Deploying Db2 in Your Own Private Cloud

Data Server Day
Stockholm - May 8th, 2018

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Agenda

- Cloud… a capability, not a location
- Components of a modern private cloud environment
- Db2 in the cloud
- Db2, virtual machines and containers
- Hyperconverged systems
- IBM Cloud Private

Cloud …

a capability, not a location

IT teams need...

Cost control
Confidence in data
Security and privacy control

CONTROL

Line of Business teams need...

Open access to all possible data
Powerful analysis and visualization tools
Ability to experiment without friction

FRICTIONLESS + AGILITY

Is Cloud the solution?

Why Cloud?

Elasticity

Instant provisioning

Reduced reliance on IT

Agility

Pay-as-you-go

Self-service

Cost flexibility

Increased reliability

Address skills gaps

Scalability (massive scale)

Why Not Cloud?

“Security”

“Data locality”

“Regulatory & compliance requirements”

“Data latency”

“Performance”

“Impracticality of large scale data movement”

“Cost uncertainty”

“Need more flexibility & customization”

Are these legitimate concerns?

For some organizations, these are real inhibitors to public cloud adoption (with some more important/relevant than others)

However, don't think of cloud as a location…

it's a capability

Get many of the benefits of public cloud in your own on-premises private cloud environment

What is a Private Cloud?

Private cloud is a cloud computing model operated solely for a single organization. It can be managed internally or by a third party. It can be hosted behind the company firewall or externally.

What are the Benefits?

- Rapid deployment with self-service provisioning
- Scalability
- Elasticity
- Greater control
- Defined performance
- Tighter security
- Reuse and pool existing hardware – utilizing it more efficiently
- Predictable costs
- Flexible management options
- Customizable

Key use cases driving private cloud adoption

1

Create new cloud-native applications

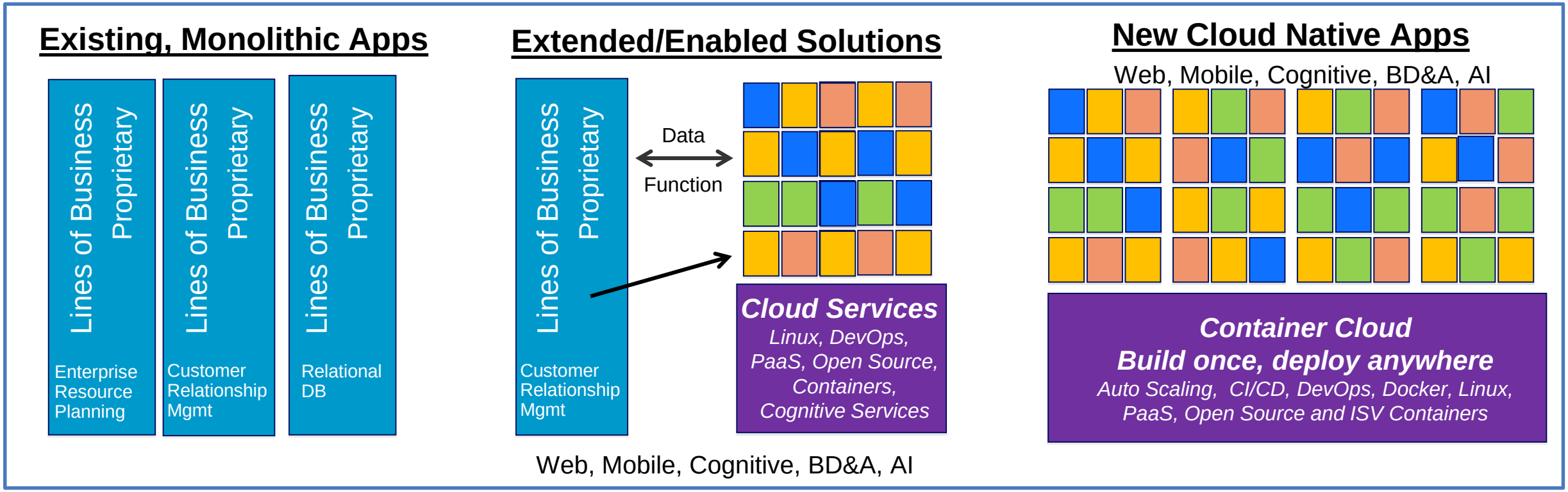
2

Modernize and optimize existing applications

3

Opening up enterprise data centers to work with cloud services

Cloud is changing how workloads are built and delivered



Goldman Sachs Shifts to Docker

… a yearlong project that will shift about 90% of the company's computing to containers, according to Mr. Duet. That includes all of the applications, nearly 5,000 in total, that run on its internal cloud.

THE WALL STREET JOURNAL.
2/24/16

By 2018, Over **60%** of New Apps Will Use **Cloud-Enabled** Continuous Delivery and **Cloud-Native Application** Architectures to Enable Faster Innovation and Business Agility. ***IDC Predicts***

Multi-cloud is a key strategy to organizational agility

81% of enterprises are pursuing a multi-cloud strategy[1]

Organizations are using an average of 4.8 different clouds[1]

Getting new value from third parties

Extracting value from your entire business

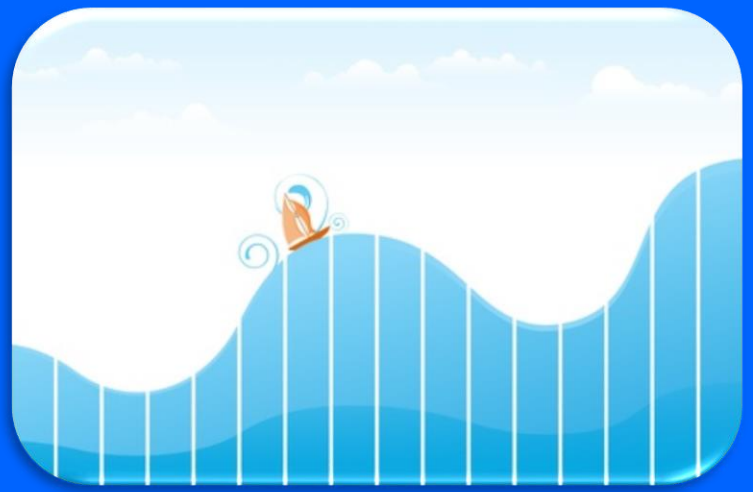
[1] RightScale 2018 State of the Cloud Report

Public, Private, or Hybrid

How to Decide?

What are the economics and usage patterns?

Is the workload predictable or is it erratic?



What are the data gravity characteristics of the application?

Buy or Rent (Private / Public)?

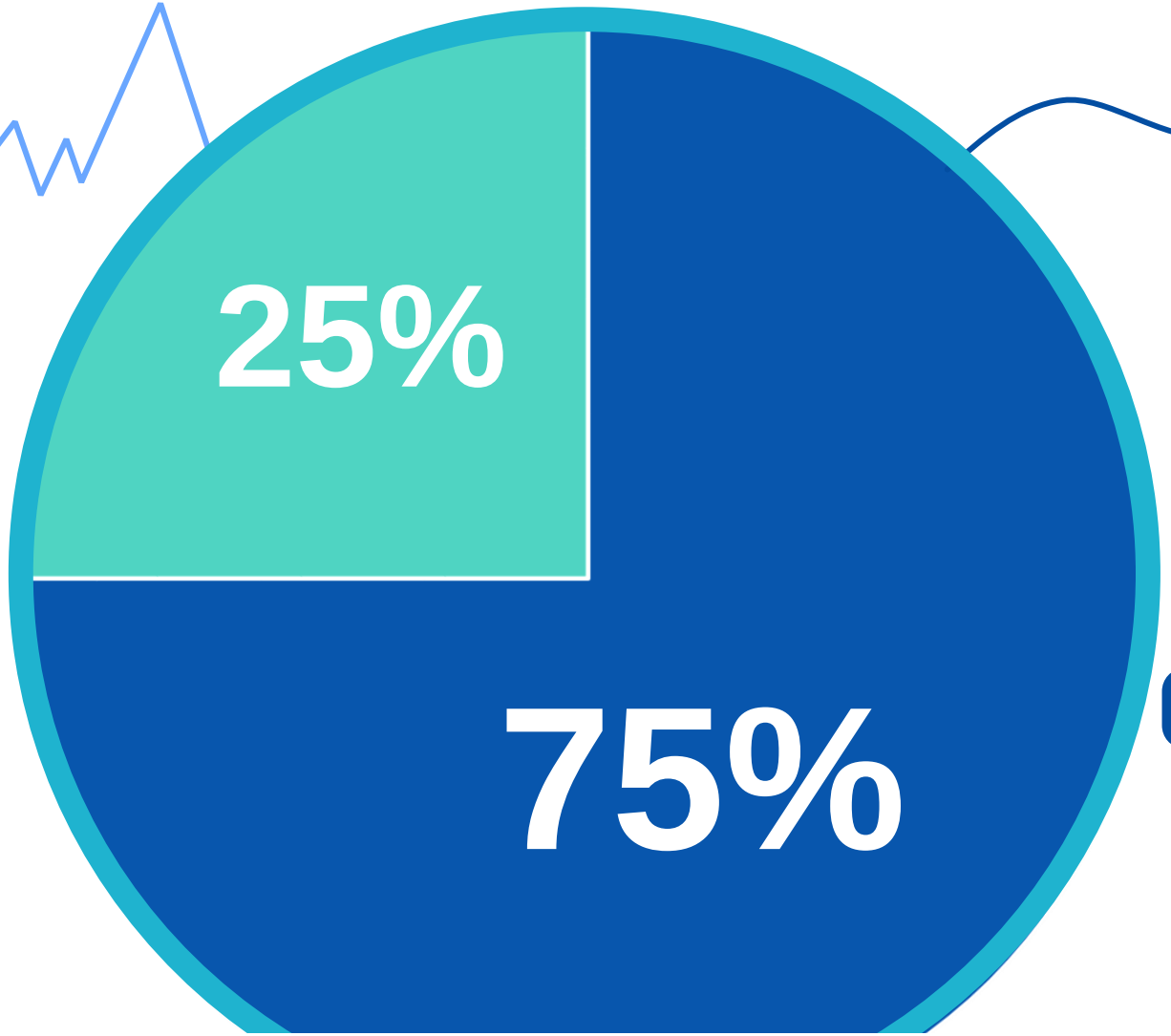
Staying in NYC for a weekend?
PUBLIC CLOUD

Staying in NYC 6 months?
PRIVATE or PUBLIC**?**

Staying in NYC 3 years?
PRIVATE CLOUD

Elastic Workloads

Spin up and down resources on the public cloud

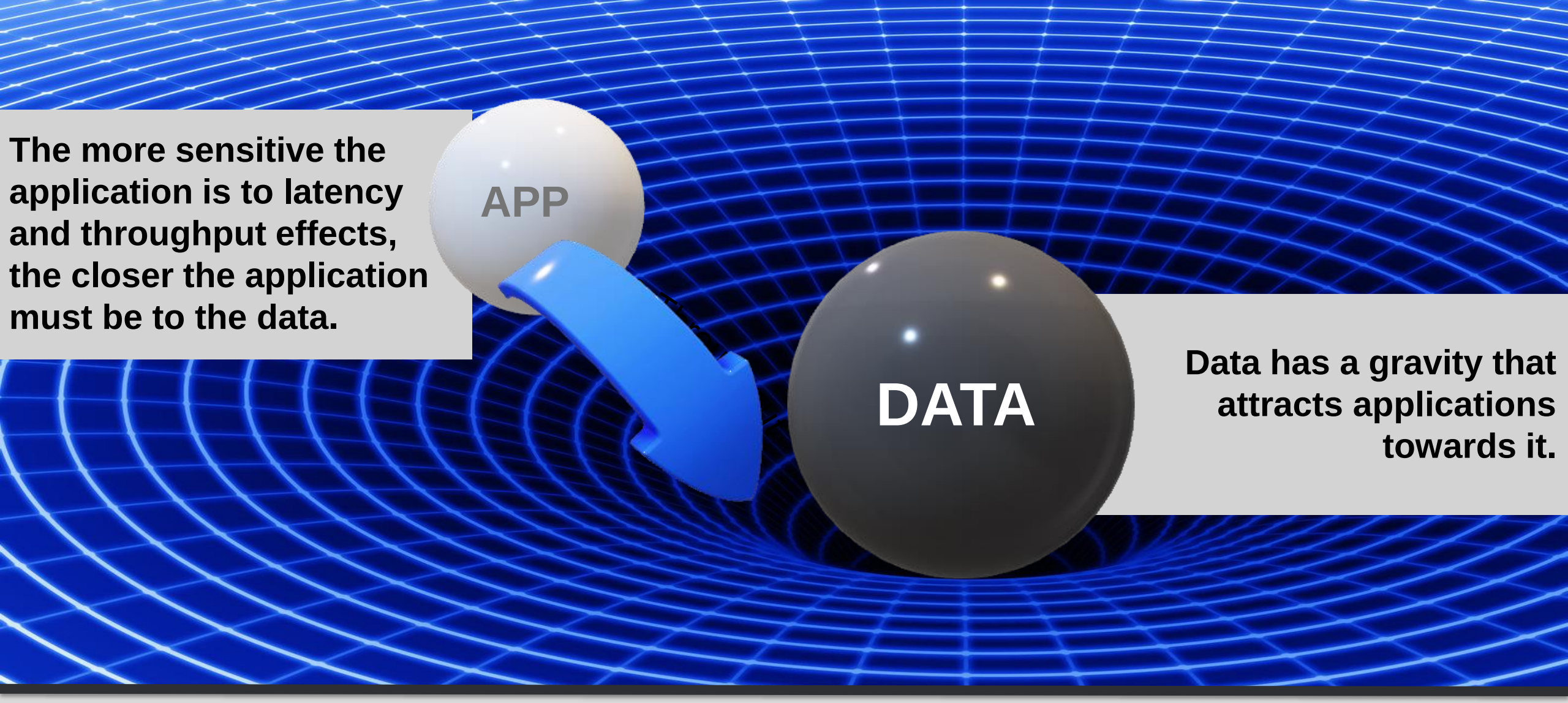


Predictable Workloads

Lower costs with private cloud infrastructure

balance **owning** and **renting** for today's enterprise workloads

The more sensitive the application is to latency and throughput effects, the closer the application must be to the data.

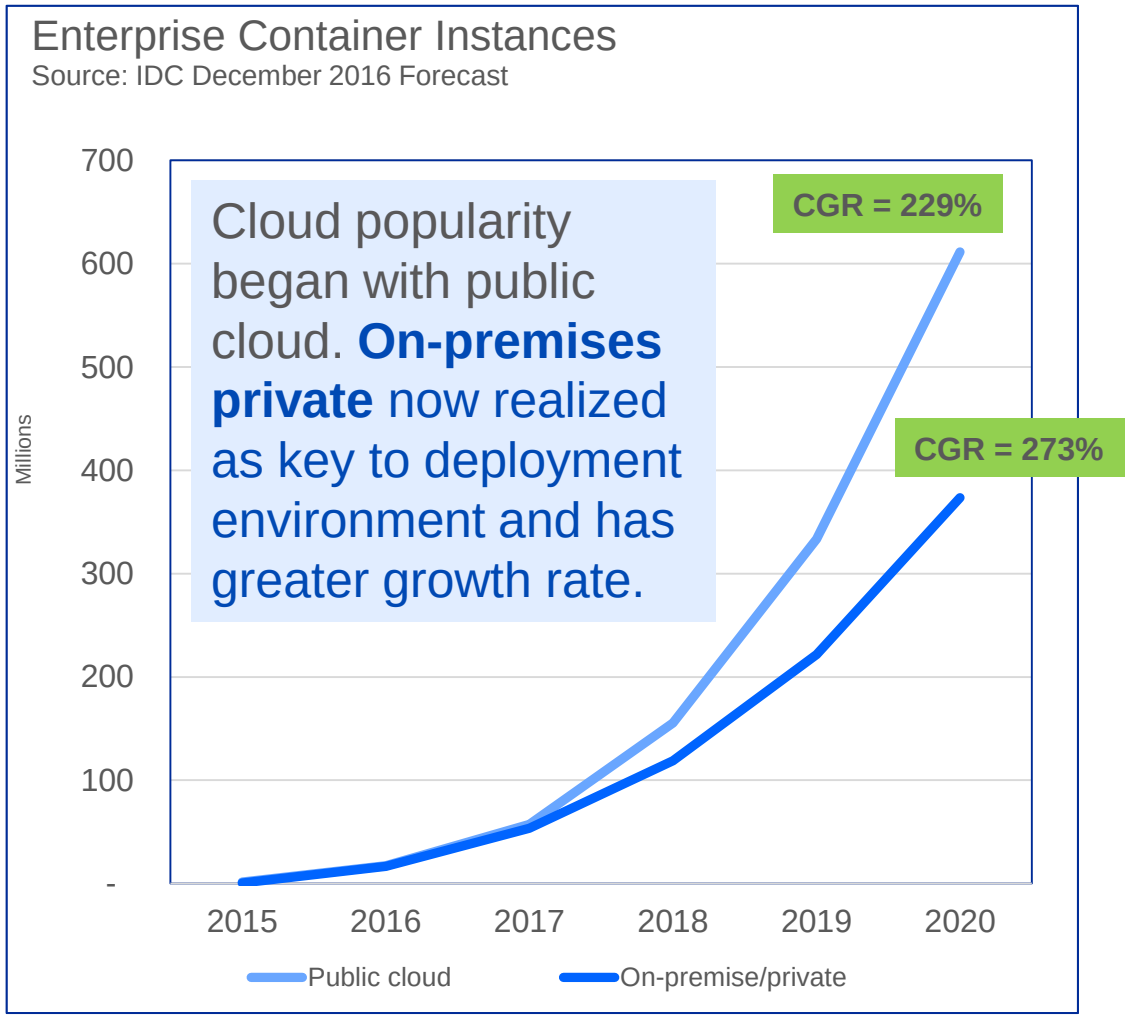


Data has a gravity that attracts applications towards it.

