docker

Module One

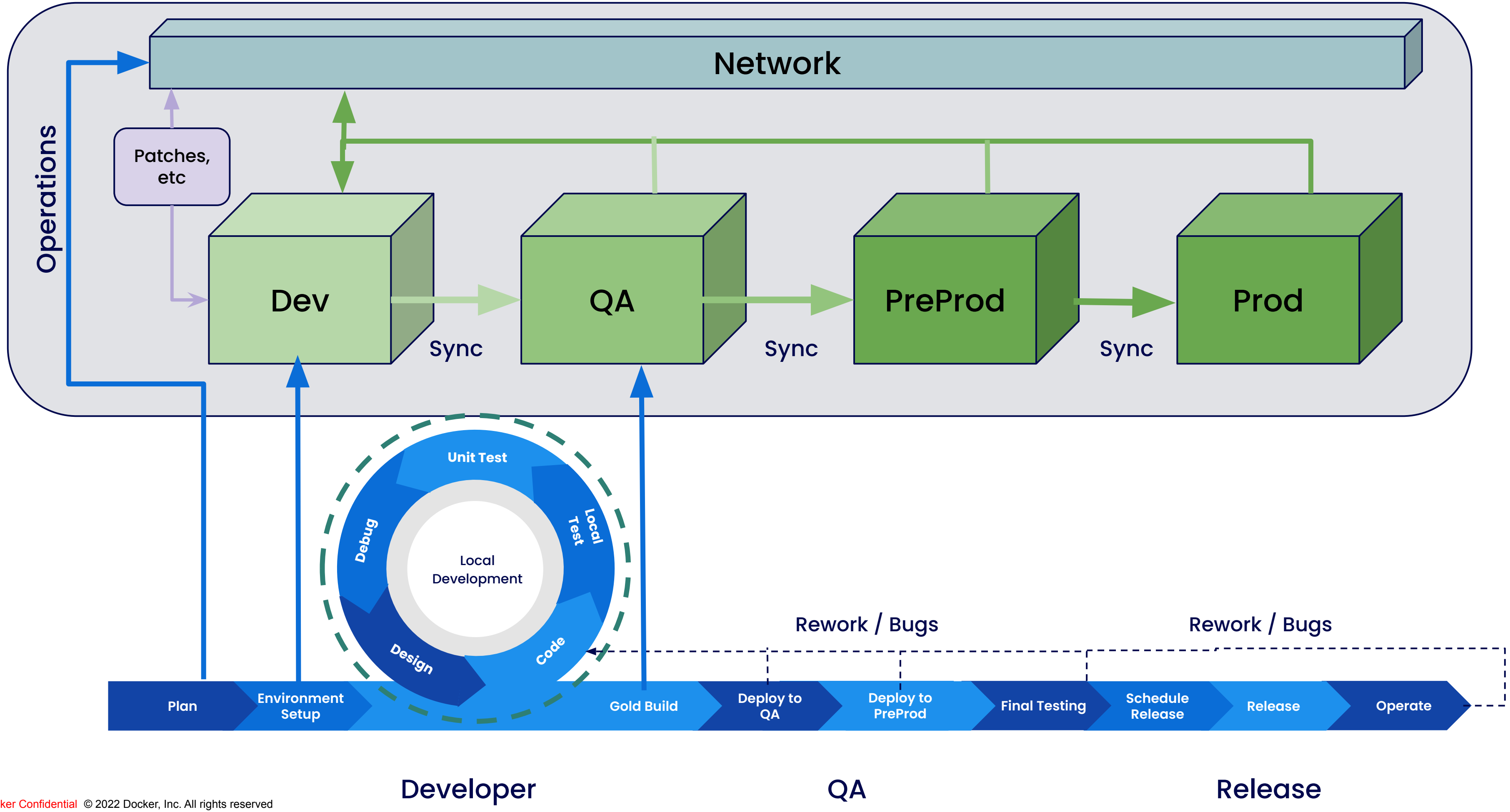
Intro to Docker and Containers

Docker’s vision

Increase the time developers spend on innovation, and decrease the time they spend on everything else

Why Change?

Before Containerization



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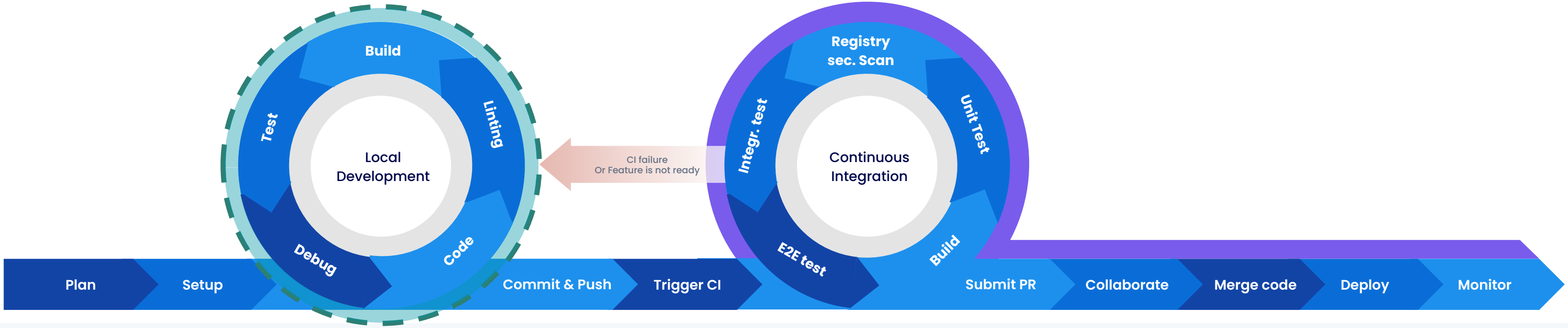
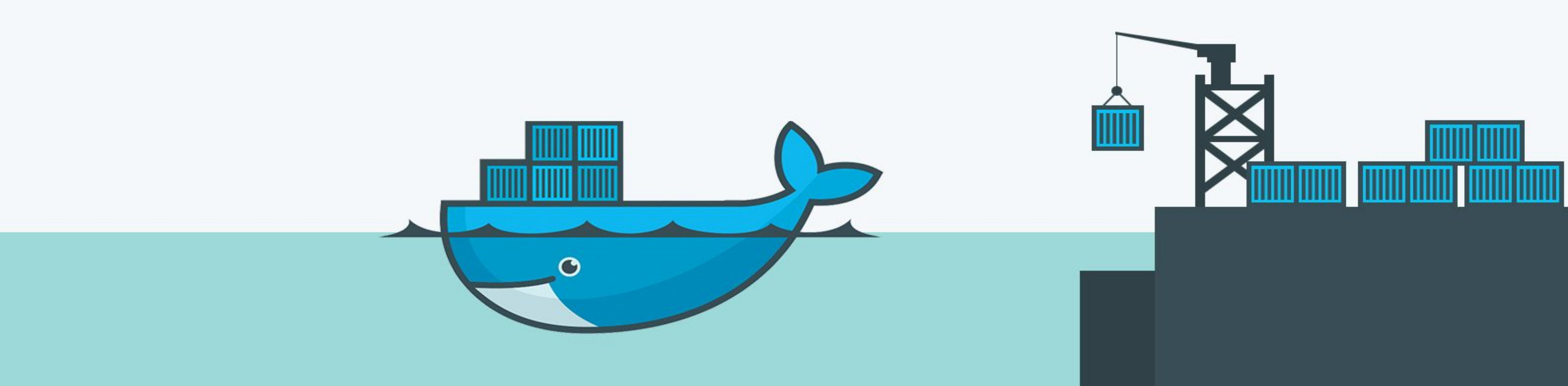
After Containerization



