Secure and Efficient Container Image Management in Enterprise

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About Me

- Chief Architect, VMware China R&D
  - Current focus: Cloud Native Apps, Blockchain, IoT
- Creator and Architect of Project Harbor, an open source enterprise class container registry
- Full stack engineer
- Coauthor of two books (in Chinese):
  - Blockchain Technical Guides
  - Software Defined Storage: Principle, Practice and Ecosystem

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Agenda

1. Container Image Basics
2. Project Harbor Introduction
3. Consistency of Images
4. Security
5. Image Distribution
6. High Availability of Registry

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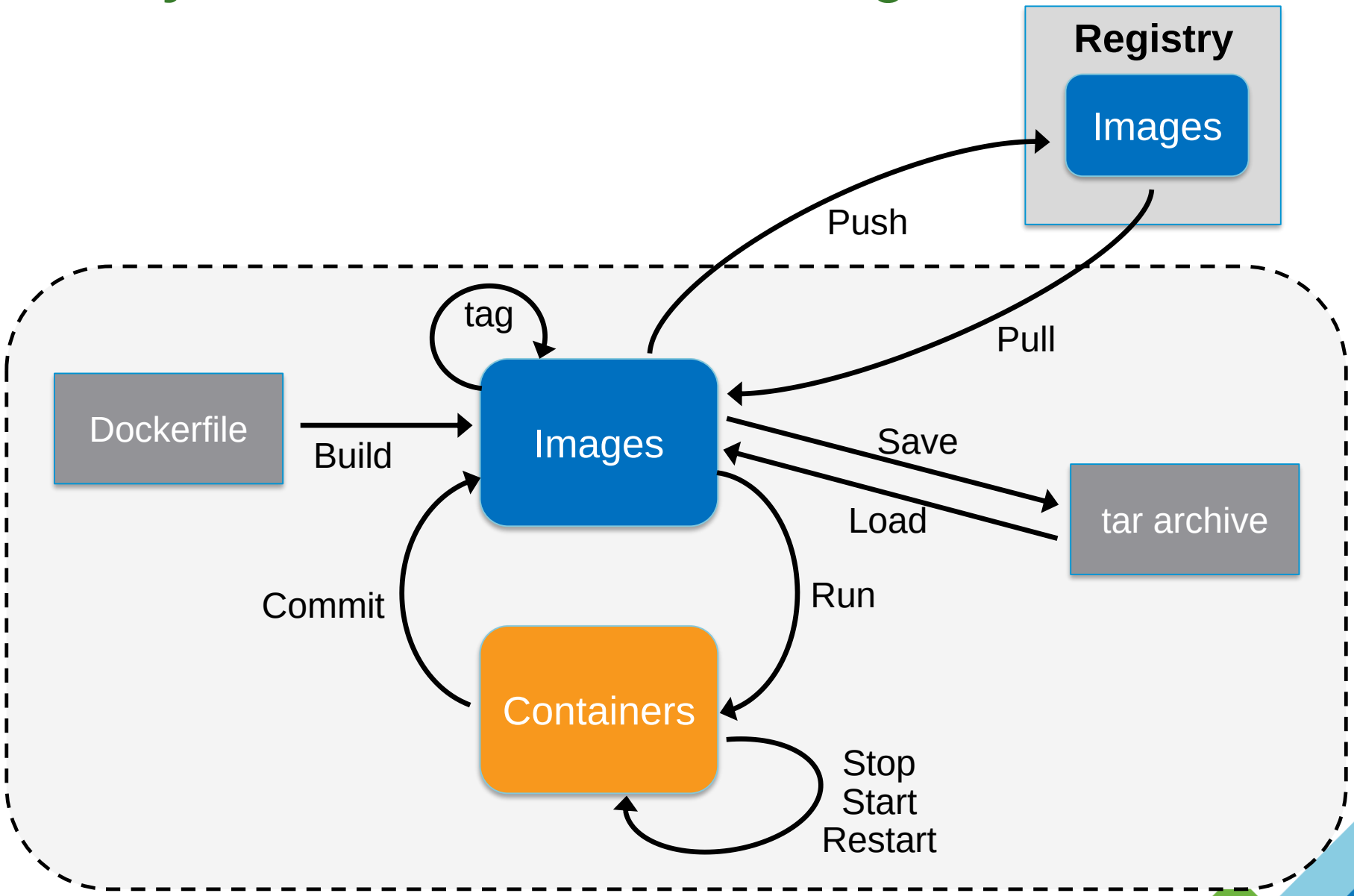
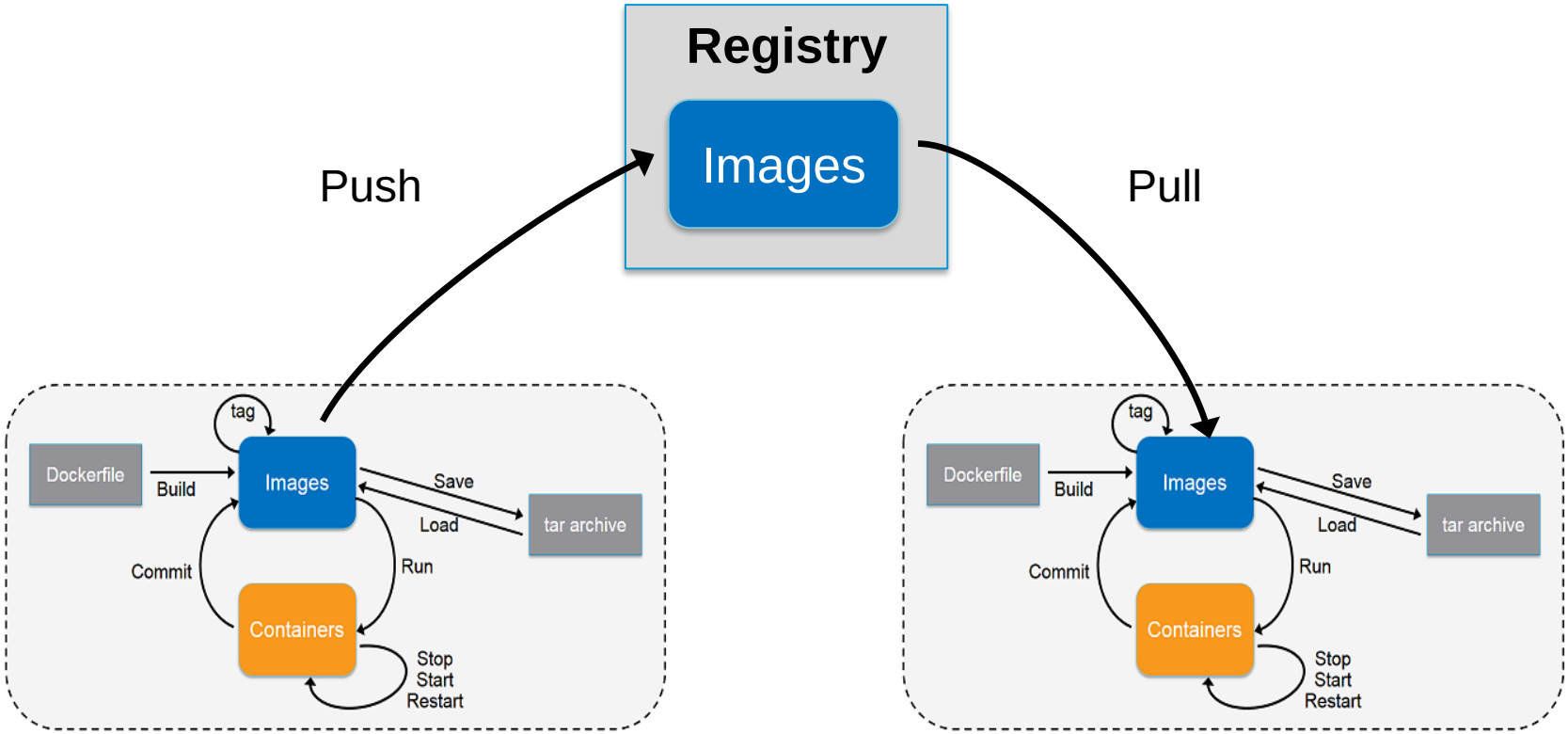
Lifecycle of Containers and Images