Data behind the firewall attracts applications on premises.
Data born on the public cloud attracts applications to public cloud.

Components of a modern private cloud environment

Enterprises are deploying on-premises clouds and containers as a foundation for their hybrid cloud strategies



$443B

Private Cloud market size in 2017

IBM MD&I

$725B

Private Cloud market size in 2020

IBM MD&I

$1.1B

Application container market size in 2018

451 Research

$3.5B

Application container market size in 2021

451 Research

What you need for a Private Cloud

Middleware, Data, Analytics and Developer Services
Cloud enabled middleware, messaging, databases, analytics, and cognitive services

Core Operational Services
Simplify Operations Management, Security, and Hybrid integration
Provision infrastructure and apps across environments

Container Platform
Container orchestration

Infrastructure
Optimized for the Cloud and Analytics

Some Common Private Cloud Infrastructure Components

Lightweight, stand-alone, executable package (containers) of software that includes everything needed to run it.

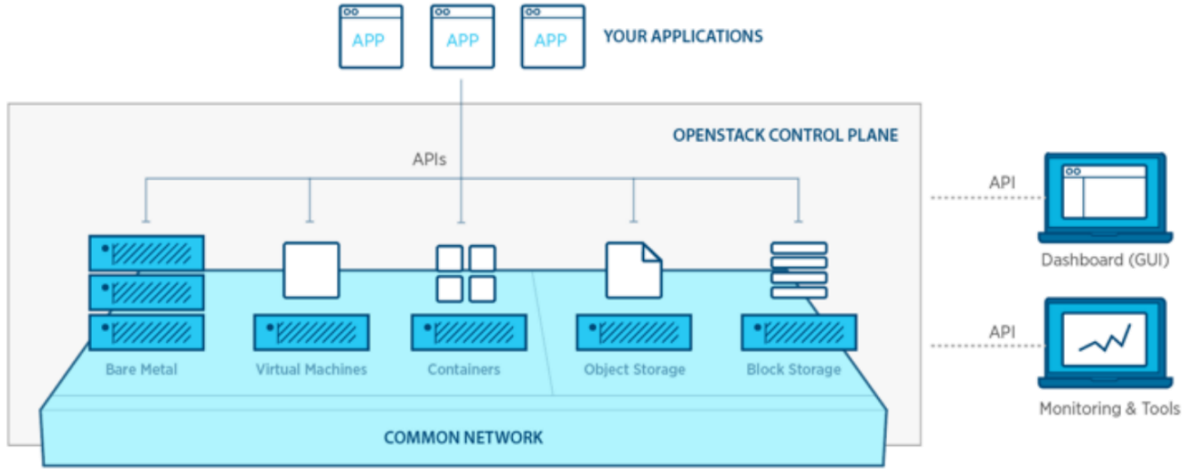
Platform for automating deployment, scaling, and management of containerized applications.

Charts that define, install, and upgrade Kubernetes applications.

Platform as a service (PaaS) for building, deploying, running and scaling applications.

OpenStack

- **Free, open source software platform for cloud computing**
- **Not just one product – modular, made up of nearly 60 open source projects**
  - Nova – core of the platform, let's you provision compute instances
    - Does not include built-in virtualization, but uses what you already have (e.g. KVM, VMware, PowerVM)
  - Cinder – persistent block storage for compute instances
  - Neutron – software-defined network functionality
  - Keystone – identity service for authentication across all OpenStack components
  - Glance – image service (discover, register, retrieve VM images)
  - Swift – object storage
  - …
- **Build it all yourself (not simple) or optionally use one of various distributions that exist (e.g. Red Hat, SUSE, Ubuntu)**



What is Docker?

- **Docker Inc. is the original author and primary sponsor of the Docker open source project**
  - Released as open source project in March 2013
  - Quickly gained traction from open source community, as well as attention from venture capitalists and technology partners (including IBM)

- **Docker is an open platform for developing, shipping, and running applications**
  - Solves dependency chaos in application development and reduces development life cycle

- **Docker brings container technology to the masses**
  - Many companies have been using container technology
  - Docker provides tooling and platform to facilitate adoption

Docker Solves Dependency Chaos

- **Before Docker**
  - Slow deployment time
  - Huge costs and resources
  - Difficult to scale
  - Difficult to migrate
  - Hardware vendor lock in
- **After Docker**
  - No more broken dependencies
  - Virtualized OS makes it light weight and portable
  - Build any app in any language in any stack
  - Dockerized app can run anywhere on anything

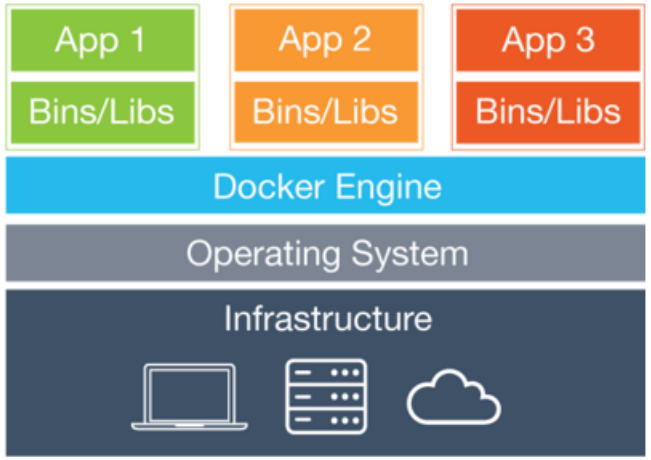
Benefits

- **Scalable** – scaling up and down is fast and easy
- **Portable** – snapshot of an environment can turn into a container easily
- **Density** – more efficient use of resources so able to fit more containers onto a physical server
- **Deployment** – many options for deployment to physical servers, virtual servers, cloud

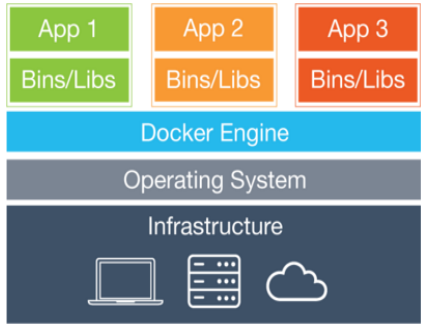
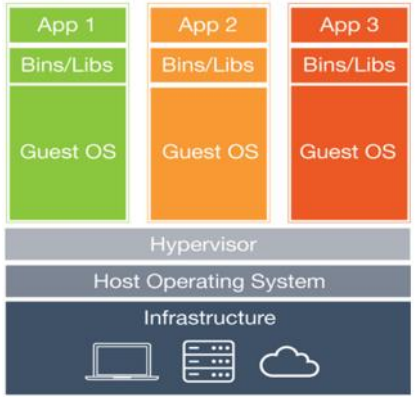
How does Docker Work?

- Docker separates applications from infrastructure using container technology
  - Wrap up a piece of software in a complete filesystem that contains everything it needs to run: code, runtime, system tools, system libraries

- Container based virtualization uses the kernel on the host's OS to run multiple guest instances
  - Each guest is a container with its own root file system, processes, memory, devices and network ports



Docker Containers vs. Virtual Machines

Docker 	**Virtual Machines** 
Based on Container technology	Virtualization Technology (hypervisor)
Provides OS-Level process isolation	Provides hardware virtualization
Containers include the application and all of its dependencies • Host kernel is shared amongst Docker containers • Run as an isolated process in userspace on the host operating system	Each virtual machine includes the application, the necessary binaries and libraries and an entire guest operating system
Advantageous for packaging and shipping • Easier and more lightweight to deploy and faster to start up than virtual machines	Best for native execution to share and manage hardware, allowing multiple different environments, isolated from each other, to be executed on the same physical machine

Both technologies can be used in conjunction

Why are Docker Images Lightweight?

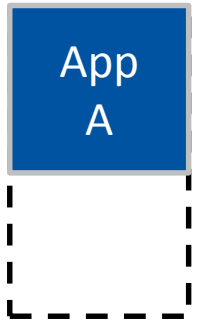
Containers

Original App

No OS to take up space, resources, or require restart

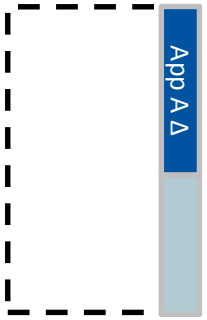
Copy of App

No OS. Can share bins/libs

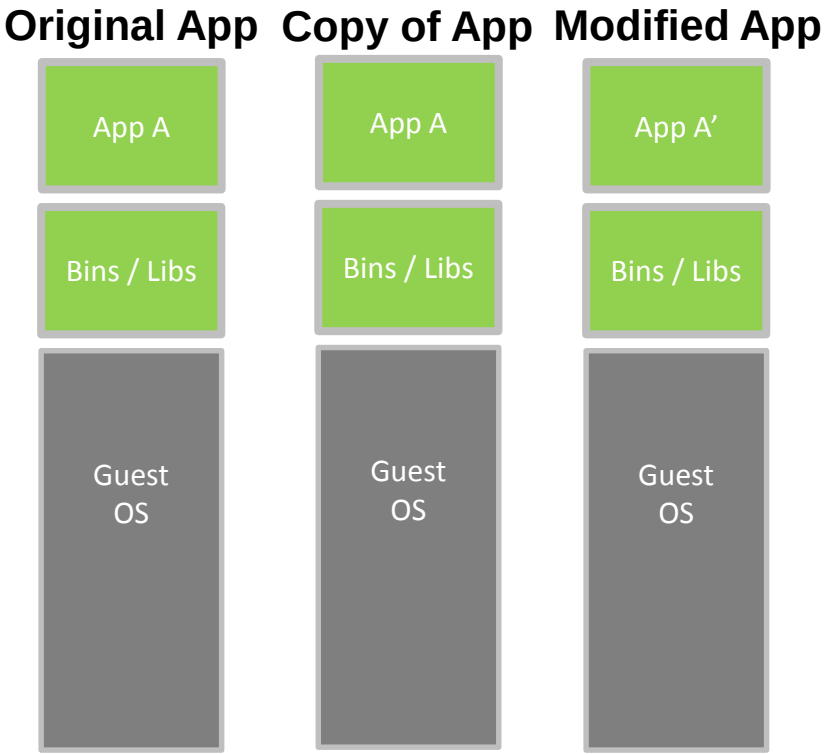


Modified App

Copy on write capabilities allow us to only save the diffs between container A and container A’



Virtual Machines



Every app, every copy of an app, and every slight modification of the app requires a new virtual server

Db2 in the Cloud

Evolution of IBM's Cloud and Db2 Offering Names

SOFTLAYER®

- Infrastructure provider (IaaS)
- Acquired by IBM in 2013

IBM Bluemix

- Platform-as-a-Service (PaaS)
- Available as Public, Dedicated and Local
- Introduced in 2014

IBM Bluemix

- Bluemix integrates SoftLayer products and services into its catalog
- Integration in 2016

IBM Cloud

- Unification of public, private, hybrid and multi-cloud under one brand
- October 2017

dashDB Local → Db2 Warehouse	DB2 on Cloud → Db2 Hosted
dashDB (for Analytics) → Db2 Warehouse on Cloud	dashDB for Transactions → Db2 on Cloud

Public/Private/Hybrid Cloud Options for Db2

		Provisioning & Db2 Setup	Maintenance	Management
“Bring Your Own License”	• Custom-deployable software on your own infrastructure, or private or public cloud • Fully customizable for any type of workload • Customer managed			
Db2 & Db2 Warehouse in IBM Cloud Private	• Private cloud platform for developing and managing on-premises, containerized applications • Db2 and Db2 Warehouse in catalog of deployable software (via containers) • Customer managed	IBM		
Db2 Hosted	• Hosted database-as-a-service (IBM Cloud, AWS) • Pre-defined hardware configurations • Fully customizable for any type of workload • Customer managed	IBM		
Db2 Warehouse	• Deploy on your own infrastructure, or private or public cloud • Docker container technology for fast and simple deployment • Scalable, elastic and optimized for analytic workloads • Customer managed	IBM		
Db2 Warehouse on Cloud	• Fully managed database-as-a-service • Pre-defined hardware configurations optimized for analytic workloads • Public cloud (IBM Cloud, AWS)	IBM	IBM	IBM
Db2 on Cloud	• Fully managed database-as-a-service • Pre-defined and flexible hardware configurations optimized for transactional and general purpose workloads • Public cloud (IBM Cloud)	IBM	IBM	IBM

Db2 in the Cloud: “Bring Your Own License”

- Traditional Db2 perpetual licenses can be used in public and private clouds
- Eligible public clouds and PVU per vCPU values listed here:
  - https://www-01.ibm.com/software/passportadvantage/eligible_public_cloud_BYOSL_policy.html

Provider	Offering	PVUs per vCPU or Core
IBM	IBM Cloud Virtual Servers	70 PVU per core
Amazon	EC2 Instances & Dedicated Instances	70 PVU per vCPU
Google	Google Compute Engine	70 PVU per vCPU
Microsoft	Azure Virtual Machines	70 PVU per vCPU

Examples – not an exhaustive list

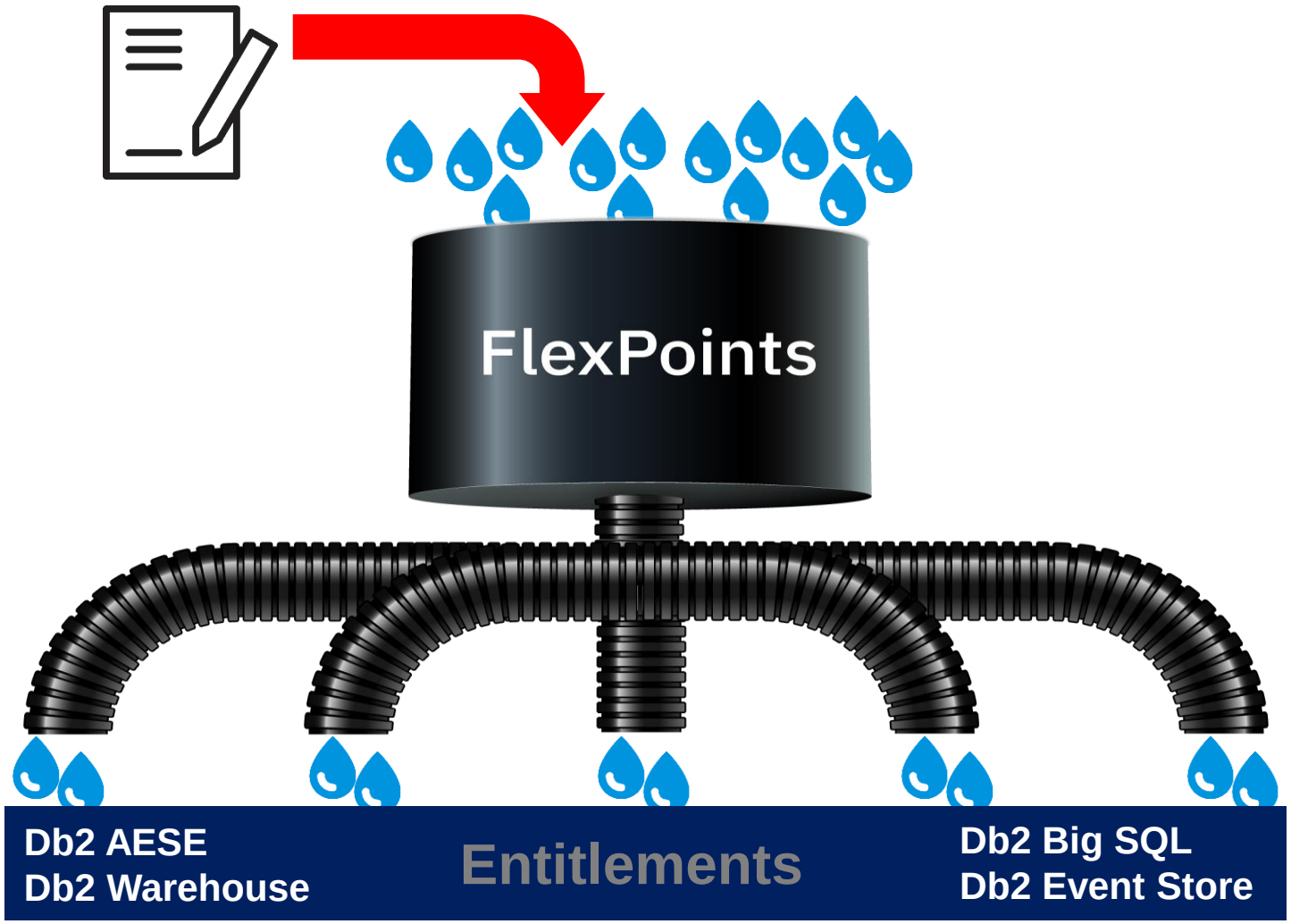
- Sub-capacity licensing applicable for virtualized environments
  - https://www-01.ibm.com/software/passportadvantage/subcaplicensing.html