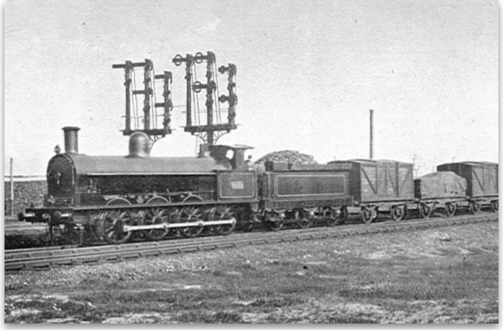


Why Containers?

Shipping over the years

Shipping by sea

Slow. Unstandardized. High chance of loss and theft.



Industrial revolution

Faster. Still unstandardized. Highlights inefficiencies.

Shipping container

Standardization causes massive improvement to throughput

Container (Shipping) Specifications

- Allows for interoperability with all users / vendors that follow the ISO Specification
- Codified under ISO 6346:1995
- Container dimensions are regulated under this code
  - Height:
    - Standard containers are 8 ft. 6 in
    - Other heights measuring from 4 ft. to 9 ft. 6 in.
  - Width
    - The majority of ISO containers have a width of 8 ft.
    - C, D, E, and F 8ft. to 8ft. 2.43in
    - L, M, N, and P exceeding 8ft. 2.43in.
  - Length
    - Common container lengths include 20 ft. and 40 ft.
    - Other available lengths comprise 24 ft., 28 ft., 44 ft., 45 ft., 46 ft., 53 ft., and 56 ft.

Note: This is illustrative; please don’t do a deep dive into Shipping Containers.

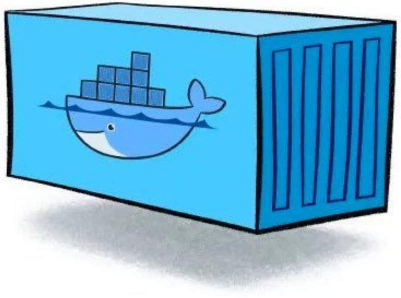
Net results

Port turnaround times dropped from 3 weeks to 24 hours

Shipping costs dropped from $5.86/ton to $0.16/ton, a 97% reduction in cost

Theft/damage dropped significantly due to fewer touches

Shipping software



Per-app deploys

Slow. Unstandardized. High chance of drift and misconfiguration.

Mobile/internet age

Need to deploy more often. Highlights gaps and environmental issues.

Container spec

Standardized packaging makes it easy to build, share, and run applications

Container (Software) Specifications

- Docker created the Open Container Initiative in June 2015
- Currently owned by the Linux Foundation
- Currently defines three specifications
    - `image-spec` - defines image structures and manifests
    - `runtime-spec` - defines how to run OCI images
    - `distribution-spec` - defines the API protocol to push, pull, and discover content

Positive results

93% of survey respondents reported accelerated application development and deployment with containers and Kubernetes and a 26% increase in developer productivity.

CNCF, 2020 / Portworx

87% of surveyed organizations reported cost savings after containerizing along with 6x higher availability

451 Research, 2020
Sysdig

Up to 50% increase in server utilization, along with 21% less deployments with containers.

Diamanti, Netflix

Where are containers?