Registry - Key Component to Manage Images

- Repository for storing images
- Intermediary for shipping and distributing images
- Ideal for access control and other image management



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Project Harbor

- An open source enterprise-class registry server.
- Initiated by VMware China, adopted by users worldwide.
- Apache 2 license.
- https://github.com/vmware/harbor/

Key Features

- User management & access control
  - RBAC: admin, developer, guest
  - AD/LDAP integration
- Policy based image replication
- Web UI
- Audit and logs
- Restful API for integration
- Lightweight and easy deployment

Users, Partners and Developers

HARBOR™

- **Users**

Downloads

Stars

Users

- **Developers**

Forks

Contributors

Partners

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Harbor Architecture

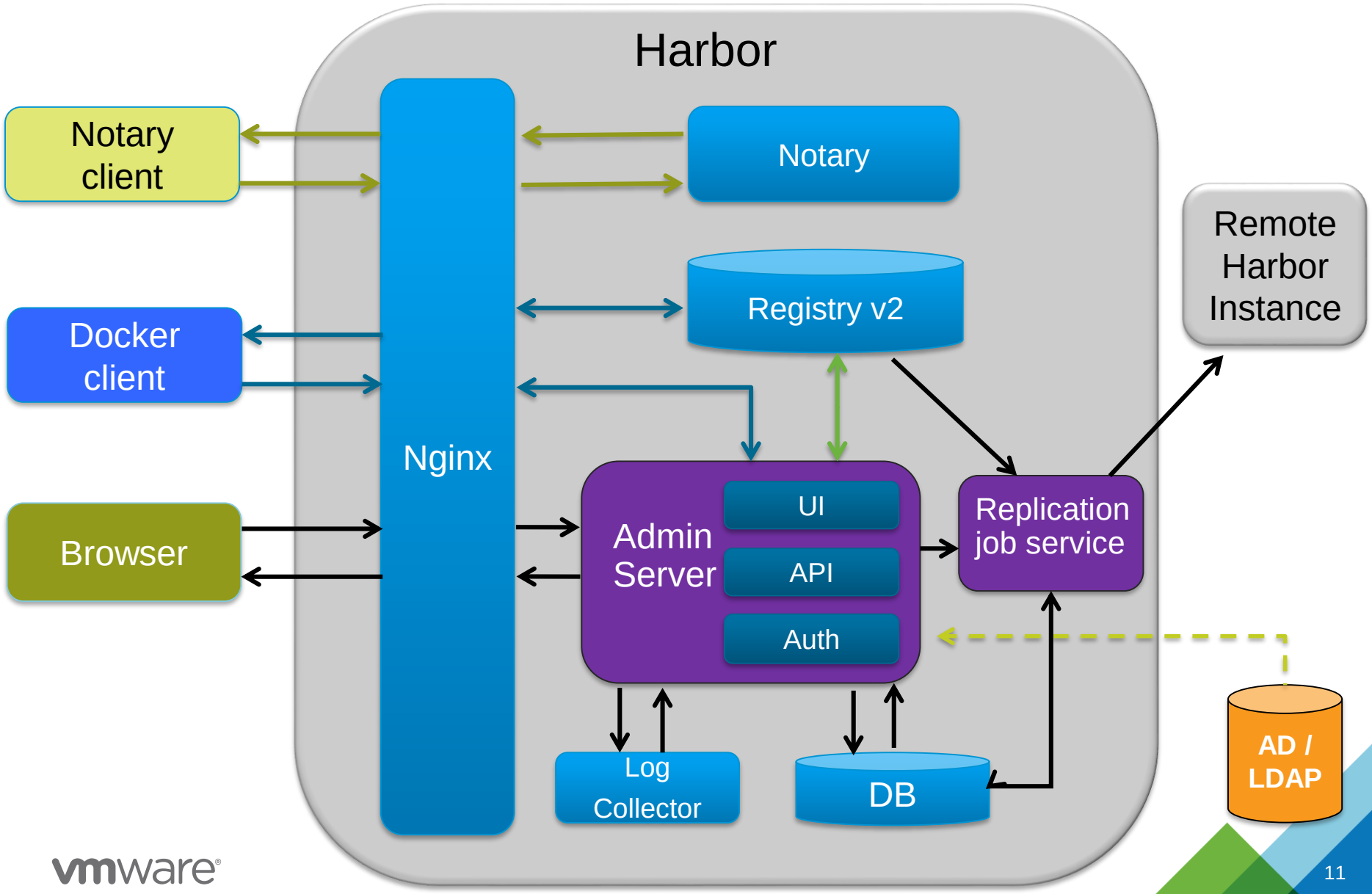
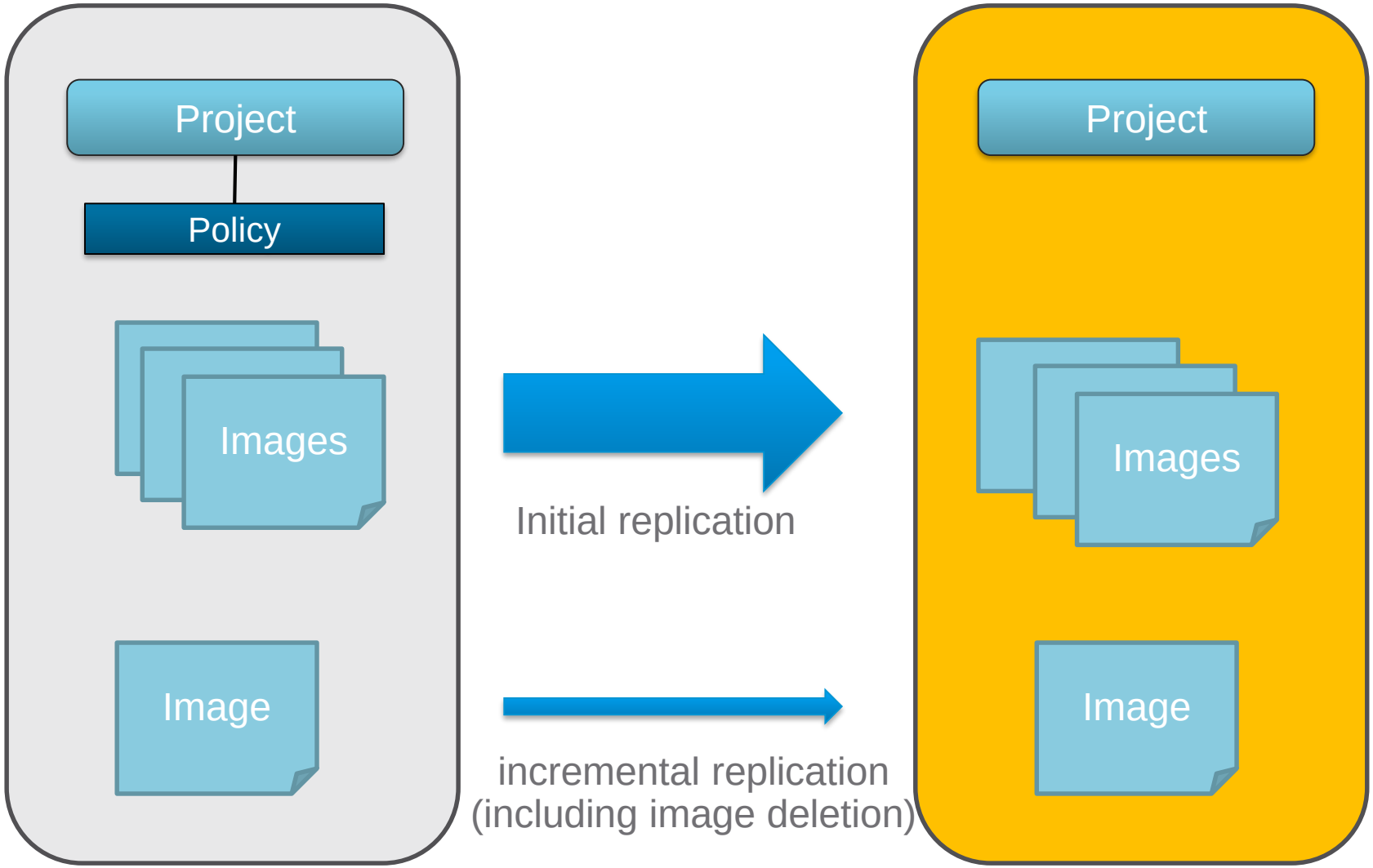


Image replication (synchronization)



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Consistency of Container Images

- Container images are used throughout the life cycle of software development
  - Dev
  - Test
  - Staging
  - Production
- Consistency must be maintained
  - Version control
  - Issue tracking
  - Troubleshooting
  - Auditing

