions a pod can perform
  - Selinux/AppArmor rules

- **Network Policies**
  - Governs how Pods communicates with each other

- **Always set Kubernetes cluster wide security policies for production deployments**

- Example Cluster-wide Security Policy Setup - https://goo.gl/oBKm2S

EXPOSING SERVICE/LOAD-BALANCING SERVICE

- **Internal** (service not accessible outside of Kubernetes cluster)
  - ClusterIP (kube-proxy)

- **External**
  - External IPs
  - NodePort
  - Cloud Loadbalancer (for off-prem)
  - Ingress
    - Requires supported Ingress controllers eg. nginx, ha-proxy
    - 3rd party controllers (check with vendors) – F5, NetScaler etc.

- **Use Ingress for exposing services in Kubernetes**

BACKUP & RESTORE OF CLUSTER

- Kubernetes state is maintained in ETCD which is a distributed key-value store
- Deployment considerations for ETCD
  - Fault-tolerant cluster
  - Storage for ETCD (Network and IO latency directly affects ETCD)
  - ETCD data backup and restore
  - Enable TLS
- Deployment considerations for ETCD - https://goo.gl/n5VX1f

ACCESSING LEGACY APPLICATIONS

- Explicitly create a Kubernetes Endpoint and a Service
  - Create a Kubernetes Endpoint with IP and Port details of the Legacy Backend
  - Create a Kubernetes Service to expose the Endpoint
- Complete Example - https://goo.gl/V8TKnK

LOGGING

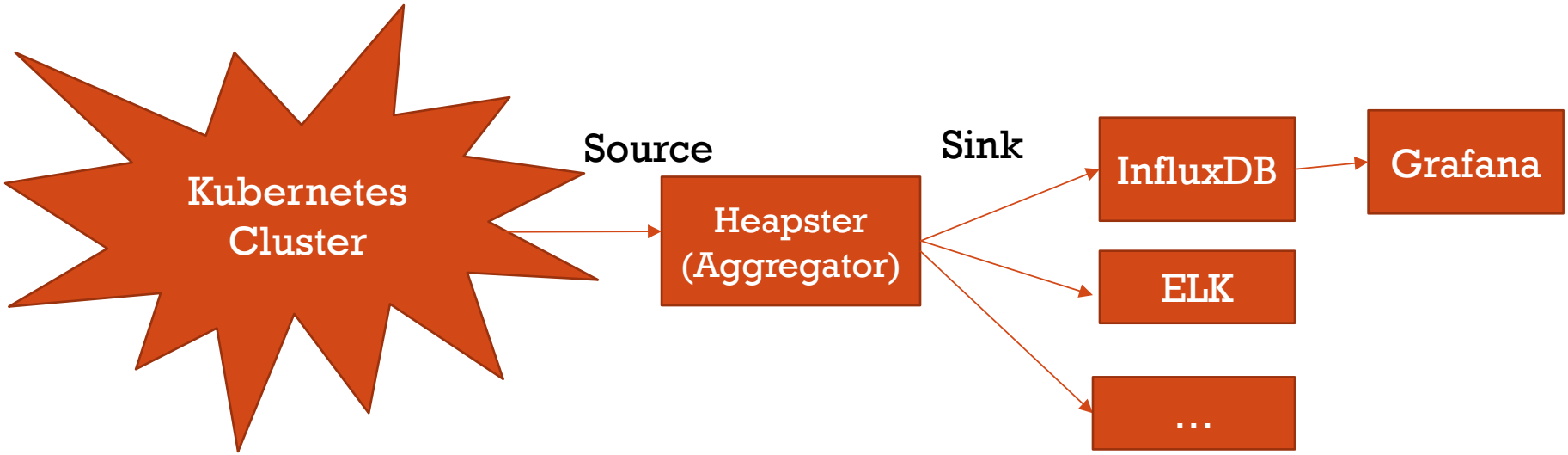
- **Docker Logging**
  - Which docker logging driver to use – json, syslog, journald etc.
  - Kubernetes metadata is available as part of docker labels

- **Kubernetes Logging**
  - If using systemd based Linux distro, then by default all logging is to journald
  - If ForwardToSyslog (/etc/systemd/journald.conf) is set to Yes, then logs will be available in syslog (rsyslog) as well
  - All kubernetes logs are in journald or /var/log/messages (if ForwardToSyslog is set to Yes).

- **Centralized logging**
  - Docker/Kubernetes -> Rsyslog -> ELK
  - Docker/Kubernetes -> Rsyslog -> Splunk

- Log rotation for Docker and Kubernetes is external and needs to be handled accordingly

MONITORING



- What if you want to integrate Kubernetes monitoring with your existing enterprise monitoring solution ?
  - Write your own sink ?
  - Use a different monitoring solution than Heapster
    - Note: Horizontal POD Autoscaling based on CPU utilization leverages Heapster

SUMMARY

- Docker Orchestration options are opinionated
- OverlayFS or Devicemapper with Direct-LVM for Docker Storage
- Plan for ETCD fault-tolerance, backup and restore
- NFS and HostPath for Docker Volumes
- Use Image Signing and Scanning
- Calico for Docker networking (low-overhead, supports Kubernetes Network Policy)
- Use Kubernetes Security Policies
- Use Ingress for exposing Services
- Use Kubernetes Authentication and RBAC Authorization
- Use Kubernetes namespaces for efficient cluster resource management

THANK YOU!!