- **Db2 11.1 Direct Editions** available for public or private cloud deployments
  - Available in Standard and Advanced editions
  - Simplified license metric, the Virtual Processor Core (VPC) sold as a **monthly license charge**

NEW!! IBM Hybrid Data Management Platform Bundle

The Hybrid Data Management Platform (HDMP) is purchased in blocks of 1000 FlexPoints

- Each component (product) has a FlexPoint price (per VPC)
- Choose how to deploy your FlexPoints and change deployment allocations (deploy and decommission) anytime you wish
- Deploy in private (on-premises) or public cloud



Choices to Build Your Own Private Cloud for Db2

- **Do everything yourself**
  - Run OpenStack, PowerVM, VMware, etc. to create virtual machines
  - Build and deploy containers using Docker and Kubernetes
  - IBM provides pre-built containers for Db2 to get you started quickly and easily
- **Leverage IaaS / hyperconverged platform like Nutanix**
  - Solutions that provide server, storage and networking virtualization
  - You just need to deploy Db2 on top of that infrastructure consolidation
- **IBM Cloud Private**
  - Provides both IaaS and an application catalog including Db2
- **… or combination of approaches (e.g. ICP on Nutanix)**

Db2,
Virtual Machines and Containers

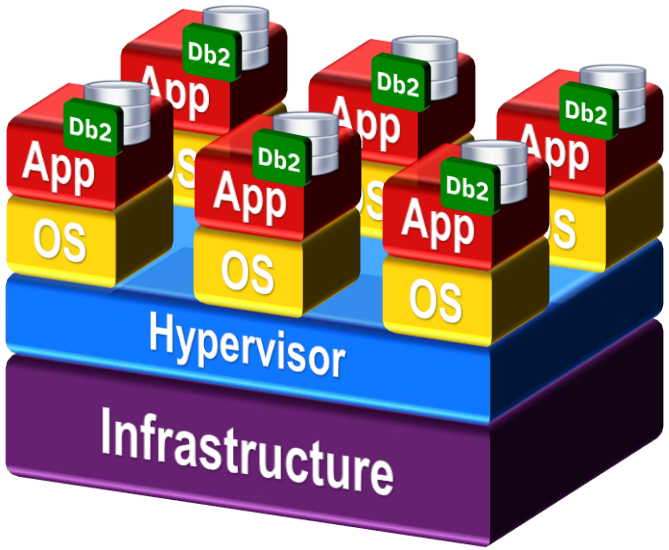
Db2 Hypervisor Support

Examples of Hypervisors supported by Db2 11.1 AESE*

- PowerVM
- PowerKVM
- KVM for z
- Red Hat KVM
- z/VM
- VMware ESXi

* **pureScale** limited to PowerVM, PowerKVM, RedHat KVM, VMware ESXi

http://ibm.biz/Db2_v11_Hypervisors



vmware ESXi

KVM

PowerVM

PowerKVM

IBM-provided Docker Container Images for Db2

- Linux x86 images can also be deployed using Docker for Mac and Docker for Windows (only available with newer versions of Windows)
- Docker Toolbox (with Kitematic) can still be used for Db2 Warehouse Developer-C for Non-Production on Mac/Windows

https://store.docker.com

IBM Db2 Developer-C Edition

- **Free**
- Full feature for non-production environments
- Ideal for developers
- Platforms: Linux on Intel x86/Power LE/Z

https://store.docker.com/images/db2-developer-c-edition

IBM Db2 Warehouse (Enterprise Edition)

- **90 day free trial** (license required after this)
- Fully supported for production workloads when licensed
- SMP or MPP
- Platforms: Linux on Intel x86/Power LE/Z

https://store.docker.com/images/ibm-db2-warehouse-ee

IBM Db2 Warehouse Developer-C for Non-Production

- **Free**
- Unwarranted, not intended for production
- No resource restrictions, no expiration
- SMP only
- Platforms: Linux on Intel x86 (Windows/Mac)

https://store.docker.com/images/ibm-db2-warehouse-dev

Data Server Manager Developer-C Edition

- **Free**
- Full feature for non-production environments
- Ideal for developers
- Platforms: Linux on Intel x86/Power LE/Z

https://store.docker.com/images/data-server-manager-developer-c-edition

IBM Db2 Warehouse Client Container

- **No charge**
- Remote shell environment with tools to migrate, operate & maintain Db2 Warehouse
- Platforms: Linux on Intel x86/Power LE

https://store.docker.com/images/ibm-db2-warehouse-client-container

IBM Db2 Warehouse Sample Data Container

- **No charge**
- Sample data container; can be deployed on a node where Db2 Warehouse is deployed
- Platforms: Linux on Intel x86/Power LE

https://store.docker.com/images/ibm-db2-warehouse-sample-container

https://www.ibm.com/support/knowledgecenter/en/SS6NHC/com.ibm.swg.im.dashdb.doc/admin/local_containers.html

Example of Deploying Db2 Developer-C Image

1. Log into Docker repository: `docker login -u=<userID> -p=<password>`
2. Pull down image: `docker pull store/ibmcorp/db2_developer_c:11.1.3.3-x86_64`
3. Create `.env_list` file with contents below (edit based on your needs):

```
LICENSE=accept
DB2INSTANCE=db2inst1
DB2INST1_PASSWORD=myPassW0rd
DBNAME=testdb
BLU=false
ENABLE_ORACLE_COMPATIBILITY=false
UPDATEAVAIL=NO
TO_CREATE_SAMPLEDB=false
REPODB=false
IS_OSXFS=false
PERSISTENT_HOME=true
HADR_ENABLED=false
ETCD_ENDPOINT=
ETCD_USERNAME=
ETCD_PASSWORD=
```

IBM DB2 IBM Db2 Developer-C Edition

- **Free**
- Full feature for non-production environments
- Ideal for developers
- Platforms: Linux on Intel x86/Power LE/Z

https://store.docker.com/images/db2-developer-c-edition

Example of Deploying Db2 Developer-C Image (cont.)

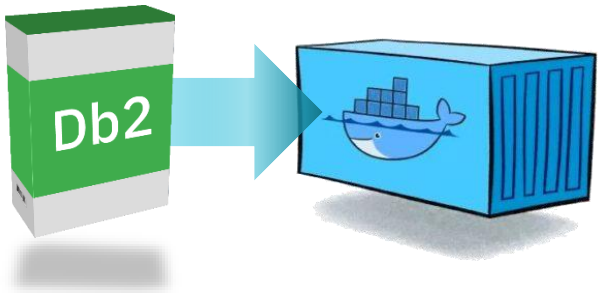
4. Create directory/file system that will be used to hold all of the permanent Db2 data and files: `mkdir /db2files`

5. Create and start new container from image: `docker run -h db2serverhost --name db2server --restart=always --detach --privileged=true -p 50000:50000 -p 55000:55000 --env-file .env_list -v /db2files:/database store/ibmcorp/db2_developer_c:11.1.3.3-x86_64`

6. The above command finishes instantaneously, but the Db2 setup (installation, instance creation) is taking place in the background. Wait for it to complete by following the logs: `docker logs --follow db2server`

7. To log into the container: `docker exec -ti db2server bash -c "su - db2inst1"`

What did IBM do behind the scenes to provide the Db2 Developer-C image?



- Built image using a Dockerfile (think of it like a recipe) that contains the following types of steps:
  - Installs various libraries and binaries that Db2 and that the overall install/setup process needs
  - Uses curl to pull down Db2 installation package
  - Runs Db2 pre-requisite checking script
  - Installs Db2
  - Sets up license file
  - Calls a script included in the image that does further setup work during initial container startup

- You can do this kind of thing as well – provide your own repeatable, customized deployments if the IBM versions don't fit the bill for whatever reason

Creating your own Db2 Container Image – Very Basic Example

- Local copy of Db2 Express-C 11.1
- Uses container's ephemeral storage by default
  - Instance and databases files will only live as long as the container itself lives – but will last through container stops and starts)

- **To build image:**
  - Create an empty directory (e.g. ~/DOCKER)
  - Download and copy Db2 installation package into directory (no need to unzip, untar)
  - Create a file in directory call Dockerfile (as shown on right)

  - **Run the following build command:**

```
docker build -t db2expr_img .
```

- **To start and enter container:**

```
docker run -it --name mydb2expr
--privileged db2expr_img
```

Dockerfile

```
# Using Ubuntu 16.04 base image as starting point.
FROM ubuntu:16.04

# My contaact information.
MAINTAINER Kelly Schlamb (kschlamb@ca.ibm.com)

# Install Db2 pre-reqs and additional commands that I find useful.
RUN dpkg --add-architecture i386 && \
    apt-get update && \
    apt-get -y install rpm binutils libaio1 libx32stdc++6 \
                       libpam0g:i386 libnuma1 file vim

# Setup temporary installation directory and copy Db2 Express-C
# install binaries into it. This will automatically unzip & untar.
RUN mkdir /tmp/db2install
ADD v11.1_linuxx64_expc.tar.gz /tmp/db2install

# Create user IDs for Db2 instance (db2inst1, db2fenc1)
RUN groupadd db2iadm1 && \
    useradd -d /home/db2inst1 -g db2iadm1 \
            -m -s /bin/bash -p passW0RD db2inst1

# Non-root install of Db2 and create the db2inst1 instance.
RUN su - db2inst1 -c "/tmp/db2install/expc/db2_install \
                      -b /home/db2inst1/sqllib -y -t \
                      /tmp/db2_install.trc -l /tmp/db2_install.log"

# Remove temporary installation files.
RUN rm -Rf /tmp/db2install
```

Creating your own Db2 Container Image – Very Basic Example (cont.)

```
root@ksserver1:~/DOCKER# docker images
REPOSITORY            TAG                 IMAGE ID            CREATED              SIZE
db2expr_img           latest              fa774af58ac4        About a minute ago   2.58GB

root@ksserver1:~/DOCKER# docker ps

root@ksserver1:~/DOCKER# docker run -it --name mydb2expr --privileged db2expr_img

root@3eda2fcb6107:/# su - db2inst1

db2inst1@3eda2fcb6107:~$ db2start
SQL1063N  DB2START processing was successful.

db2inst1@3eda2fcb6107:~$ db2 create database testdb
DB20000I  The CREATE DATABASE command completed successfully.

root@ksserver1:~/DOCKER# docker ps    (need to run in another window, outside container, to see this)
CONTAINER ID    IMAGE          COMMAND       CREATED          STATUS          PORTS    NAMES
3eda2fcb6107    db2expr_img    "/bin/bash"   2 minutes ago    Up 2 minutes             mydb2expr
```

Some next steps to properly productize the environment:

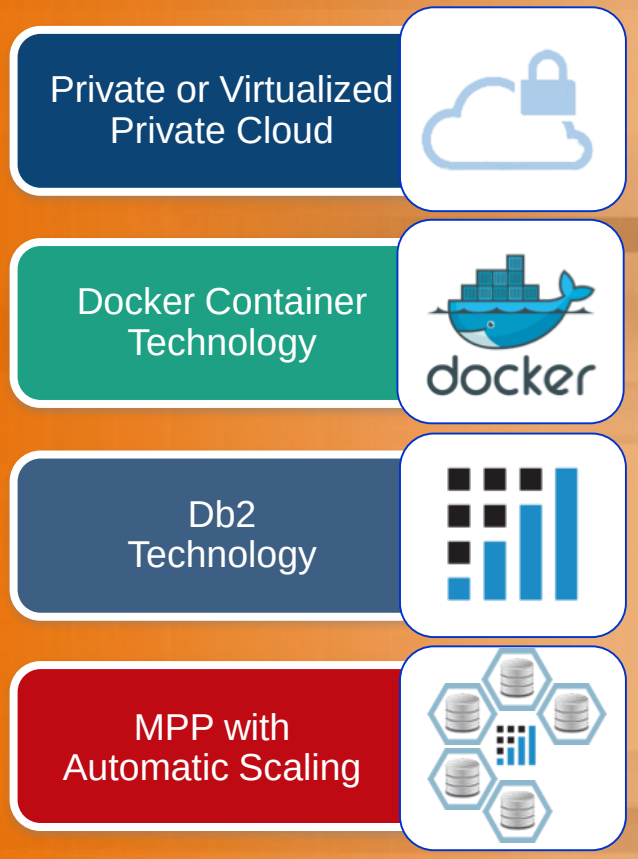
- Use a permanent volume for your database directory and files (`--volume` in docker run command)
- Expose ports from the container to the host for client/server connectivity (`--publish` in docker run command)
- Create entry point script to start Db2 and have container run permanently in the background

Useful Docker Commands

Action	Command
Show Docker version	`docker version`
Show Docker system information	`docker info`
List Docker images	`docker images`
List all Docker images, even intermediate ones	`docker images -a`
List running Docker containers	`docker ps`
List all Docker containers, not just those that are running	`docker ps -a`
Start new container from an image	`docker run <options> <imageName>`
Run command (interactively) in existing container	`docker exec -it <containerName> <command>`
Login to Docker registry	`docker login -u=<userID> -p='<password>'`
Show process tree for container	`docker top <containerName>`
Start container that was previously stopped	`docker start <containerName>`
Stop container that is currently running	`docker stop <containerName>`
Search for images (from repository)	`docker search <term> (e.g. docker search db2)`
Pull image	`docker pull <imageName>[:TAG]`
Remove container	`docker rm <containerName>`
Remove image	`docker rmi [-f] <imageName>`

Db2 Warehouse

Benefits of Db2 Technology with Fast Deployment into Your Private Cloud Environment



Db2 Warehouse

- Highly flexible data warehouse
- Optimized for fast and flexible deployment into **private clouds**
- Uses **Docker** container technology
- Built on top of **Db2 technology**, it shares the benefits of
  - BLU Acceleration in-memory columnar technology
  - Netezza In-database analytics
  - Oracle compatibility
- **Massively Parallel Processing** (MPP) with automated scaling capabilities to increase infrastructure efficiency
- Simplified setup and updates

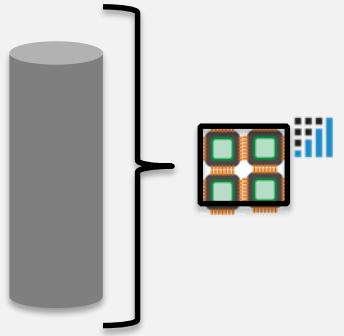
Db2 Warehouse Utilizes Massively Parallel Processing (MPP)

- **Coordination of multiple CPU cores *and* servers, working together to solve complex tasks and queries faster**
- **Add more servers for additional processing power!**