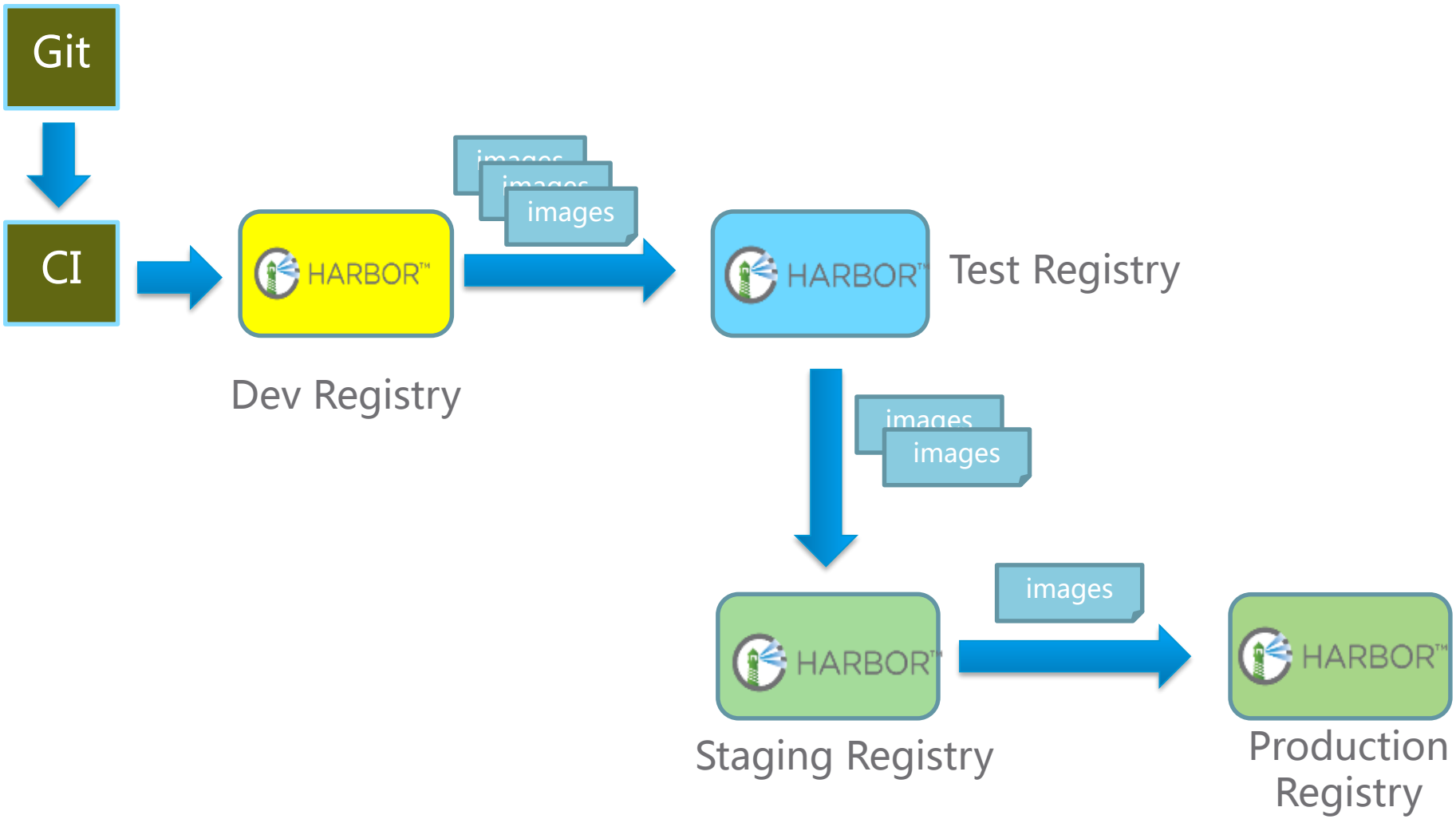
Same Dockerfile Always Builds Same Image?

Example:

```
FROM ubuntu
RUN apt-get install –y python
ADD app.jar /myapp/app.jar
```

- Base image `ubuntu:latest` could be changed between builds
- `ubuntu:14.04` could also be changed due to patching
- `apt-get` (`curl`, `wget`..) cannot guarantee always to install the same packages
- ADD depends on the build time environment to add files

Shipping Images in Binary Format for Consistency



Images are synchronized between environments by using Harbor registry.

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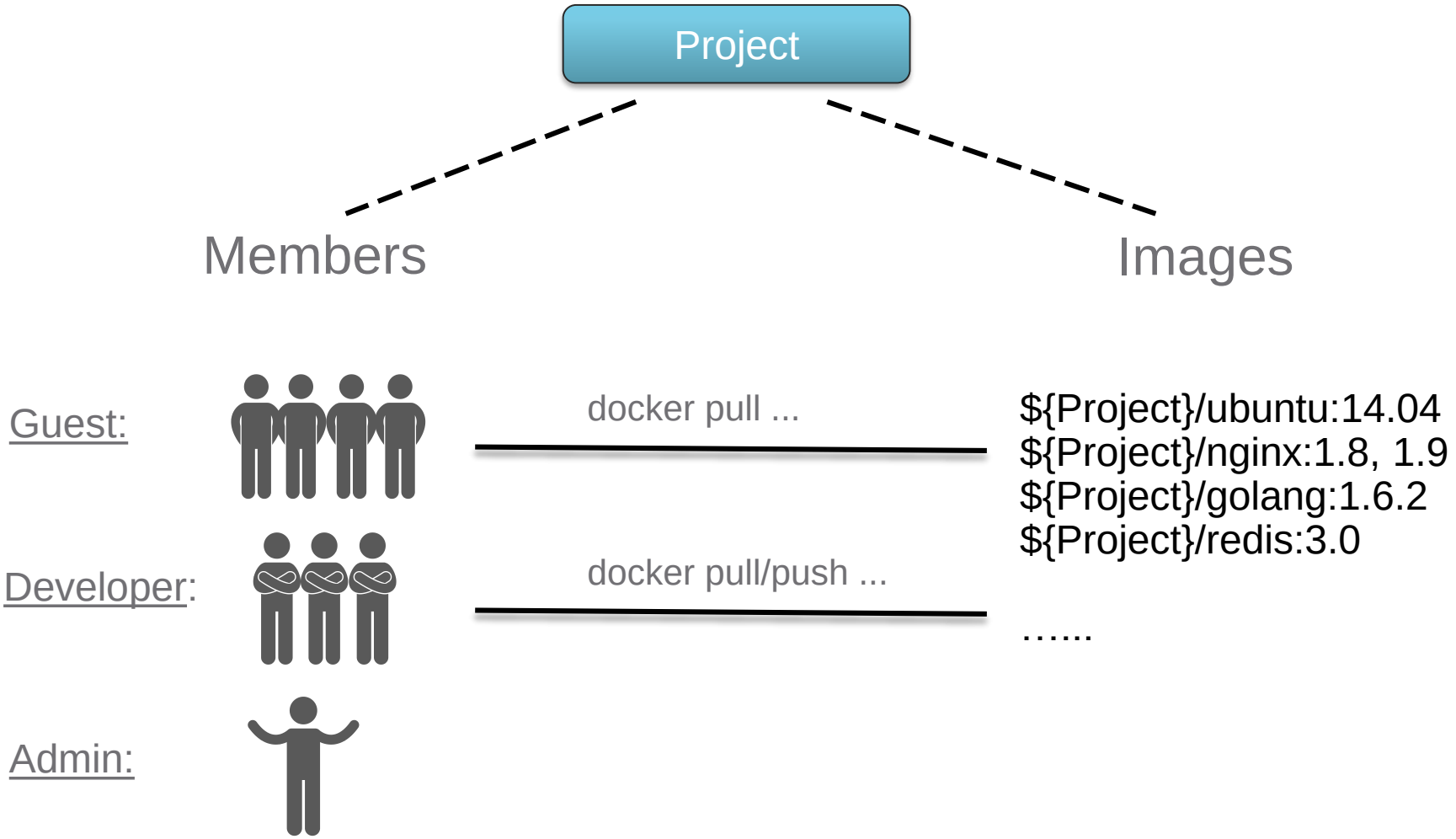
Access Control to Images