Software development

Dev environments

Microservices

Monoliths

In production

CI/CD pipelines

Education

Classroom environments

Reproducible research

Emerging fields

Data sciences

Edge computing

AI/ML model training

Distribution/ usage of models

DIYers

Home automation

Private game servers

Media streaming

Network monitoring

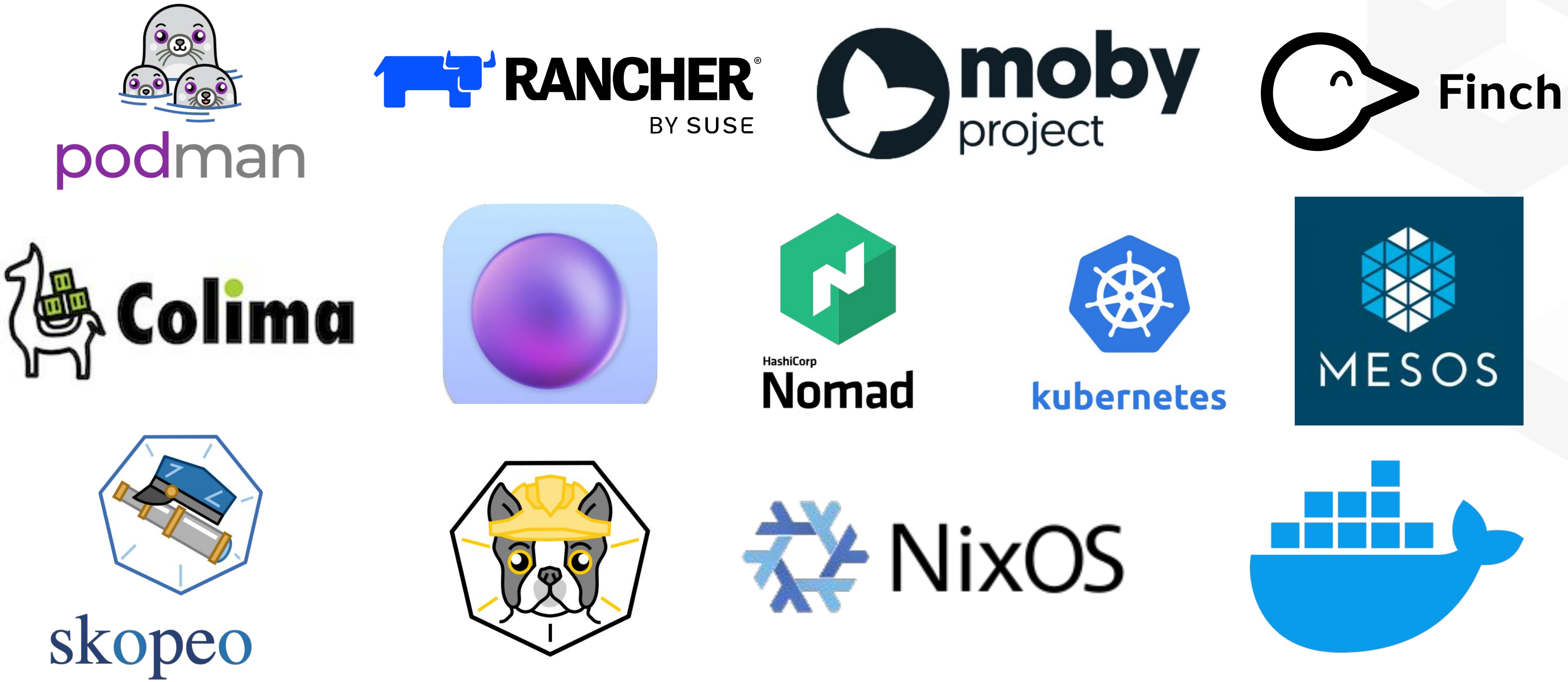
NAS servers

Why does OCI Matter?

OCI is the cornerstone of containerization, providing standardization and interoperability that fuels the container ecosystem's growth and ensures portability, security, and long-term stability.