Traditional Approach

Parallelization of Cores

- For smaller data sets < 12TB
- Generally less expensive
- Slower performance

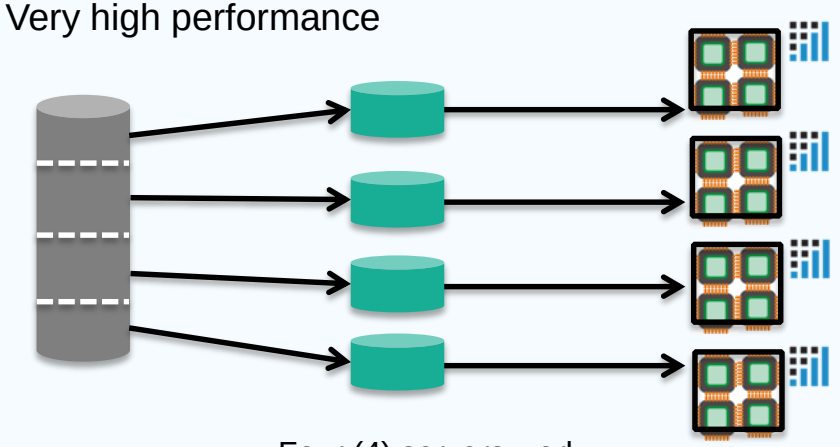


Query takes **1 hour**

MPP Approach

Parallelization of Cores and Servers

- For larger data sets > 4 TB
- Larger monthly budget
- Very high performance

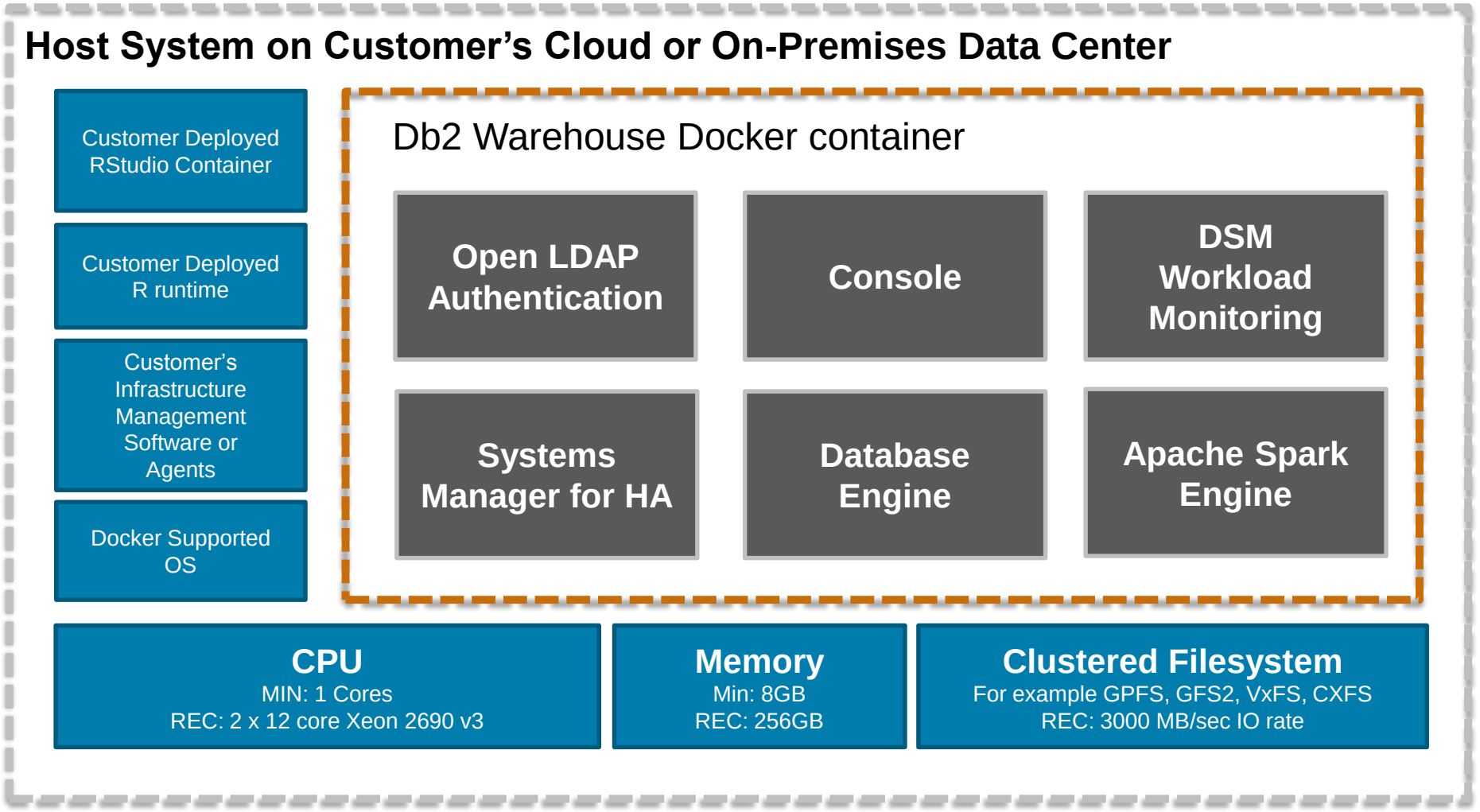


Query is segmented into smaller tasks

Four (4) servers work together on separate tasks of the original query

Query takes **15 min**

Db2 Warehouse Architecture



Scale Up CPU, Memory, IO according to your infrastructure availability

Db2 Warehouse MPP Elastic Scalability

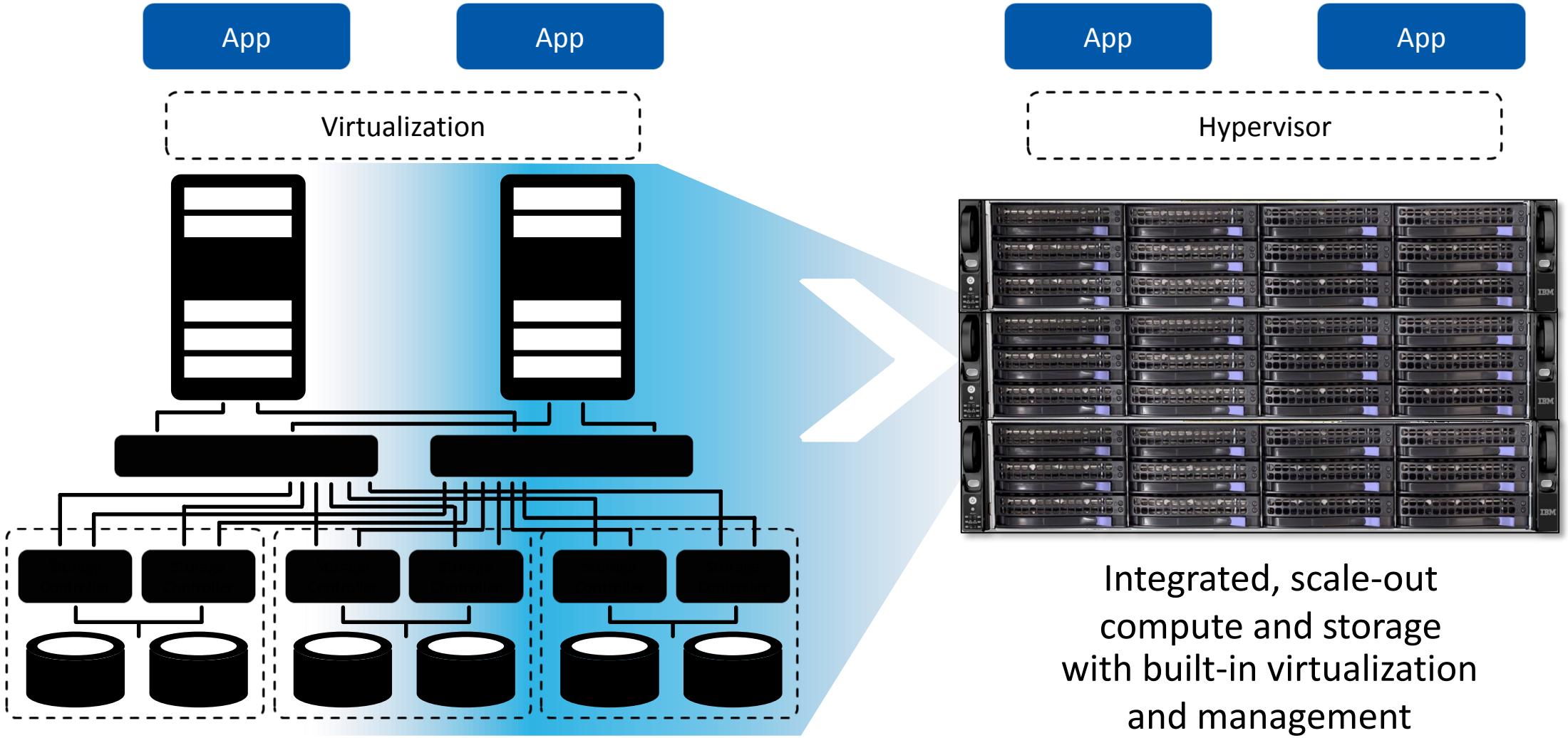
- **Automatic detection of hardware resources for scaling operations**
  - Docker container automatically detects hardware resources available
  - Minimal interruption to your database operation - requires temporarily stopping Db2 Warehouse services while you implement the changes
- **Scale in or scale out: removing existing or adding new nodes**
  - Partitions will be automatically re-balanced across all containers
- **Scale up or scale down: change the resources available to a node**
  - Easy because independence between application container and named volume storage container
- **Portability: Replacing the node and clustered file system**
  - Stop container on old server, copy data to new file system, start container on new server

Hyperconverged Systems

NUTANIX

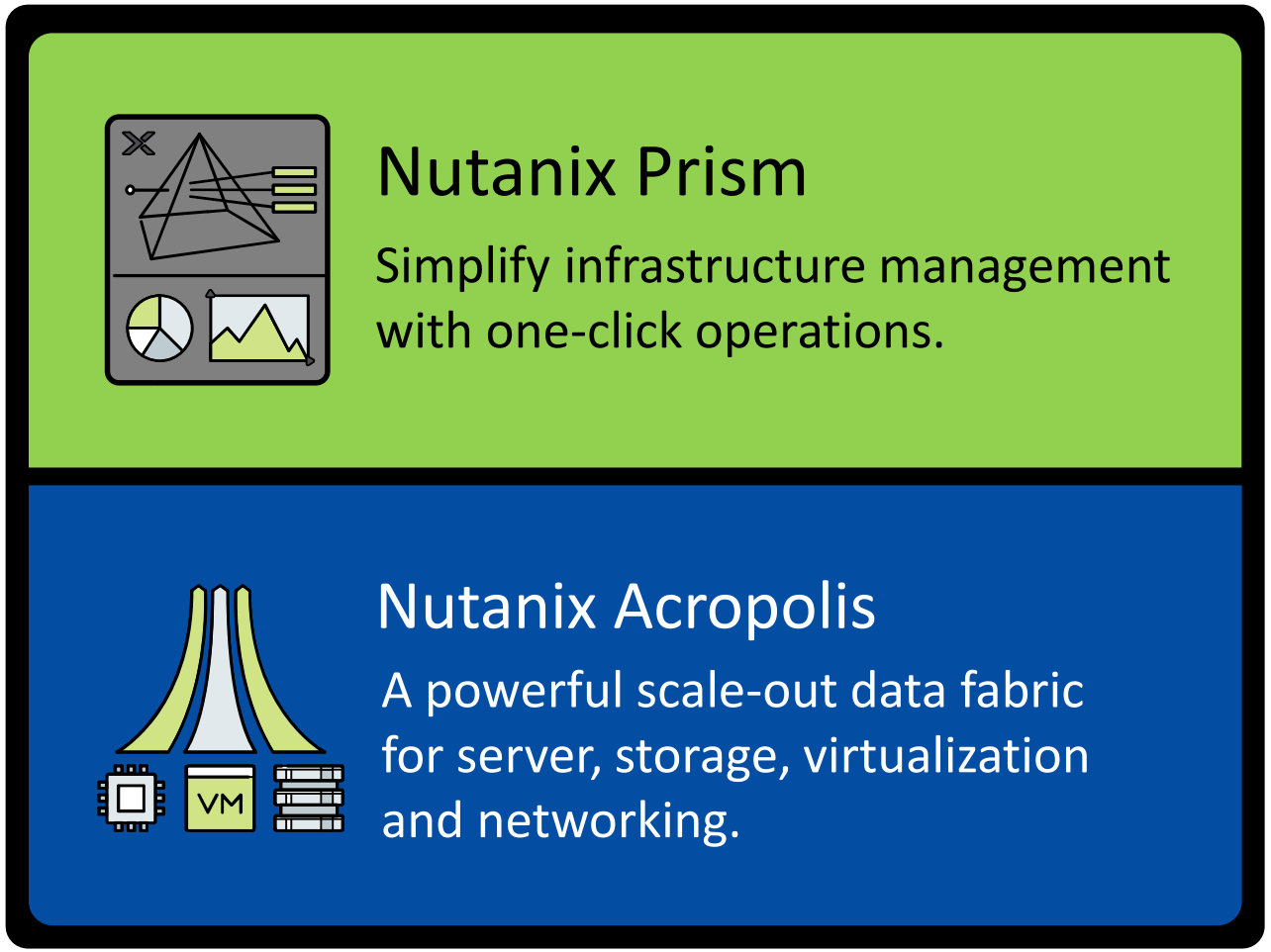
Power Systems

On-premises Enterprise Cloud – Building Blocks Defined



Integrated, scale-out
compute and storage
with built-in virtualization
and management

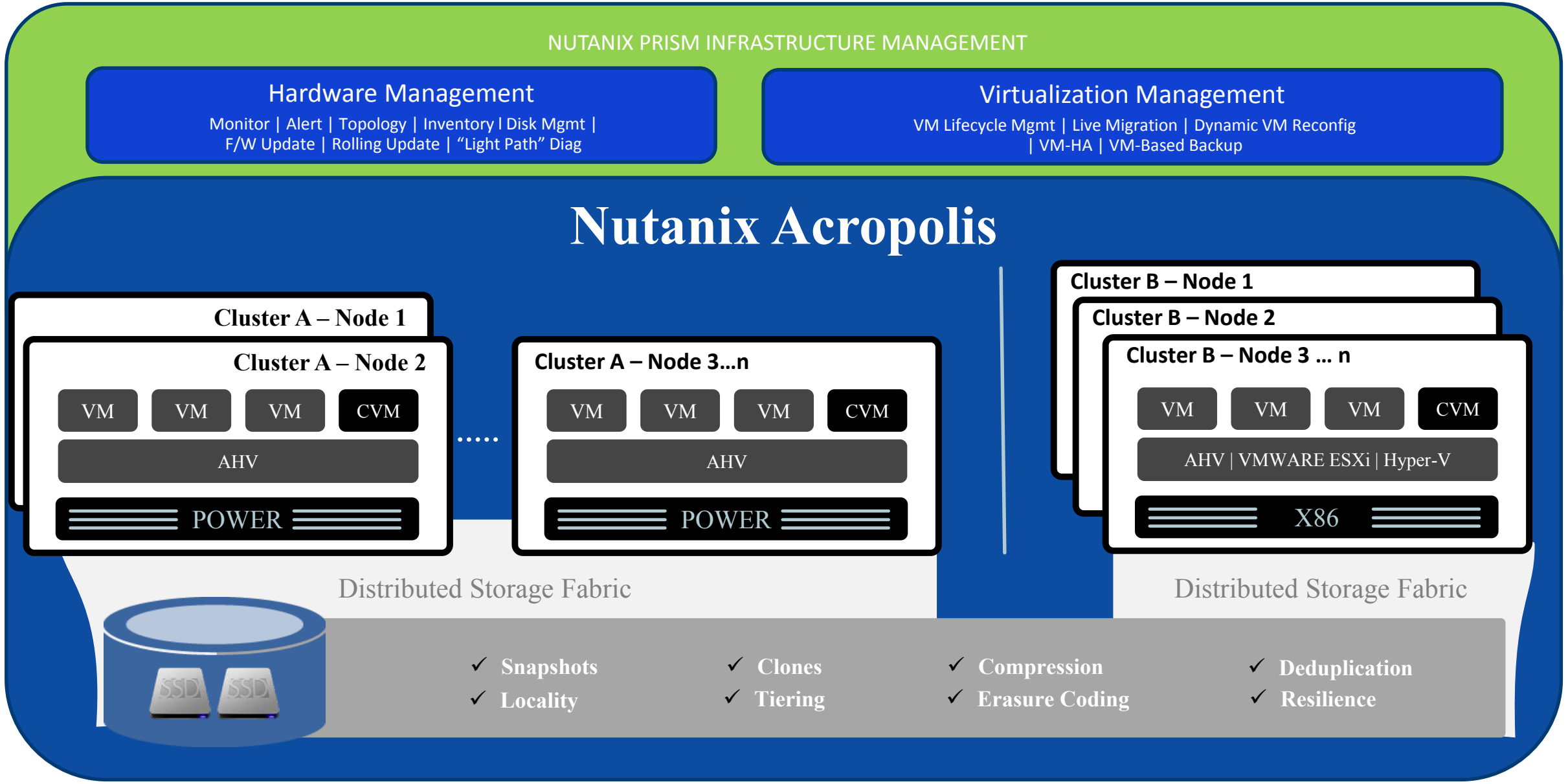
IBM Hyperconverged Solution with Nutanix Components



Application and infrastructure management
that radically simplifies datacenter operations.