- Organizations often keep images within their own organizations
  - Intellectual property stays in organization
  - Efficiency: LAN vs WAN
- People with different roles should have different access
  - Developer – Read/Write
  - Tester – Read Only
- Different environments should enforce different rules
  - Dev/test env – many people can access
  - Production – a limited number of people can access
- Can be integrated with internal user management system
  - LDAP/Active Directory

Example: Role Based Access Control in Harbor



Other security considerations

- Enable content trust by installing Notary service
  - Image is signed by publisher's private key during pushing
  - Image is verified using publisher's public key during pulling
- Perform vulnerability scanning
  - Identify images with vulnerabilities during pushing
  - Prevent images with vulnerabilities from being pulled
  - Regular scanning based on updated vulnerability database

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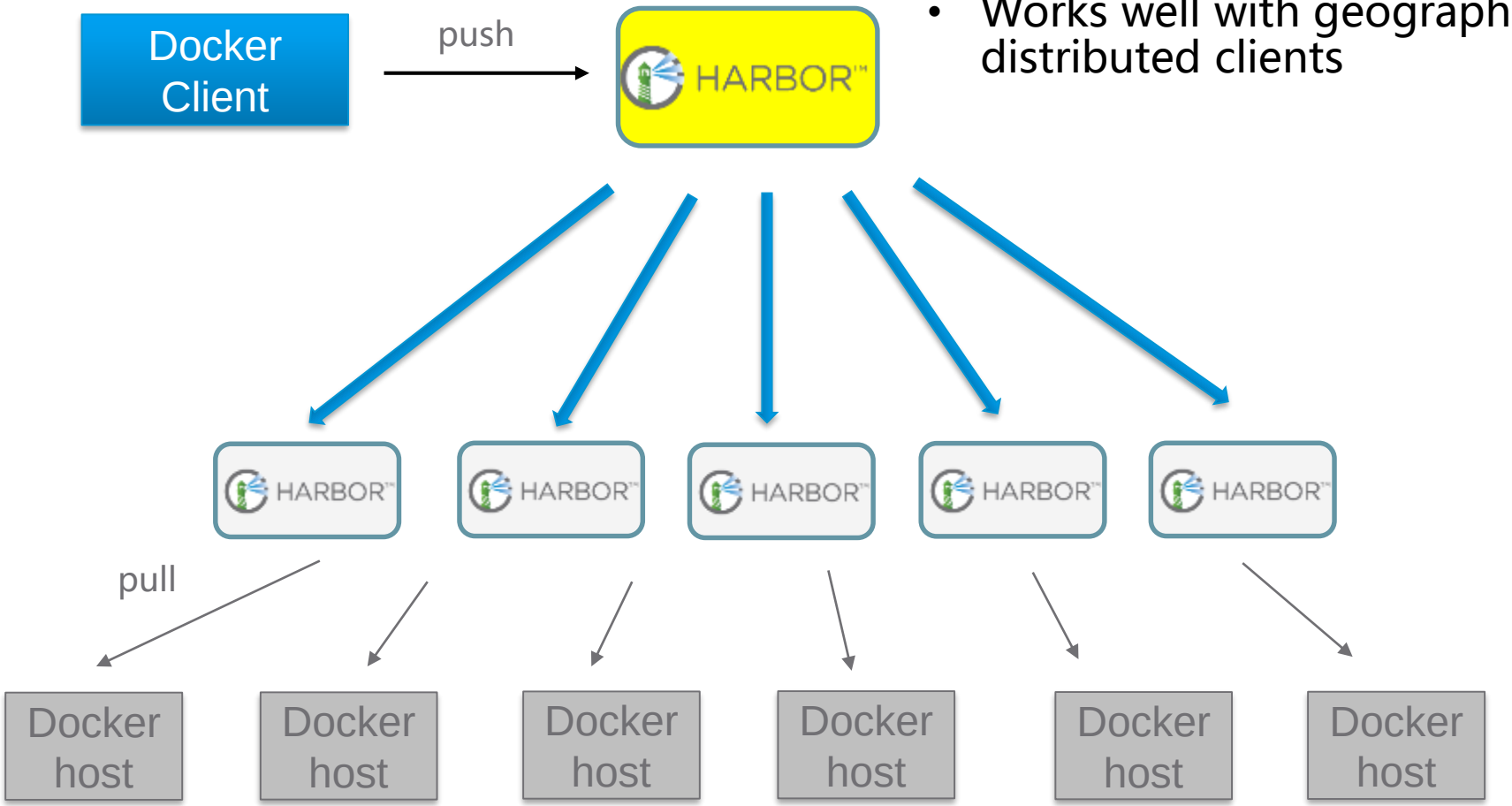
Image Distribution

- Container images are usually distributed from a registry.
- Registry becomes the bottleneck for a large cluster of nodes
  - I/O
  - Network
- Scaling out an registry server
  - Multiple instances of registry sharing same storage
  - Multiple instances of independent registry sharing no storage