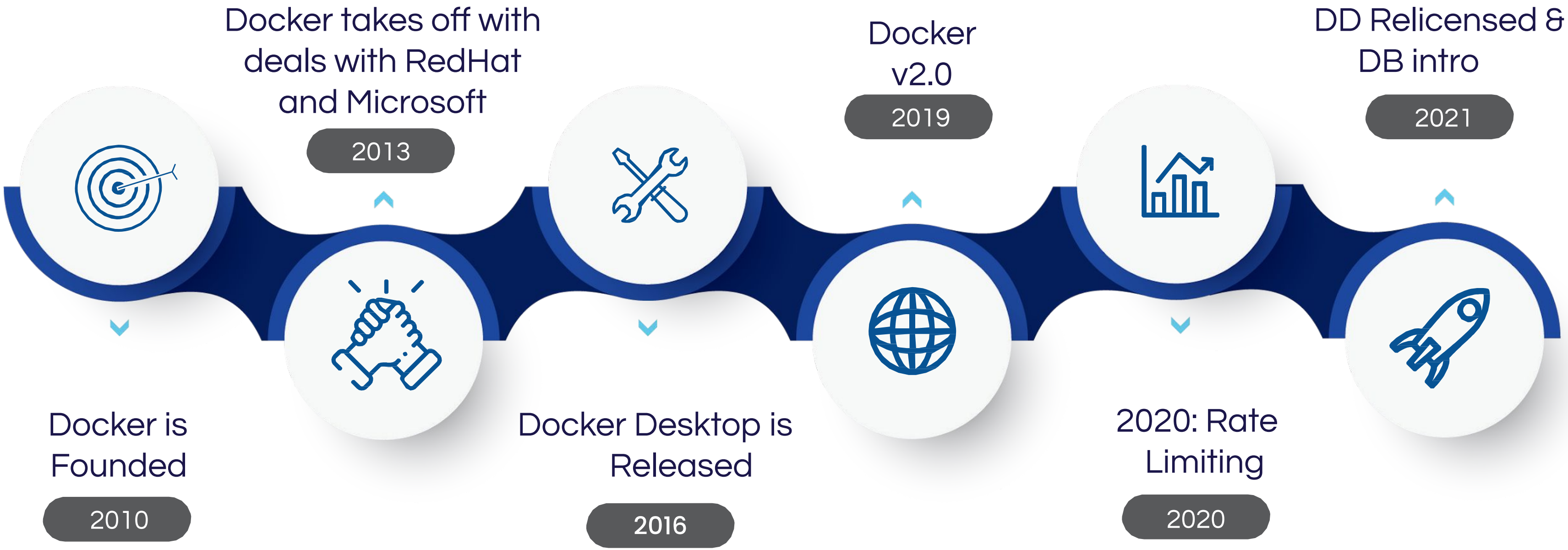
Some OCI Compliant Tooling

OPEN CONTAINER INITIATIVE



About Docker…

Brief History Timeline



Docker is Founded

2010

Docker takes off with deals with RedHat and Microsoft

2013

Docker Desktop is Released

2016

Docker v2.0

2019

2020: Rate Limiting

2020

DD Relicensed & DB intro

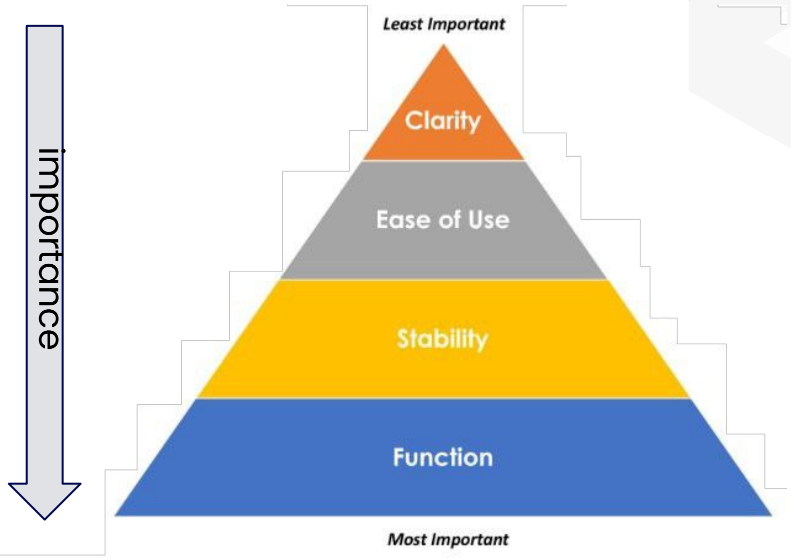
2021

At Docker We Believe It Is Critical To **Empower** Developers

Developer Experience Is A Leading Indicator Of A Successful Company

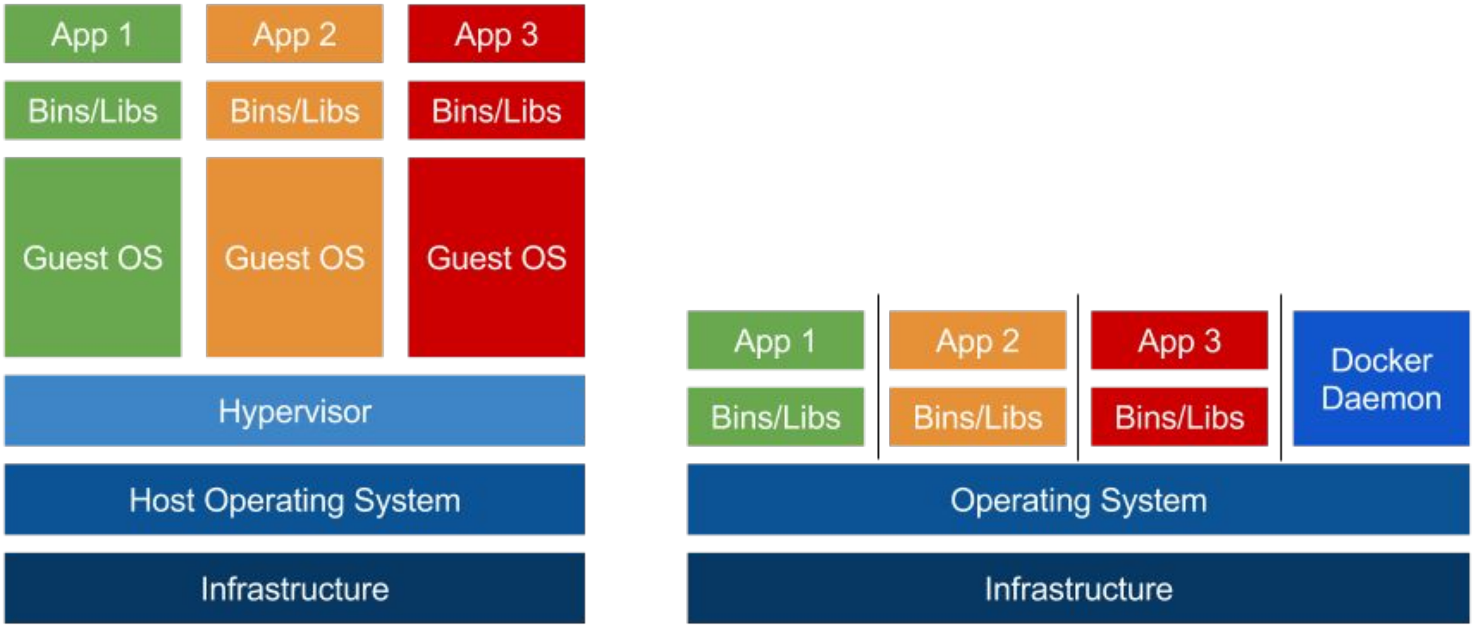
Side Effects Of Bad Dx

- Inability To Retain Top Talent
- Buggy Software
- Change Is Slow
- Low Customer Satisfaction
- Outages
- Excessive Spending



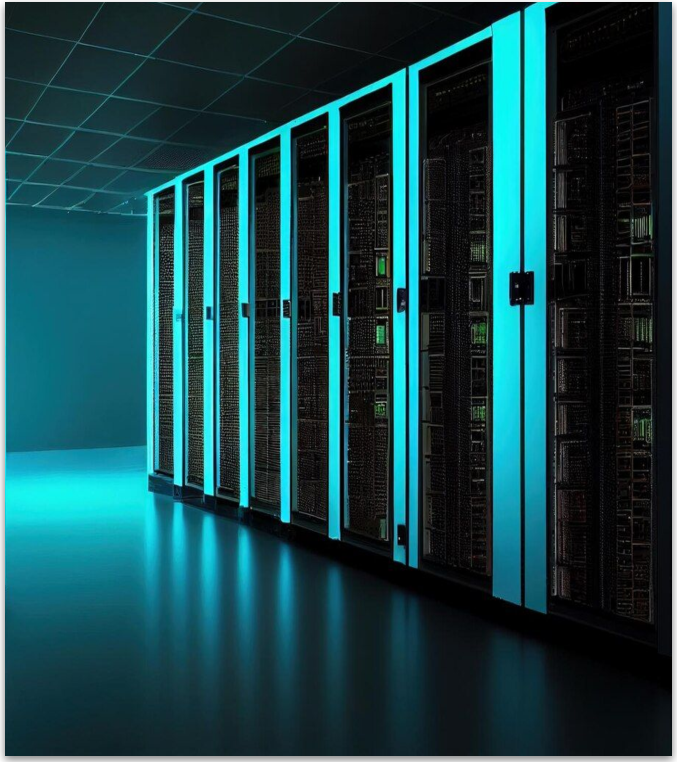
Containerization Benefits

But What About VMs?



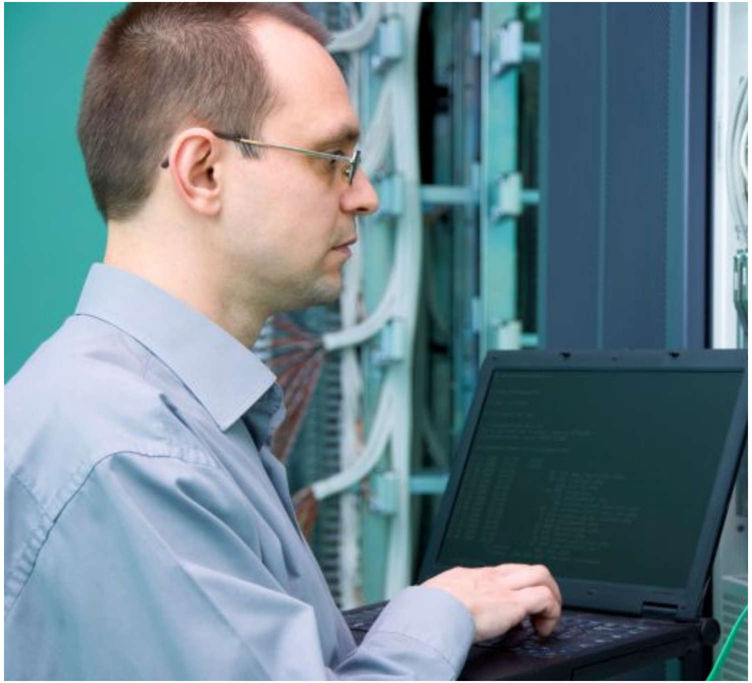
Reduction in Infrastructure Costs

- Containers are more efficient than virtual machines
  - Shared host kernel
  - Easier to share resources
- Containers reduce overhead
  - Each container is self-contained
  - Host is only responsible for container runtime



Reduction in Management Costs

- Containers are easier to manage
    - Versioned
    - Simple Migration Path
- Easier Host Management
    - OCI Runtime
    - Storage
- Easier Scalability
    - Add/Remove Containers

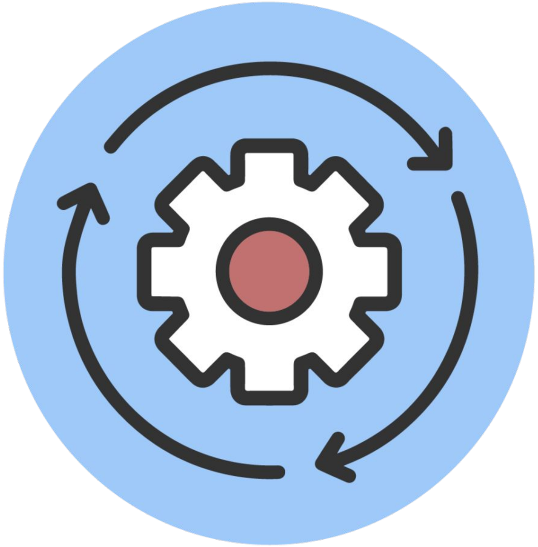


Developer Velocity

- Use Prebuilt Images
  - Official / Verified Images
  - Easier Upgrades
- Reduce “Cold Start” Problem
  - Stand Up / Tear Down Environments
- Consistent Environment
  - “Works on My Machine”