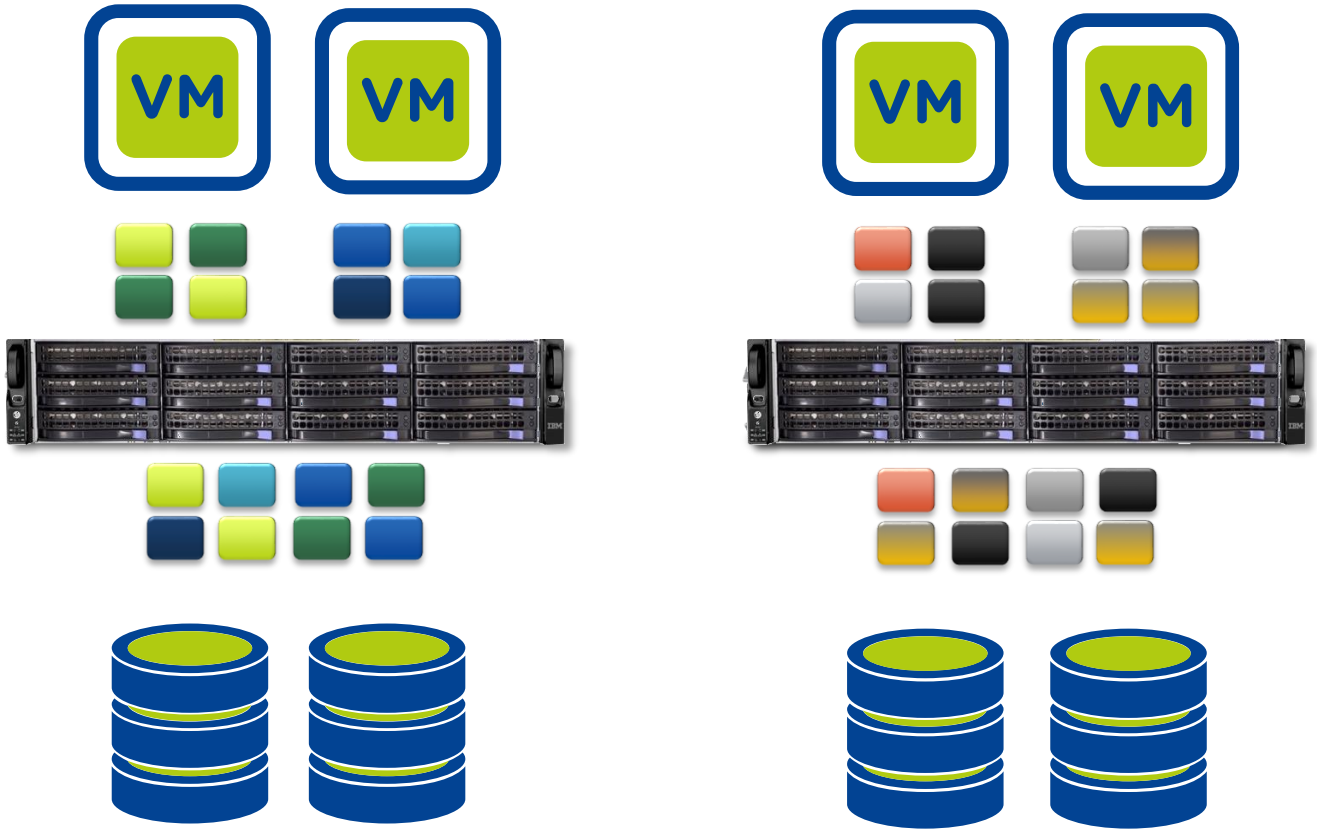
Turnkey infrastructure platform
that converges compute, storage, networking and virtualization to run any application, at any scale.

Nutanix Architecture

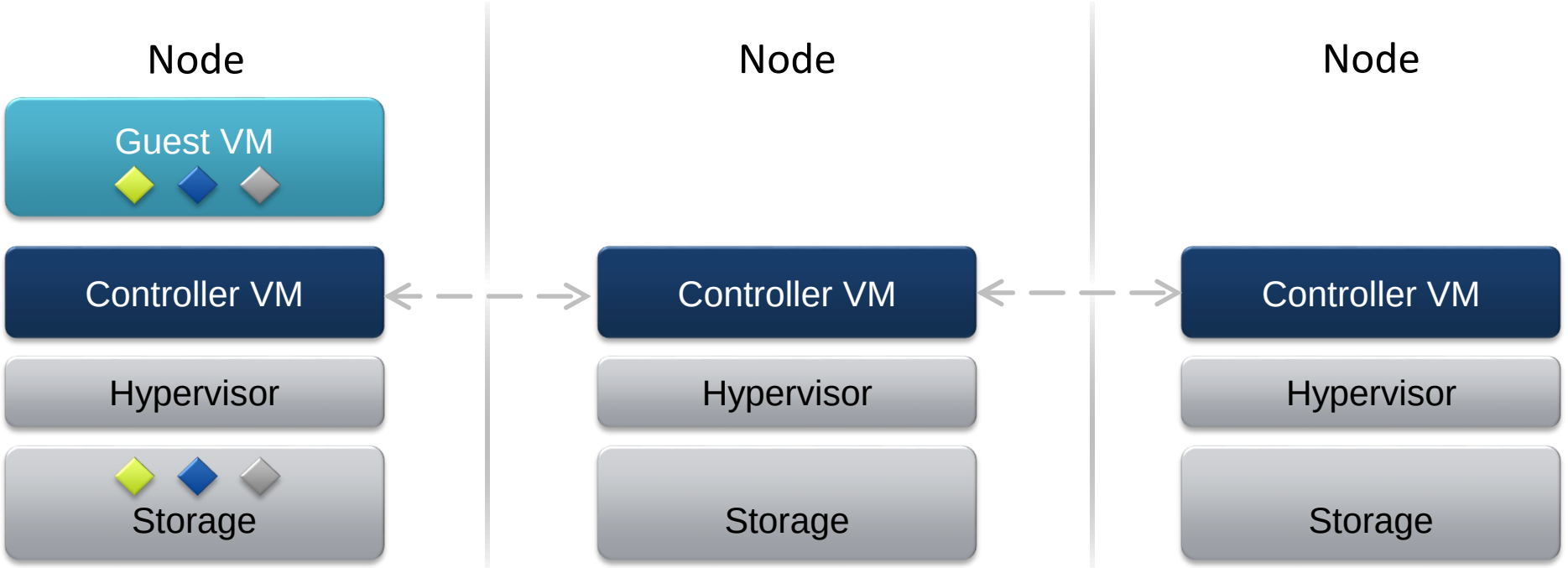


Important to keep the data local to the VM accessing it

- Keep data on the same node as VM
- All read operations localized on same node
- ILM (Intelligent Lifecycle Management) transparently moves remote data to local controller
- Reduces network chattiness significantly
- Data follows VM during vMotion, Live Migration



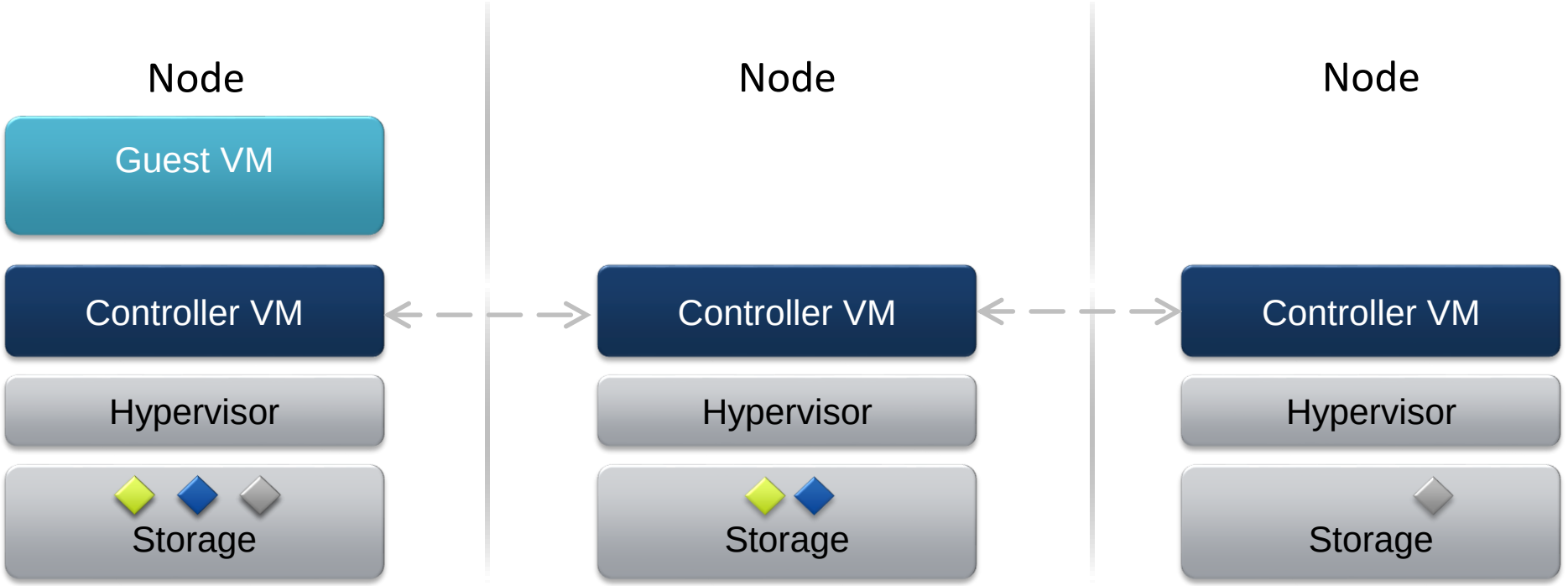
Anatomy of a write I/O



Performance and availability

- Data is written locally
- Replicated on other nodes for high availability
- Replicas are spread across cluster for high performance

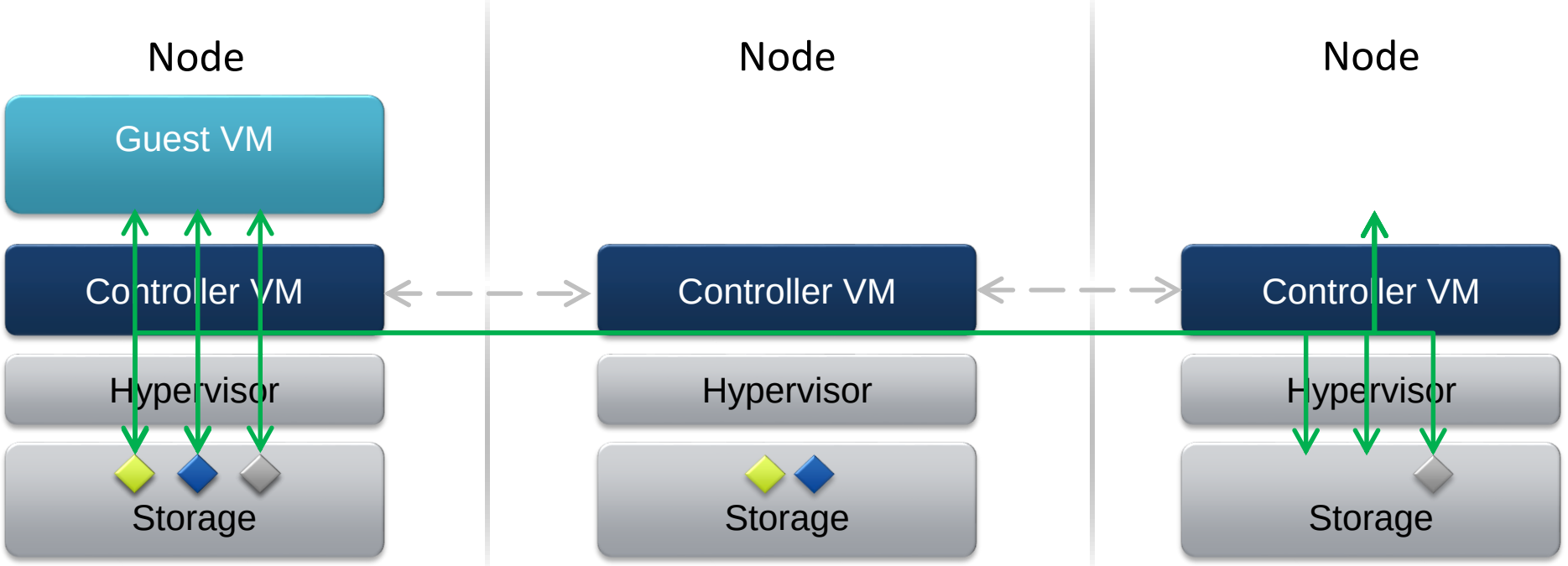
Anatomy of a read I/O



Performance and availability

- Data is read locally
- Remote access only if data is not locally present

Moving a VM from one node to another



Seamless VM Migration

- Metadata service can access data from anywhere
- Locality improves over time

Db2 on Nutanix

NUTANIX + Db2

- Nutanix is an IaaS platform
- Using Prism management console, create VM and assign storage for Db2
- Snapshot and clone VMs
  - Prism includes a catalog service for storing VM snapshots and images – for simplified deployment (prod, test, dev)
- HADR, backup, restore, archive logging all used as usual
  - Additionally, multi-node Nutanix platform built to be resilient (e.g. VM migration for unavailable node)
- Video demoing use of Db2 on Nutanix:

https://www.youtube.com/watch?v=uzo89IaGBsc

Details on benchmarks in speaker notes.

IBM Hyperconverged Systems CS822

IBM Db2

WebSphere

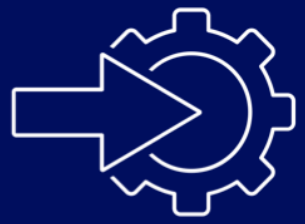
3YR with Support

Dell XC630-10

IBM Cloud Private

Introducing
IBM Cloud Private

- Full stack private cloud software offering – not an appliance
- Built using industry standard open source projects including Docker, Kubernetes and Terraform
- Sits behind your firewall
- Enterprise grade, open by design



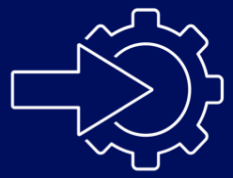
Rapid Innovation

Hybrid Integration

Investment Leverage

Management and Compliance

IBM Cloud Private brings cloud native to the enterprise



Rapid Innovation

- Open Kubernetes-based container platform
- Cloud Foundry for app dev and deployment
- DevOps toolchain integration

Hybrid Integration

- Integration capabilities to unlock and connect
- Secure access to public cloud services (AI, Blockchain)
- Consistent experience across private/public

Investment Leverage

- Containerized versions of IBM Middleware
- Prescriptive guidance to optimize workloads
- Work with existing apps, data, skills, infrastructure

Management and Compliance

- Core operational services including logging, monitoring, security
- Flexibility to integrate with existing tools and processes

IBM Cloud Private

Empowering developers, data scientists and administrators to meet business demands

Developers

Developers tap into a rich stack of built-in development tools and services.

Data Scientists

Data scientists can build and train models more quickly and business analysts can provide critical insights faster.

Administrators

Provide on-demand self-service IT, with security and control, optimized for the workloads of developers, data scientists and business analysts.