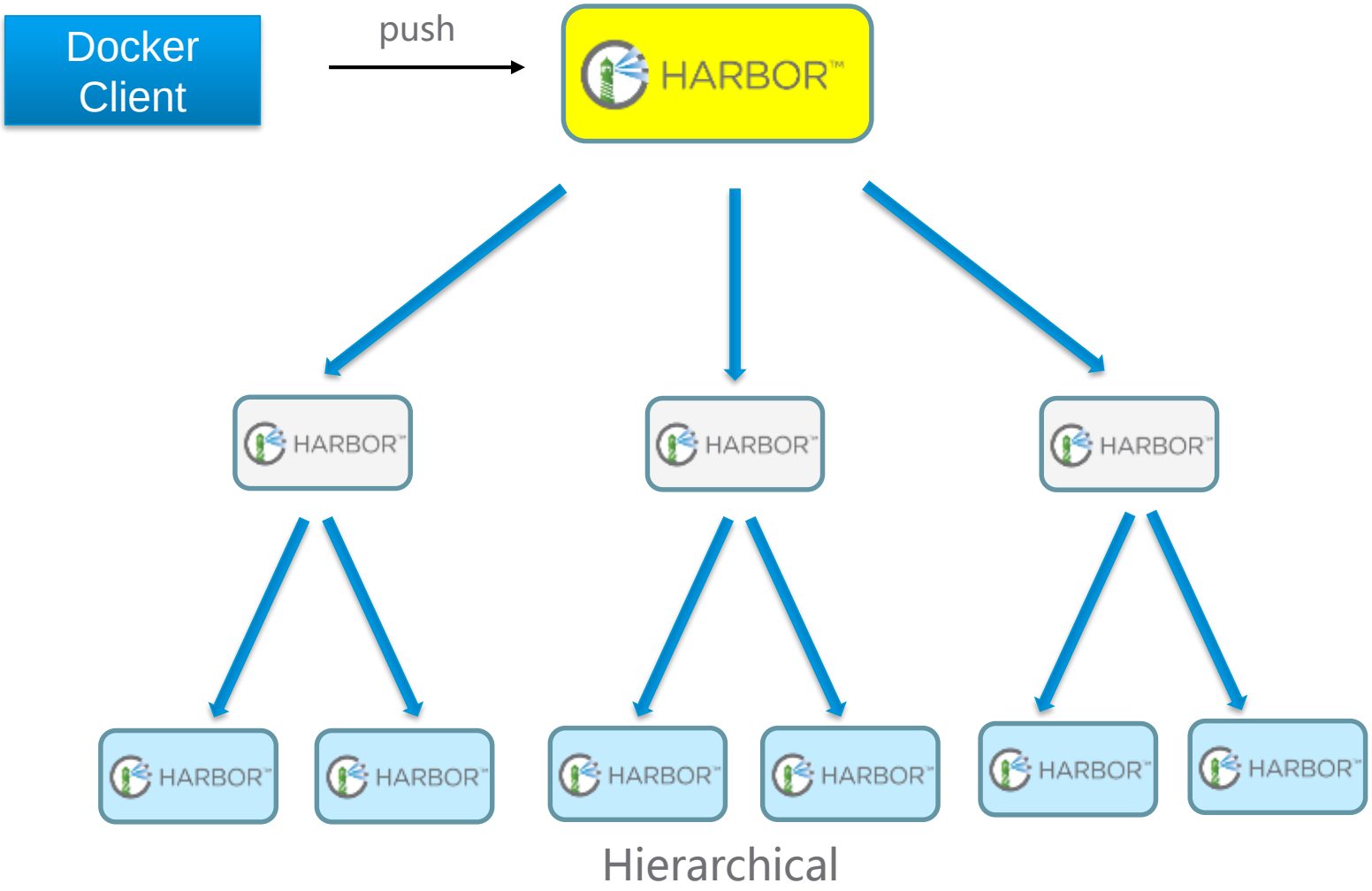
Image Distribution via Master-Slave Replication

- Load balancing
- Works well with geographically distributed clients



Master – Slave model

Hierarchical Image Distribution



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High Availability of Registry

- To remove single point of failure on registry
- Three models to achieve HA
  - Shared storage
  - Replication (no shared storage)
  - Using other HA platform