Moving to Production

- Many OCI Compliant Options
  - Kubernetes / OpenShift
  - NOMAD
  - Serverless
- Large Ecosystem of Tooling
  - Management
  - Security
  - Authentication / Management
  - Virus / Malware



Other Options

- Virtual Machines
  - Resource Overhead
  - Management Overhead
- Cloud Based VMs
  - Management Overhead
  - Price

- Physical Servers
  - Resource Overhead
  - Lack of Flexibility
  - Management Overhead
- Development Systems
  - Configuration Management
  - Resource Management

Important Terms and Definitions

Code Repository

- A storage location for source code
  - Code is pushed/pulled from the repository during its lifecycle
  - Can be SaaS or Local
  - Can be Public or Private
- Examples:
  - Github
  - Gitlab
  - BitBucket

OCI Image

- An image that complies with the OCI specifications
- Other names
  - Docker Image
  - Container Image
- Includes everything necessary to create / run a piece of software
  - Running Image == Container
- Built from Dockerfile + Base Images + Code / Files / Packages
- Images are annotated with tags
  - “latest”
  - “test”
  - “v1.1”

Image Registry

- A storage location for container images
  - Many repositories exist inside a container registry
  - Images are pushed/pulled from a repository in the registry
  - Can be SaaS or Local
  - Can be Public or Private
- Examples:
  - Docker Hub
  - Amazon ECR
  - Harbor
  - JFrog Artifactory

Namespace

- A string used as a container for repositories
  - Can be a username
  - Can be an organization name
  - Multiple namespaces exist in a registry
  - Each namespace has one to many repositories
- Examples
  - Docker Hub User Namespace: jayschmidt
  - Docker Hub Organization Namespace: virington

Image Repository

- A collection of related container images
  - A repository can contain many images
  - Images can have one to many tags
  - Repositories live inside a registry
- A fully qualified image consists of:
  - registry/namespace/repository:tag
- Examples
  - Repository: hub.docker.com
  - Namespace: jayschmidt
  - Registry: ratg
  - Tag: latest
  - All together: hub.docker.com/jayschmidt/ratg:latest

Container

- A running instance of a container image
- Also called
  - Docker Container
  - OCI Container
- OCI images run on any OCI compliant runtime environment
  - “containerd”
  - “runc”
  - “Sysbox”
- Isolates the application and its environment to run on any machine

Container Orchestrator

- A system designed to manage containers
  - Controls lifecycle management
  - Provides monitoring / management / security
- Some examples:
  - Kubernetes (EKS, AKS, Microk8s, K3s, KinD, Talos, etc)
  - Hashicorp NOMAD
  - Mirantis Container Runtime
  - Serverless (Fargate, ECS, etc)

Quick Summary

- Code Repositories
  - Where application code is stored and managed
- Image Registries
  - Where container images are stored after they are built
- Container Images
  - Blueprint of the app, ready to be deployed
- Containers
  - Running instances of the image, isolated and lightweight
- Orchestrators
  - System to run/manage/monitor/secure multiple containers

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Containerization Journey

Your Containerization Journey

- Almost nobody starts containerization with a blank slate
- There is a mix of new applications and existing applications
- The best practice is to understand your companies' willingness to containerize applications, and create standard processes for doing so
- This process must include a triage/prioritization step

Application Modernization Triage

What are the considerations for modernizing applications?

- **Business priorities** – What are the business priorities, and how do they align to modernizing this application?
- **Application knowledge** – does anyone really understand how the application works or how its deployed?
- **Application tech stack** – how do the technologies used in this application align to our current application technology standards?
- **Application lifespan** – is this application still needed in its current form?
- **Organizational capacity** – how much capacity do the development /testing/operations teams have to work on this application?
- **Cost/Risk** – What are the costs and risks of running the current monolith vs the costs and risks of modernizing the application?

Application Modernization Strategies

5 R’s first popularized by Gartner

- **Rehost** – Minimal/No changes “Lift and Shift”
- **Refactor** – Light modifications to the application
- **Rearchitect** – Significant modifications/splitting of the application
- **Rebuild** – Rewriting/Redesigning the application
- **Replace** – Retire application and replace with other systems

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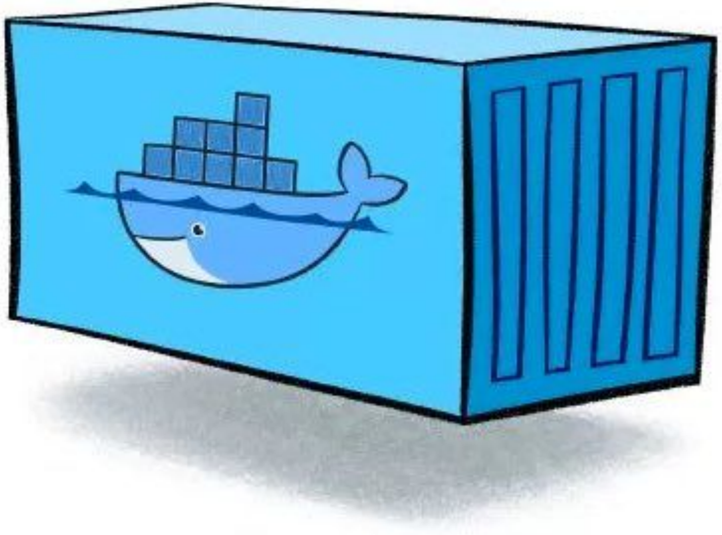
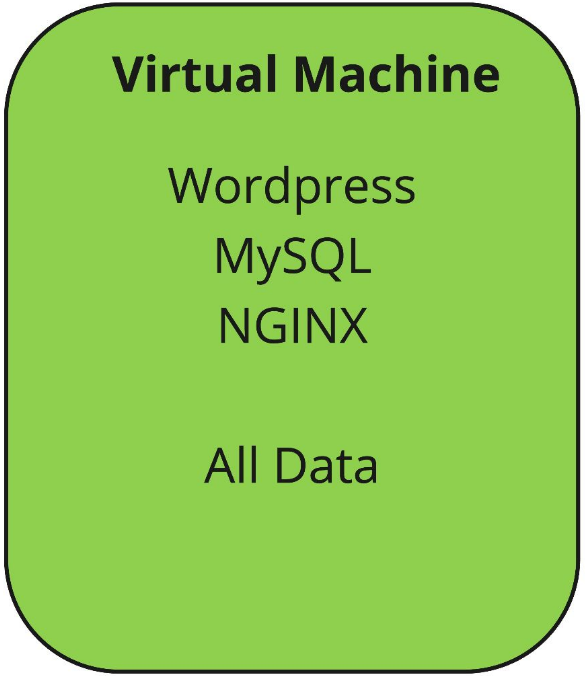
Migrating to a Container