IBM Cloud Private Solution Overview

Enterprise Content Catalog

Open Source and IBM Middleware, Data, Analytics, and AI Software

Core Operational Services

Log Management, Monitoring, Security, Alerting

Kubernetes Container Orchestration Platform

kubernetes

docker

Choose your infrastructure:

Power Systems

openstack

IBM Spectrum

vmware

IBM Z

intel

Strategic Value:

- Self-service catalog
- Agility, scalability, and elasticity
- Self-healing
- Enterprise security
- No vendor lock-in

Extend to the Heterogeneous Public Cloud for Optimized Multi-Cloud Strategy

Choice with consistency

Hybrid integration

DevOps productivity

Powerful, secure, accessible data and analytics

Accelerated Cognitive solutions

Public IBM Container Service

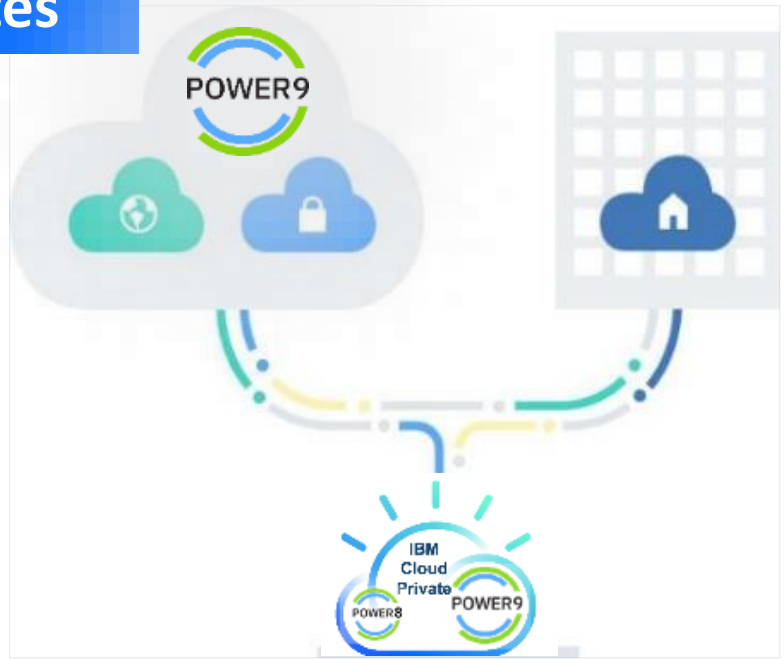
Maximize on cloud economics and agility

Kubernetes

Develop in Public

Capacity on Demand

Deploy in Private



IBM Cloud Private

On-premises, behind the firewall for the most sensitive workloads

Kubernetes

Seamless Experience

Regardless of which combination you choose, you can expect a single, seamless experience

IBM Cloud Private Editions

Community

Platform
- Kubernetes
- Core services
- Content catalog of open source and IBM software

Freely Available in Docker Hub

Cloud Native

Platform
- Kubernetes
- Core services
- Content catalog

Cloud Foundry (Optional)

IBM Enterprise Software
- Microservice Builder
- WebSphere Liberty
- IBM SDK for node.js
- Cloud Automation Manager

Enterprise

Platform
- Kubernetes
- Core services
- Content catalog

Cloud Foundry (Optional)

IBM Enterprise Software
Cloud Native Edition, plus:
+ WAS ND
+ MQ Advanced
+ API Connect Professional

+ ala carte IBM (e.g. Db2), ISV and open source applications or bring your own license

ICP – Kubernetes Content

Toolchain & Runtimes
- UrbanCode Deploy
- Microclimate
- Microservice Builder
- Jenkins (open source)
- IBM WebSphere Liberty (MicroProfile, Web Profile, JEE Profile)
- Open Liberty (open source)
- IBM SDK for Node.js
- Swift runtime (open source)
- Nginx (open source)

Logging & Monitoring Services
- ELK (open source)
- Prometheus & Grafana (open source)

App Modernization Tooling
- IBM Transformation Advisor

Multi-cloud Management
- IBM Cloud Automation Manager

Digital Business Automation
- IBM Operational Decision Manager
- IBM Operational Decision Manager for Developers

Mobile
- IBM Mobile Foundation

Data Services
- IBM Db2 Direct Advanced Edition / AESE with Data Server Manager
- IBM Db2 Dev-C
- IBM Data Server Manager (for Db2 Dev-C)
- IBM Db2 Warehouse Enterprise
- IBM Db2 Warehouse Dev-C
- IBM Cloudant Developer Edition
- MongoDB (open source)
- PostreSQL (open source)
- MariaDB (open source)
- Galera clustering with MariaDB (open source)
- Redis HA Topology (open source)

Messaging
- IBM MQ Advanced
- IBM MQ Advanced for Developers
- Rabbit MQ (open source)

Integration
- IBM Integration Bus
- IBM Integration Bus for Developers
- IBM DataPower Gateway Virtual Edition
- IBM DataPower Gateway for Developers
- IBM API Connect Professional
- IBM API Connect Enterprise

Watson
- IBM Watson Compare & Comply: Element Classification

Data Science and Business Analytics
- IBM Data Science Experience Local
- IBM Data Science Experience Developer Edition
- IBM Watson Explorer Deep Analytics Edition

Data Governance and Integration
- IBM InfoSphere Information Server for Evaluation

Management
- IBM Netcool - integration (Probe for ICP Services – Logging events & Monitoring alerts)

Connectivity
- IBM Voice Gateway Developer Trial

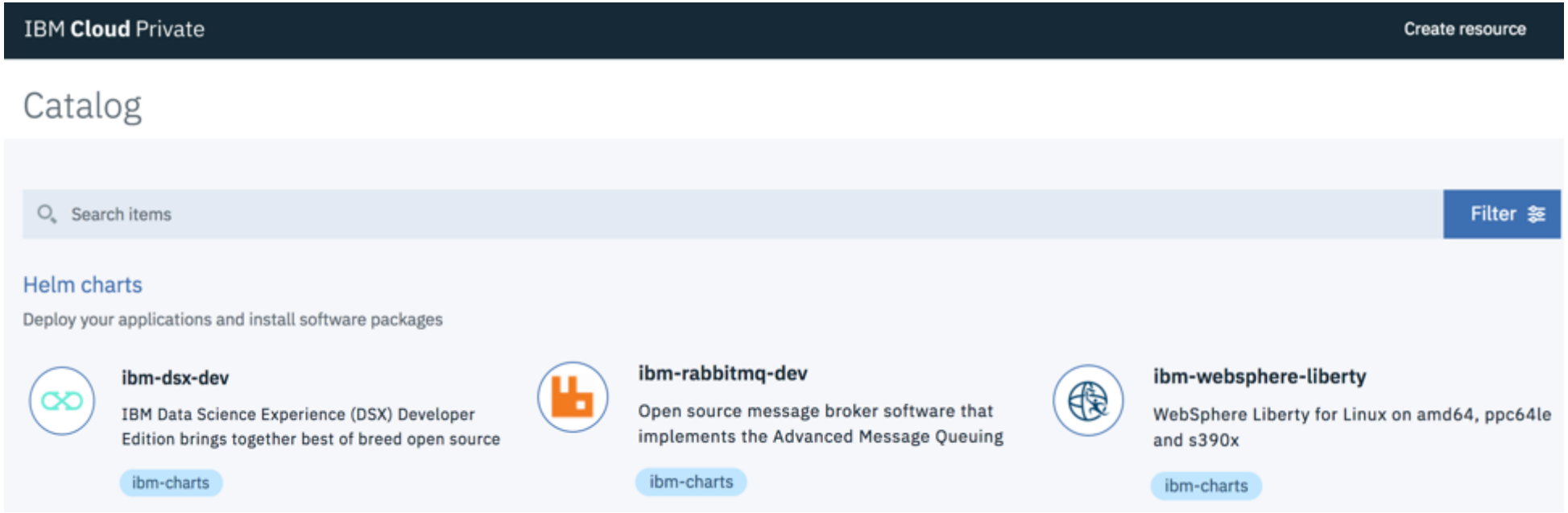
Tooling
- Web Terminal (open source)
- Skydive – network analyzer (open source)

HPC / HPDA
- IBM Spectrum LSF Community Edition
- IBM Spectrum Symphony Community Edition
- IBM Spectrum Conductor Tech Preview

Catalog content is not distributed with IBM Cloud Private. Content is distributed separately, licensed under separate terms and conditions.

What is the ICP Catalog?

Collection of deployment packages (Helm Charts) displayed as tiles with a simple UX to view and deploy software.



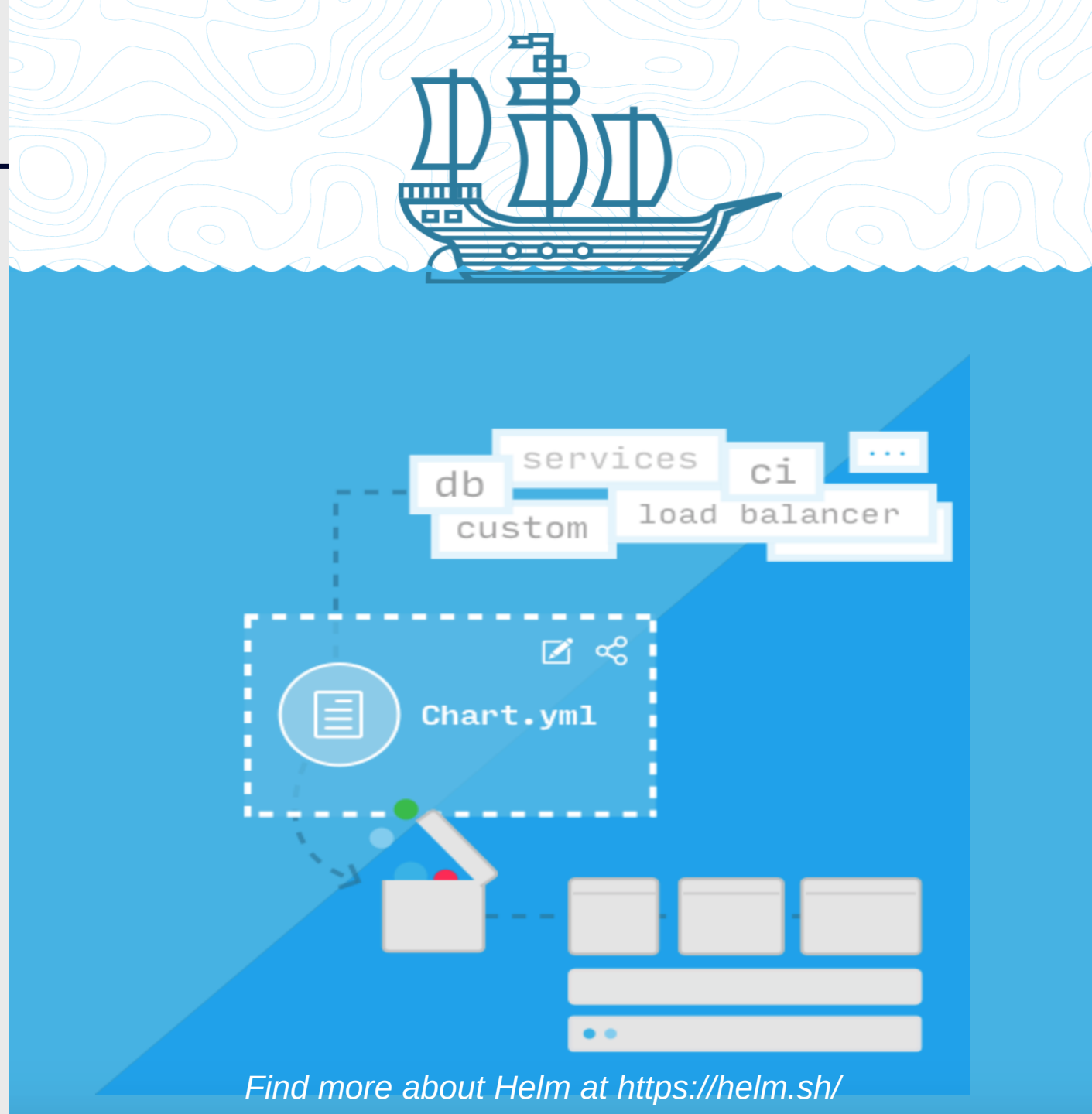
The Catalog provides access to software under separate license terms.

What is Helm?

The package manager for Kubernetes

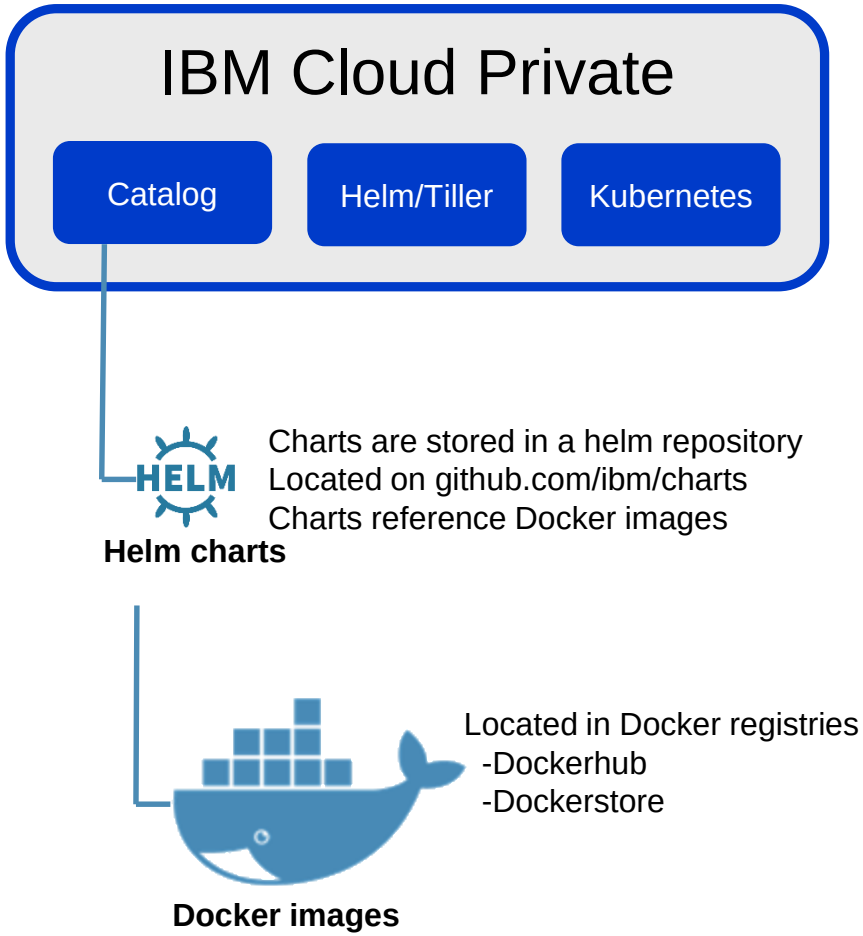
Helm is the **open standard** for Application **Packaging and Deployment** for Kubernetes.

Helm charts can describe the most complex software built for Kubernetes: Resources, dependencies, variables, image locations.



Find more about Helm at https://helm.sh/

Discover and Try Software



Discover and Try helm charts reside in the IBM Charts Repository on github.com/ibm/charts

Available from catalog in all IBM Cloud Private offerings, including Community Edition. Not shipped with the product.

Client accepts **separate license terms**: open source, IBM ILAN or ILAE licensed.

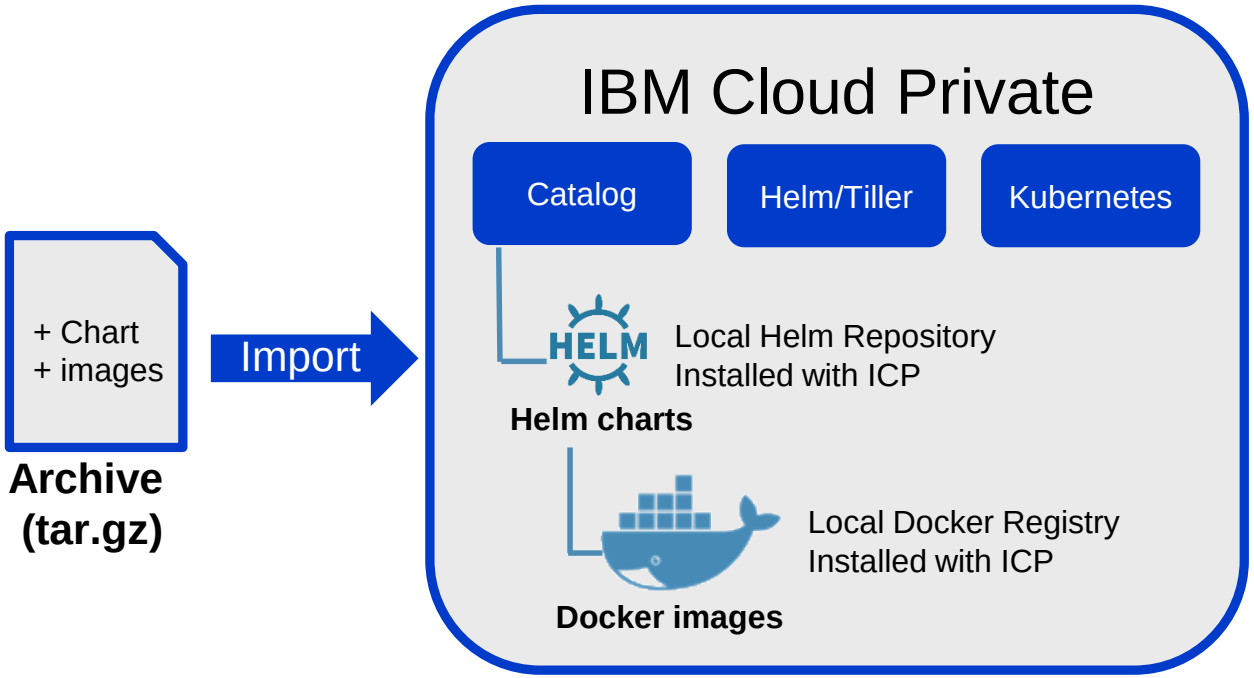
Content is continuously updated, **automatically available** to client's catalog upon refresh.