Registries using Shared Storage

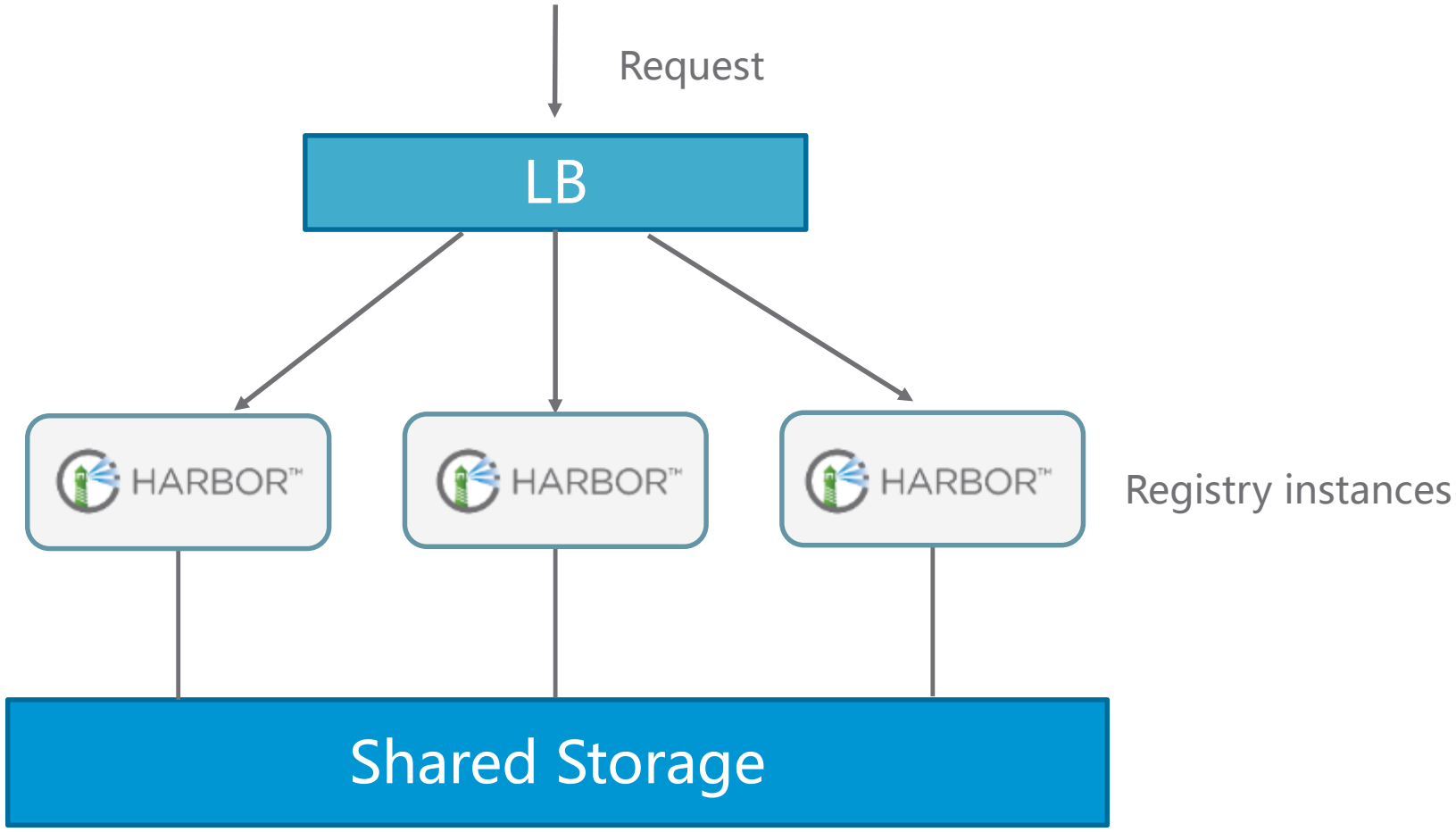

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