The Challenge: Containerize a VM or Bare Metal Workload



Current Deployment



Virtual Machine

Wordpress

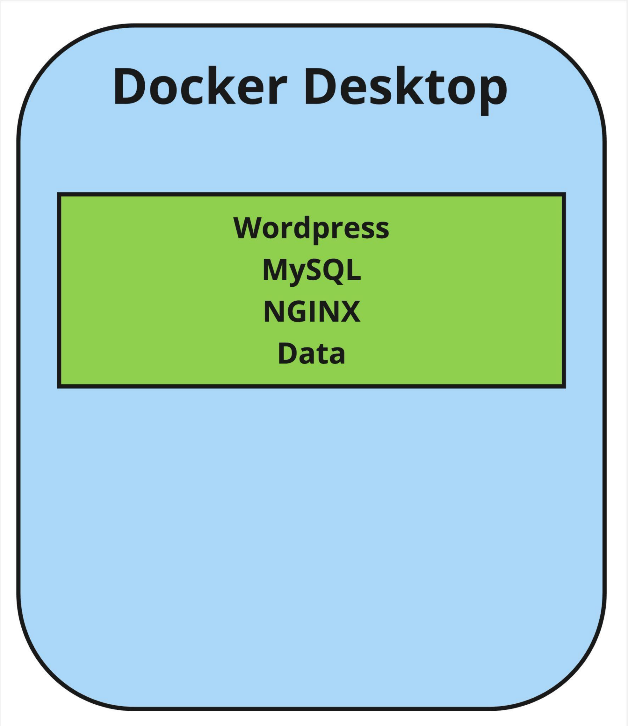
MySQL

NGINX

All Data

- Ubuntu 20.04 LTS
- WordPress application
- MySQL for data storage
- Data directory for media and uploads
- NGINX for serving the site
- All data stored locally

Simple solution - why not Lift and Shift?



Pros:

- Everything from the VM
- But now in an image!
- Repeatable and shareable

Cons:

- Missing out on a lot of container benefits
- May not be easily scalable

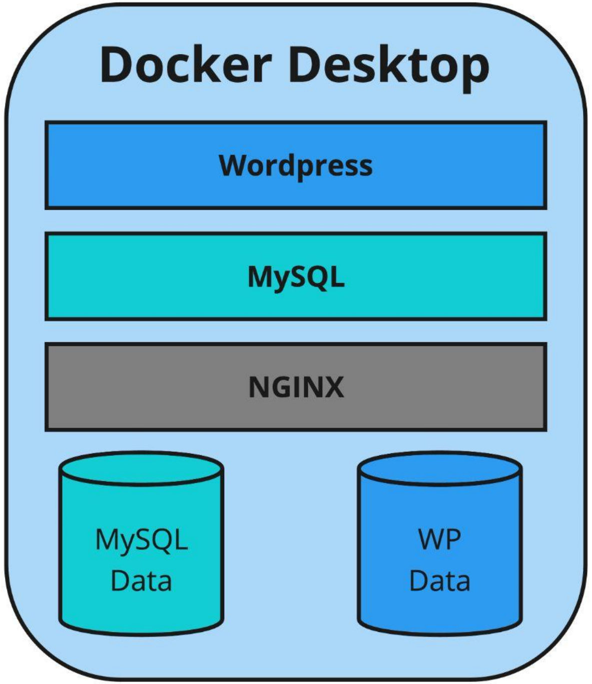
Bottom Line:

- Choose what works best for you…
- …but understand the tradeoffs

Remember why are we doing this

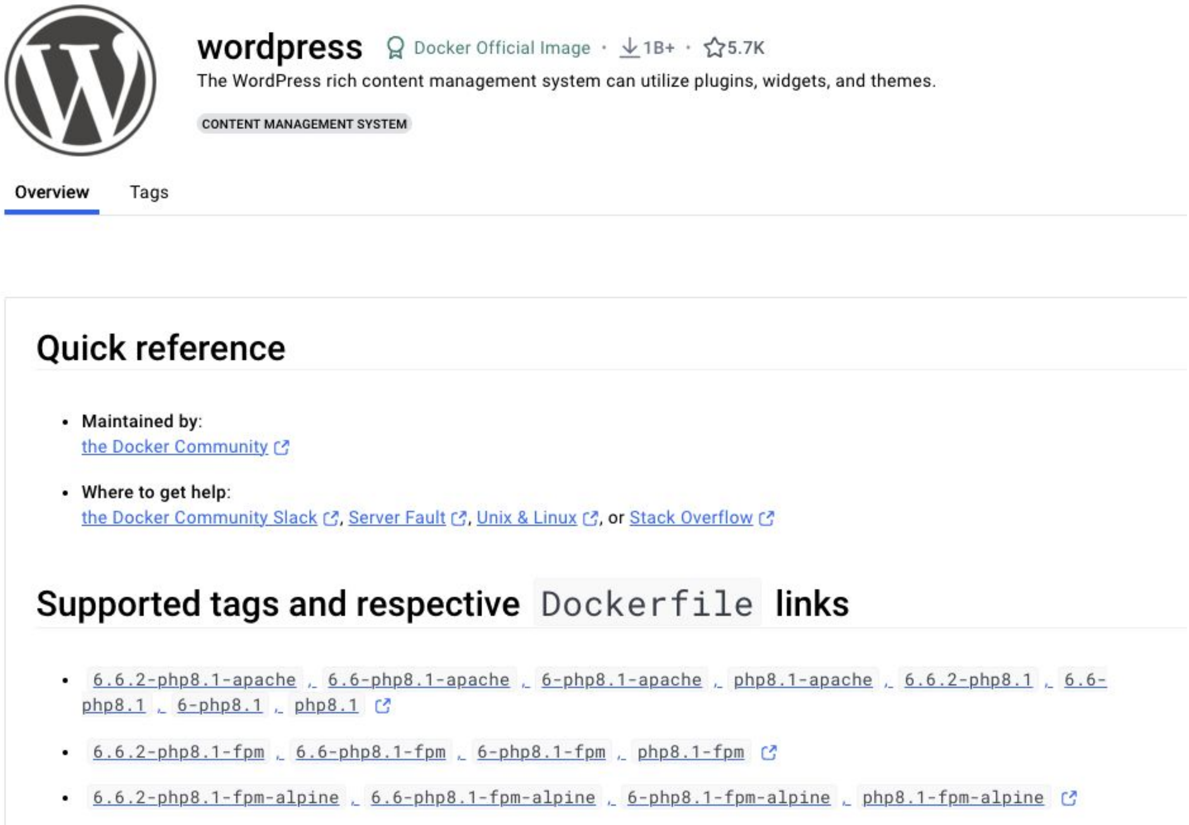
- Isolation
  - Each component runs in its own environment
- Version Control
  - Easily manage and update software versions
- Scalability
  - Scale components independently based on demand
- Portability
  - Run the application consistently across different environments
  - This can include other OCI compliant runtimes/orchestrators

A Better Container Deployment



- Ubuntu 20.04 LTS Base
- WordPress container
- MySQL container
- NGINX container
- Wordpress Volume
- MySQL Volume

Wordpress



wordpress Docker Official Image · 1B+ · 5.7K

The WordPress rich content management system can utilize plugins, widgets, and themes.