Docker images are **sourced from public** Docker registries.

Requires **internet connectivity**.

Documented process for disconnected mode (Knowledge Center)

Adding Purchased IBM Software to your Catalog



Purchased IBM Software is entitled in PPA

1. **Download** from Passport Advantage
2. **Import locally** into IBM Cloud Private (ICP)

Purchased IBM software is provided with IPLA license.

Some software maybe sold with priced metrics other than VPC. Client is responsible for compliance to those metrics.

Several packages are entitled for production use and S&S through ICP Cloud Native and Enterprise editions, but are only accessed from IBM Charts repo and public Docker registries. This includes Microservice Builder, WebSphere Liberty and Node.js runtimes.

Inspur selects IBM Cloud Private to deploy their industrial cloud solutions

Business Needs

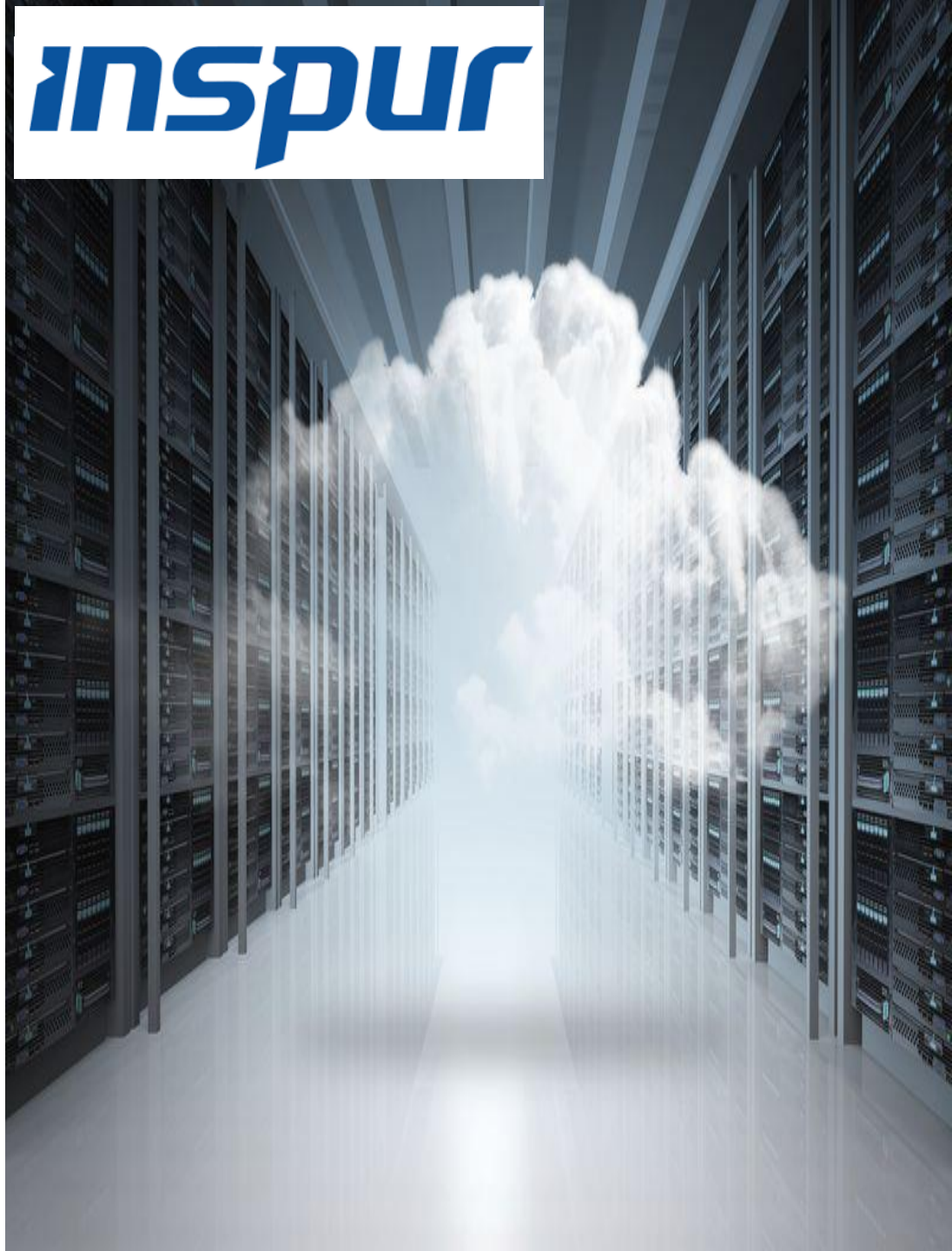
- Enterprise grade Platform as a Service
- Support across x86 and Power platforms
- Support for multiple development languages and runtimes

Solution

- IBM Cloud Private
- IBM UrbanCode Deploy
- IBM MQ

Benefits

- Increased speed of app development and deployment
- Platform flexibility



Five9 modernizes application infrastructure with IBM Cloud Private

Business Needs

- Optimize and modernize its existing application infrastructure
- Quickly develop and deploy industry-specific cloud native applications
- On-premises cloud-native environment

Benefits

- Ability to leverage existing investments in applications and infrastructure
- Reduced costs associated with deployment, management, monitoring and scaling of applications

Db2 on IBM Cloud Private

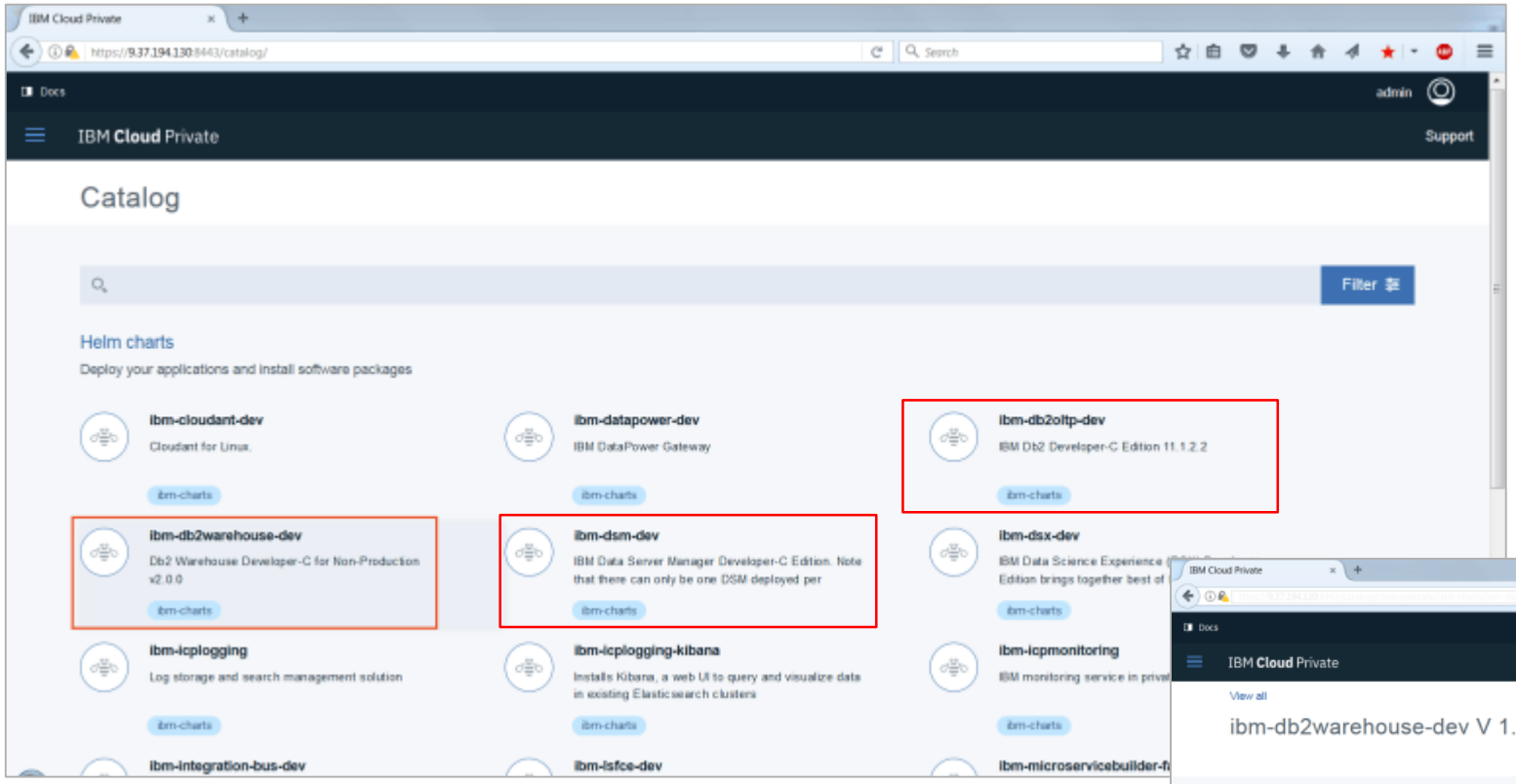
- Non-production/community editions of Db2 are in catalog and are free to use
  - Db2, Db2 Warehouse, DSM
- Production editions (e.g. Direct Advanced, AESE) can be purchased (PPA)
- Build and deploy your own containers (you must have licenses for any licensed software you're deploying)
- ICP and Db2 Solution Brief:

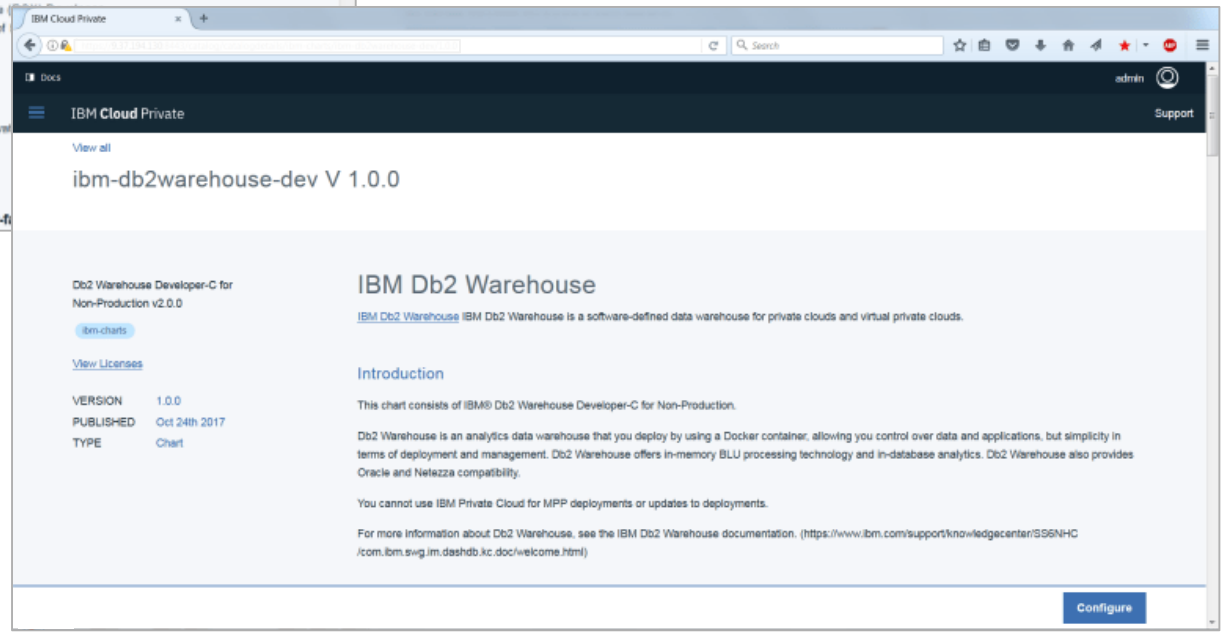
https://www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=GMS14039USEN

- Tutorial for deploying Db2 in ICP:

https://developer.ibm.com/recipes/tutorials/db2-integration-into-ibm-cloud-private