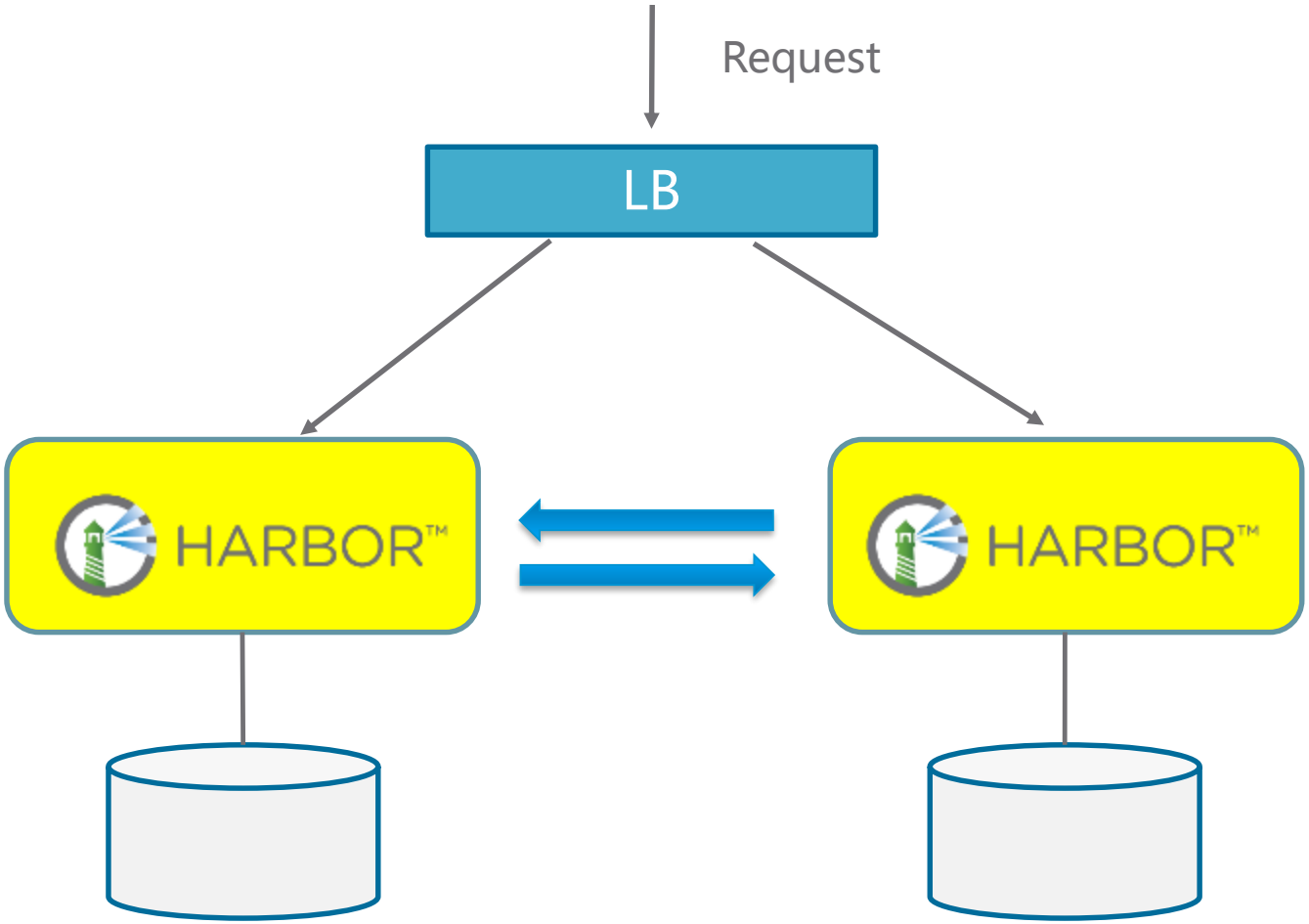
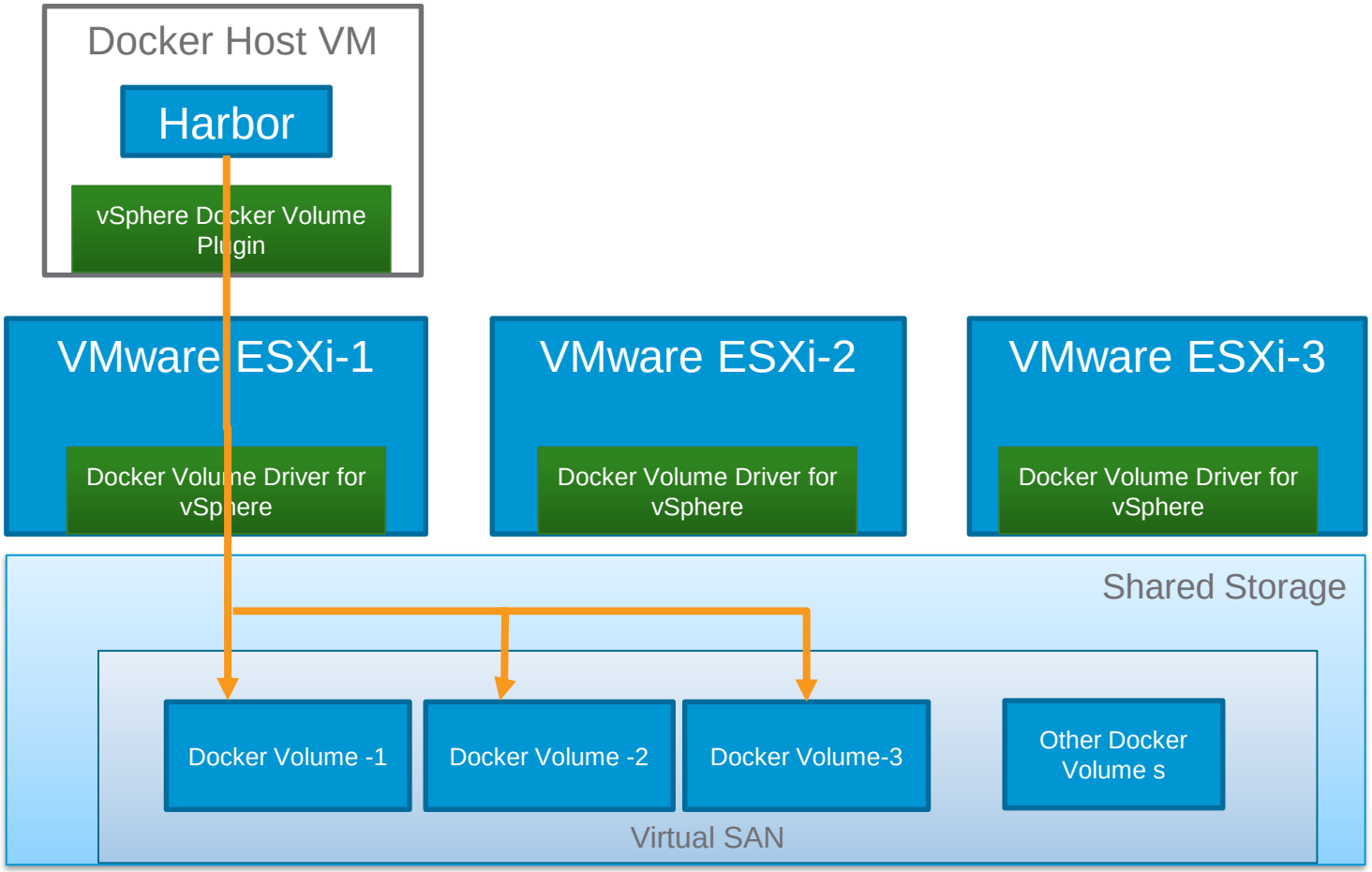
Image replication between registries