CONTENT MANAGEMENT SYSTEM

Overview Tags

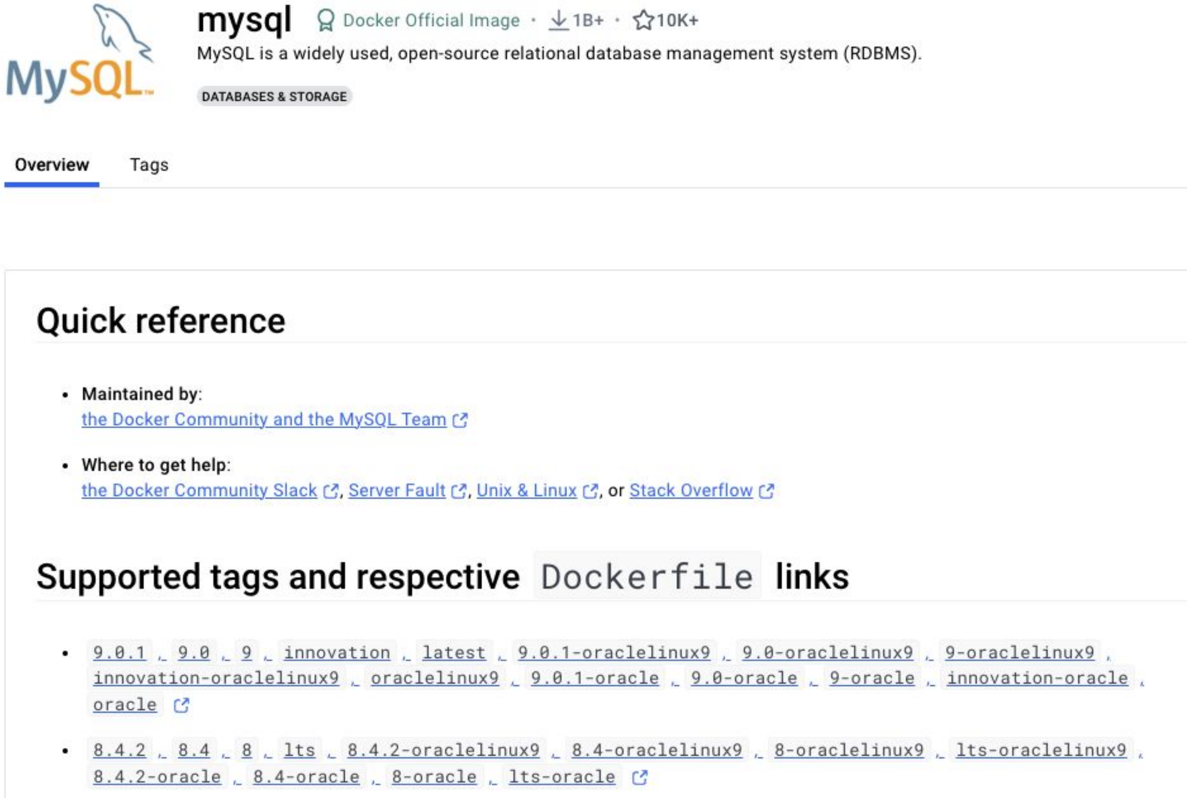
Quick reference

- **Maintained by:**
  the Docker Community
- **Where to get help:**
  the Docker Community Slack, Server Fault, Unix & Linux, or Stack Overflow

Supported tags and respective `Dockerfile` links

- `6.6.2-php8.1-apache`, `6.6-php8.1-apache`, `6-php8.1-apache`, `php8.1-apache`, `6.6.2-php8.1`, `6.6-php8.1`, `6-php8.1`, `php8.1`
- `6.6.2-php8.1-fpm`, `6.6-php8.1-fpm`, `6-php8.1-fpm`, `php8.1-fpm`
- `6.6.2-php8.1-fpm-alpine`, `6.6-php8.1-fpm-alpine`, `6-php8.1-fpm-alpine`, `php8.1-fpm-alpine`

MySQL



mysql Docker Official Image · 1B+ · 10K+

MySQL is a widely used, open-source relational database management system (RDBMS).