Registry HA on vSphere



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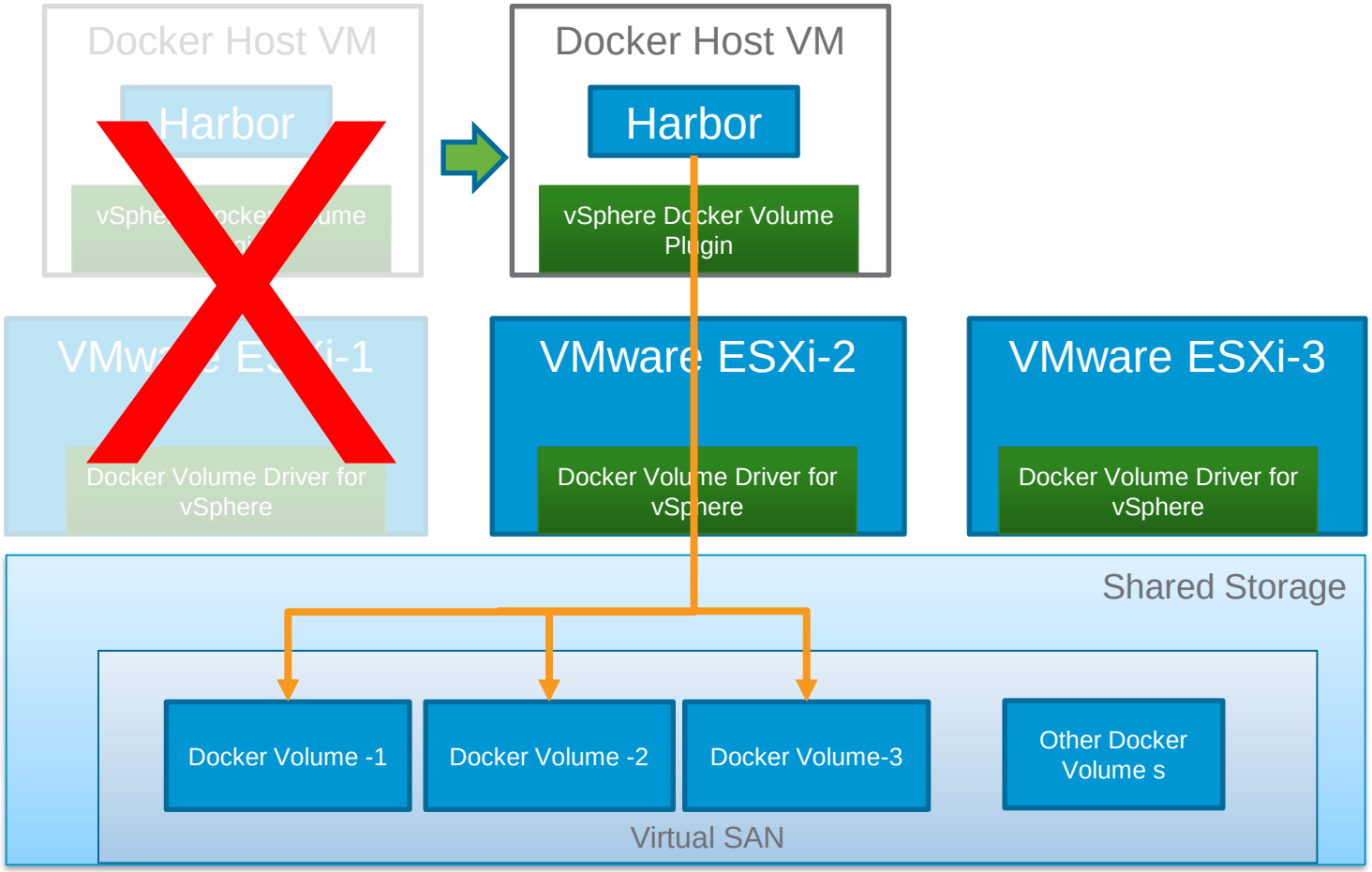

Summary

- Container image is the static part of container lifecycle
- Registry is the key component to manage images
- Organizations usually need a private registry
  - Security
  - Efficiency

Thank you!

https://github.com/vmware/harbor

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