DATABASES & STORAGE

Overview Tags

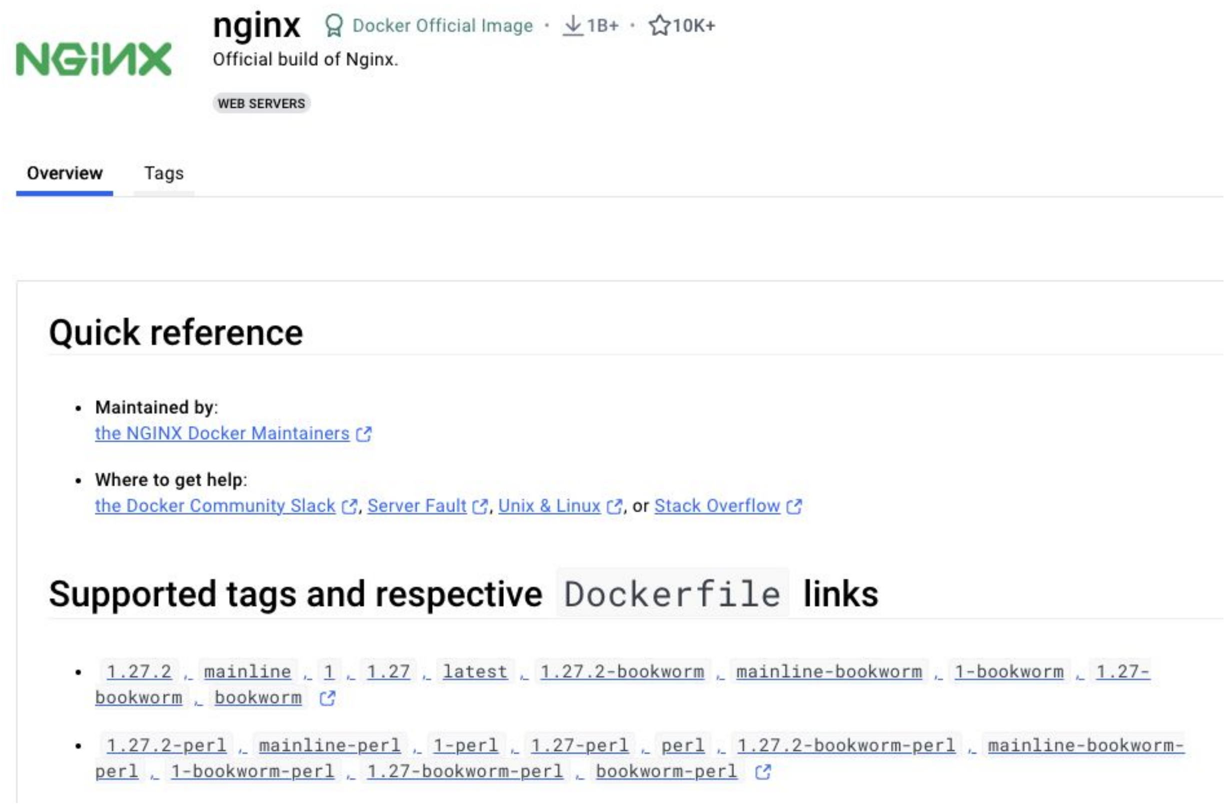
Quick reference

- **Maintained by**:
  the Docker Community and the MySQL Team
- **Where to get help**:
  the Docker Community Slack, Server Fault, Unix & Linux, or Stack Overflow

Supported tags and respective `Dockerfile` links

- `9.0.1`, `9.0`, `9`, `innovation`, `latest`, `9.0.1-oraclelinux9`, `9.0-oraclelinux9`, `9-oraclelinux9`, `innovation-oraclelinux9`, `oraclelinux9`, `9.0.1-oracle`, `9.0-oracle`, `9-oracle`, `innovation-oracle`, `oracle`
- `8.4.2`, `8.4`, `8`, `lts`, `8.4.2-oraclelinux9`, `8.4-oraclelinux9`, `8-oraclelinux9`, `lts-oraclelinux9`, `8.4.2-oracle`, `8.4-oracle`, `8-oracle`, `lts-oracle`

NGINX



nginx

Docker Official Image · 1B+ · 10K+

Official build of Nginx.

WEB SERVERS

Overview Tags

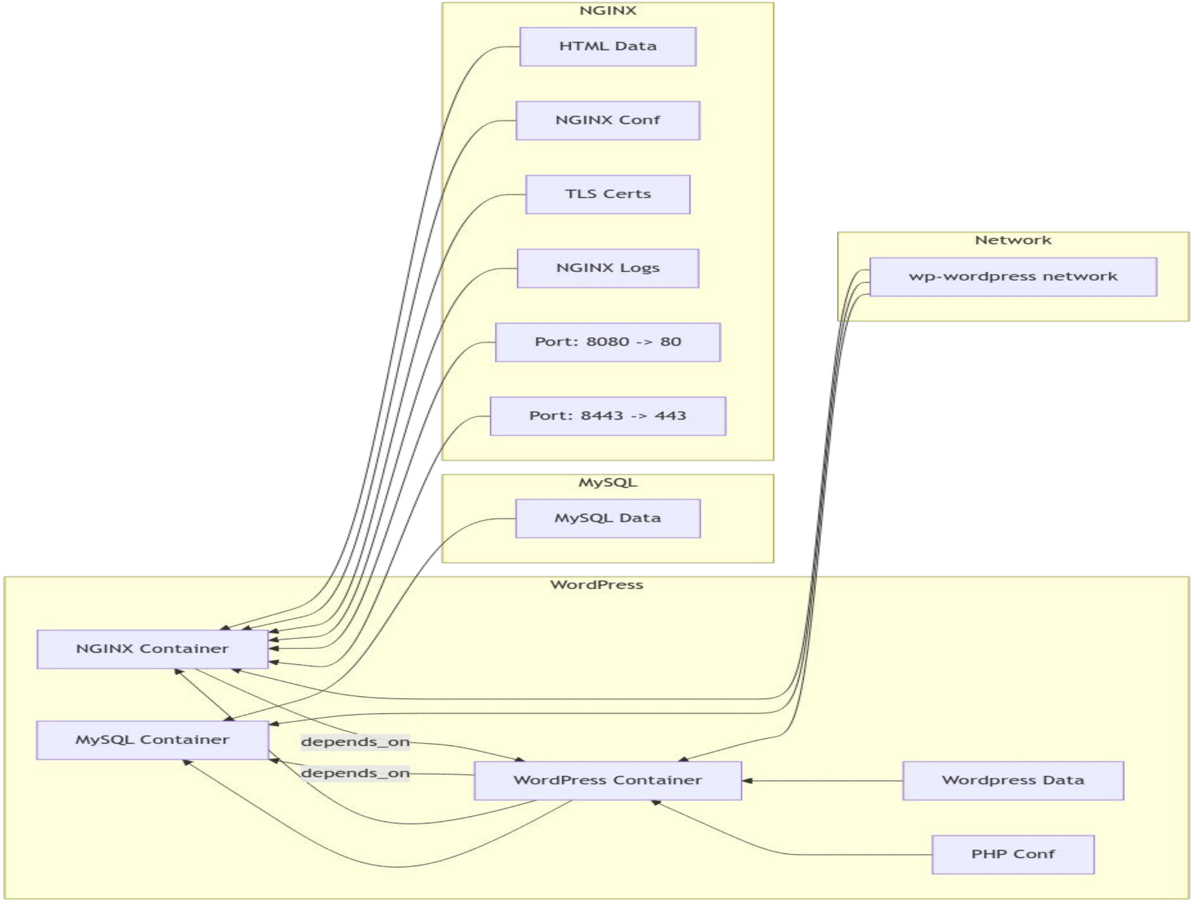
Quick reference

- **Maintained by**:
  [the NGINX Docker Maintainers]
- **Where to get help**:
  [the Docker Community Slack], [Server Fault], [Unix & Linux], or [Stack Overflow]

Supported tags and respective `Dockerfile` links

- `1.27.2`, `mainline`, `1`, `1.27`, `latest`, `1.27.2-bookworm`, `mainline-bookworm`, `1-bookworm`, `1.27-bookworm`, `bookworm`
- `1.27.2-perl`, `mainline-perl`, `1-perl`, `1.27-perl`, `perl`, `1.27.2-bookworm-perl`, `mainline-bookworm-perl`, `1-bookworm-perl`, `1.27-bookworm-perl`, `bookworm-perl`

What it Looks Like



Regardless of your application's **architecture**, **containerization** offers a **consistent** and **portable** environment for deployment and scaling.

docker

Questions and Answers