Db2 on IBM Cloud Private

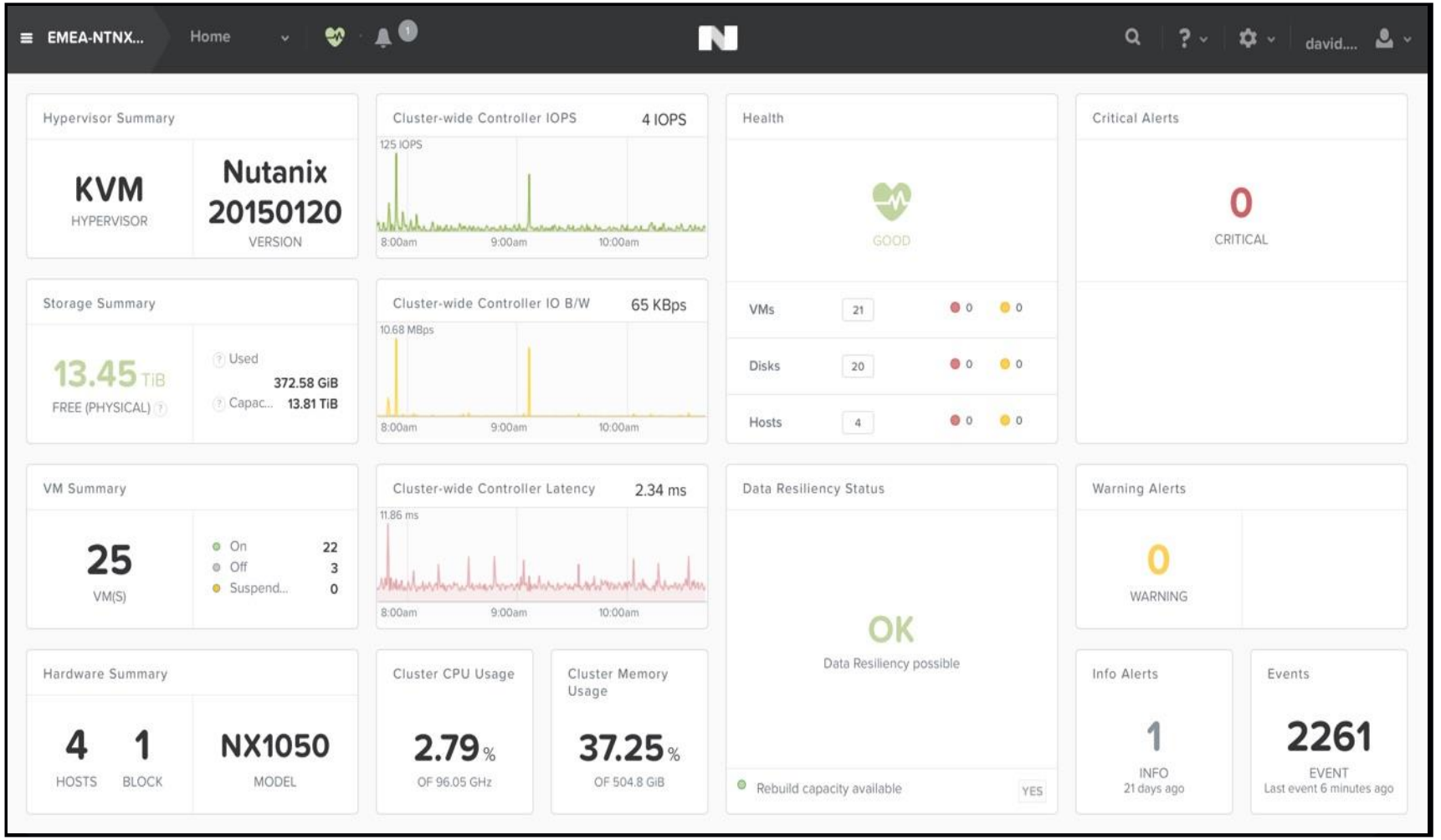




IBM Cloud Private on Nutanix for Cloud Native DevOps

Manage Your Cloud Infrastructure

VM's, Compute, Storage, Networking

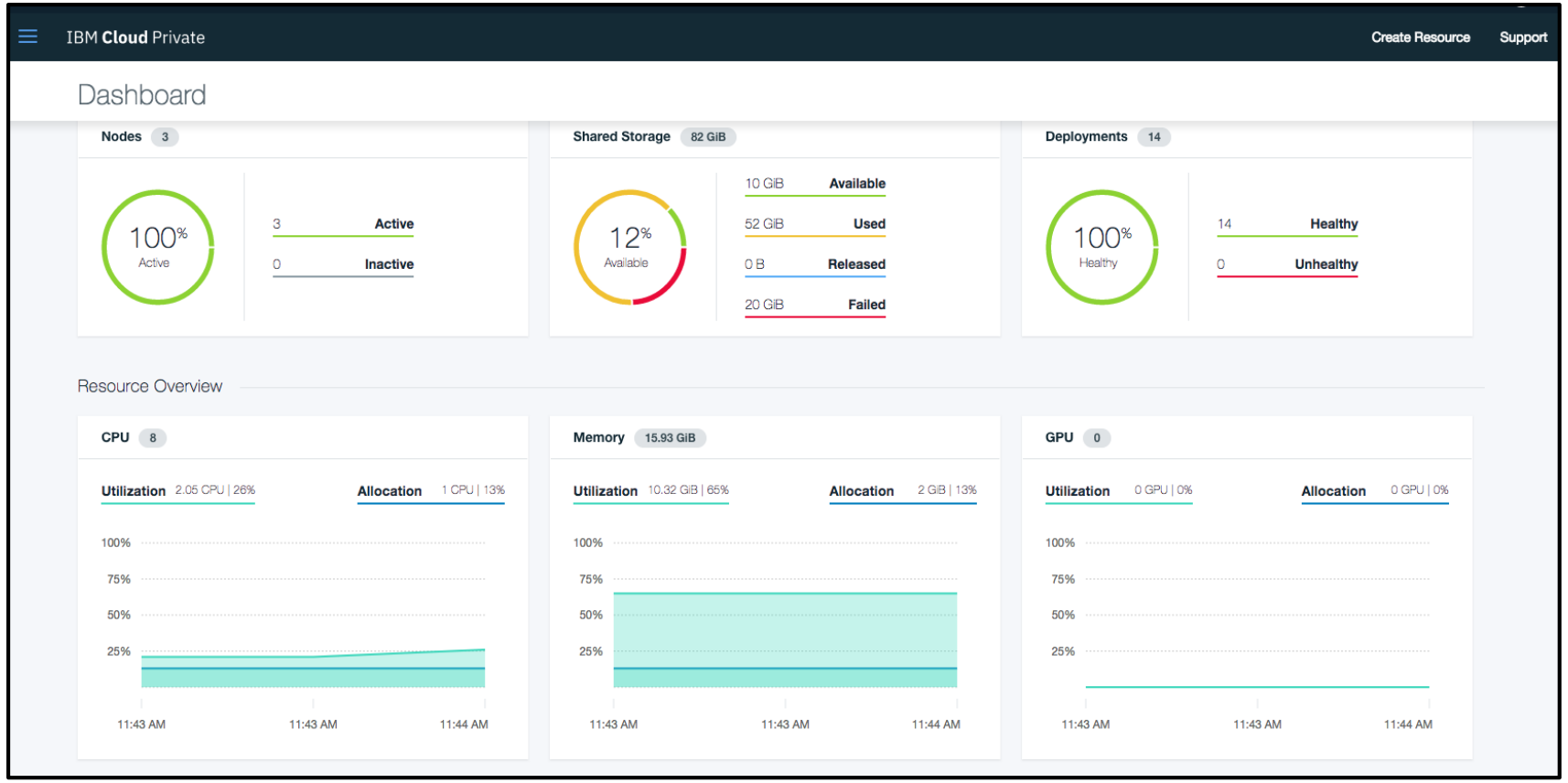


IBM Cloud Private on Nutanix for Cloud Native DevOps

Manage Your Cloud Infrastructure

VM's, Compute, Storage, Networking

Manage Your Container Cluster



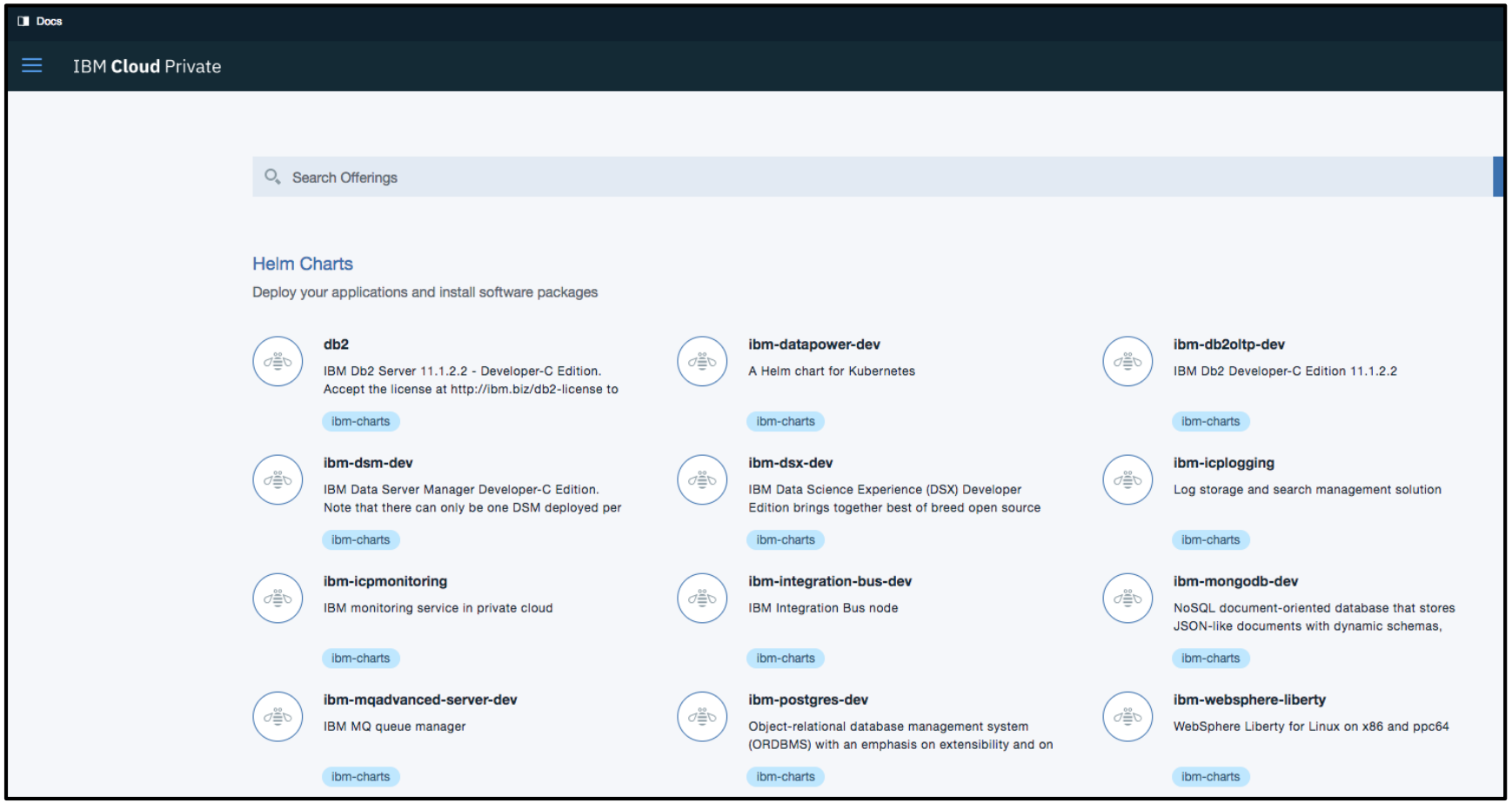
IBM Cloud Private on Nutanix for Cloud Native DevOps

Manage Your Cloud Infrastructure

VM's, Compute, Storage, Networking

Manage Your Container Cluster

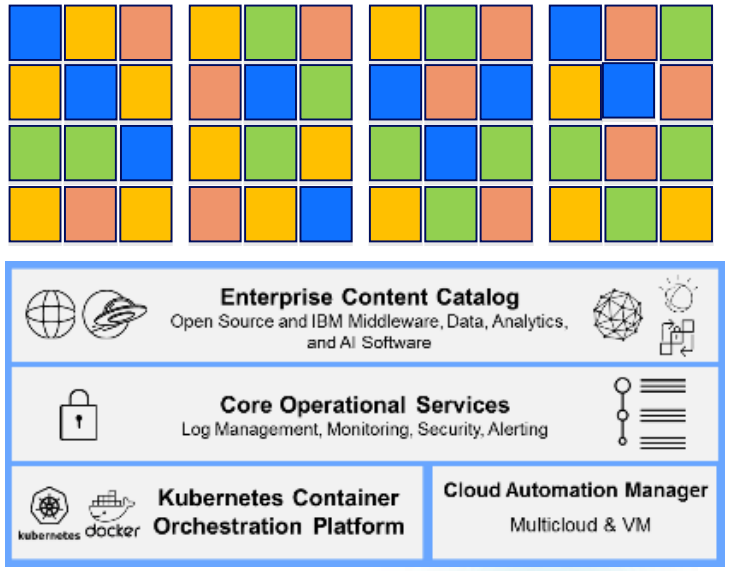
Manage Your Applications



POWER9 + IBM Cloud Private = AI Superhighway

The **only processor** specifically designed for the **AI era**

- ✓ Train 4X the Deep Learning models per hour on P9 -vs- Competition
- ✓ Accelerate your Data Scientists productivity
- ✓ Accelerate your Developers productivity with fully supported containers, cloud native DevOps and Cloud
- ✓ AI optimized clusters of standard CPU and accelerated GPU



CPU Optimized

GPU Accelerated

4x
Threads per core vs x86

9.5x
Up to 9.5x more I/O bandwidth than x86

2.6x
More RAM possible vs. x86

1st
CPU to deliver PCIe gen 4

Reduce operating costs with Power L922 Server running IBM Cloud Private

1.66X price-performance per rack unit over tested Intel Xeon SP Gold 6130 servers (Skylake)

IBM Cloud Private	IBM Power L922 (16-core, 256GB, 2 VMs)	Intel Xeon SP based 2-socket server (32-core, 256GB, 2 VMs)
Server price [2,3,4] -3-year warranty	**$25,932**	**$29,100**
Solution Cost [5] -Server + RHEL OS + Virtualization + ICP Cloud Native VPC Annual Subscription @ $250 per core per month x 36 months	**$180,049** ($25,932 + $10,117 + $144,000)	**$321,019** ($29,100 + $3,919 + $288,000)
Acme Air workload [1] Total Transactions per Second - With 2 VM's	**36,566 tps**	**39,312 tps**
TPS/K$	**203.1 tps/K$**	**122.5 tps/K$**

1.86X
per core performance

43%
Lower solution costs

1.66X
Better Price-performance

1. Based on IBM internal testing of a VM image running the Acme Air workload (https://github.com/acmeair) with containers bound to a socket including a MongoDB microservice. Results valid as of 3/17/18. and conducted under laboratory condition with speculative execution controls to mitigate user-to-kernel and user-to-user side-channel attacks on both systems, individual result can vary based on workload size, use of storage subsystems & other conditions.
2. IBM Power L922 (2x8-core/3.4 GHz/256 GB memory) 2 x 600GB SATA 7.2K rpm LFF HDD, 10 Gb two-port, 1 x 16gbps FCA, EDB Postgres Advanced Server 10, RHEL 7.4 with PowerVM (2partitions@8-cores each),
3. Competitive stack: 2-socket Intel Xeon Skylake Gold 6130 (2x20-core/2.1 GHz/256 GB memory), 2 x 600GB SATA 7.2K rpm LFF HDD, 1 Gb two-port, 1 x 16gbps FCA , RHEL 7.4, KVM (2 VMs@16-cores each)
4. Pricing is based on Power L922 http://www-03.ibm.com/systems/power/hardware/linux-lc.html, **T**ypical industry standard x86 pricing **https://www.synnexcorp.com/us/govsolv/pricing/**
5. IBM software pricing for ICP Cloud Native VPC Monthly Subscription .

Reduce operating costs with Power L922 Server running IBM Cloud Private

$2M less per rack vs tested Intel Xeon SP Gold 6130 servers (Skylake)

- **Save over $2M per 15 server rack with Power L922 Server running IBM Cloud Private** vs comparable Intel Xeon SP servers

- IBM Power Systems designed for Cognitive Clouds
  - Deliver more container throughput per core (1.86X vs compared Intel based systems)
  - Deliver more price-performance value per rack unit when running container based workloads

IBM Cloud Private	15 x IBM Power L922 (16-core, 256GB, 2 VMs)	15 x Intel Xeon SP based 2-socket server (32-core, 256GB, 2 VMs)
Rack Solution Cost [2,3,4,5] -Server + RHEL OS + Virtualization + ICP Cloud Native VPC Annual Subscription @ $250 per core per month x 36 months	**$2,700,735**	**$4,815,285**
Acme Air workload [1] Total Transactions per Secondw With 2 VM's	**548,490 tps**	**589,680 tps**
TPS/K$	**203.1 tps/K$**	**122.5 tps/K$**

1. Based on IBM internal testing of a VM image running the Acme Air workload (https://github.com/acmeair) with containers bound to a socket including a MongoDB microservice. Results valid as of 3/17/18. and conducted under laboratory condition with speculative execution controls to mitigate user-to-kernel and user-to-user side-channel attacks on both systems, individual result can vary based on workload size, use of storage subsystems & other conditions.
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5. IBM software pricing for ICP Cloud Native VPC Monthly Subscription .

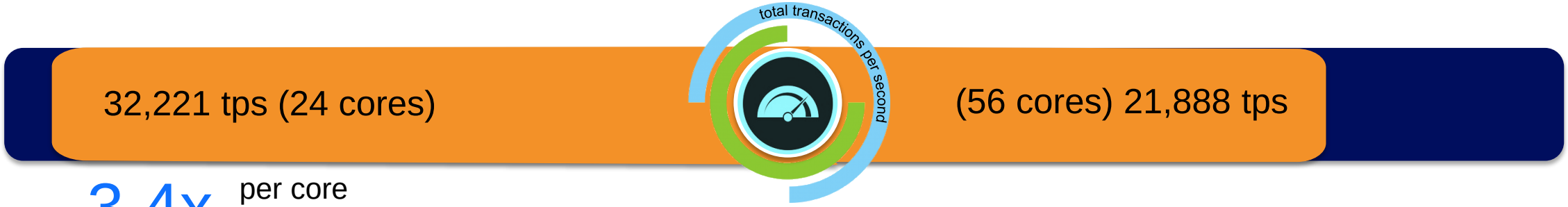
Transaction Processing

POWER9 S924

IBM Db2 WebSphere

Intel Xeon Skylake Platinum 8180

2.43x better price performance



3.4x per core performance

Details on benchmarks in speaker notes.

Data Warehousing

POWER9 L922

IBM Db2

Intel Xeon SP Platinum 8168

3.74 QphH per $K

1.53 QphH per $K

2.44x better price performance

3064 QphH (20 cores)

(48 cores) 2891 QphH

2.54x per core performance

Details on benchmarks in speaker notes.

A Fully Integrated, Multi-architecture, Hybrid Cloud-enabled Data Center ready for the Enterprise

IBM Cloud Private — IBM Cloud Private, kubernetes, docker

Manage Your Client Apps — VM, Container and Bare Metal Apps

vmware | SUSE openstack | PowerVC | openstack | NUTANIX Your Enterprise Cloud Platform

Manage Your Cloud & Infrastructure

Off-premises Cloud

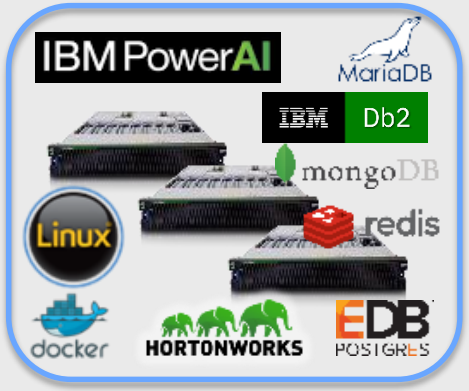
x86

LinuxONE (Z)

Hybrid-enabled

Cloud Ready Enterprise Power E, C and L

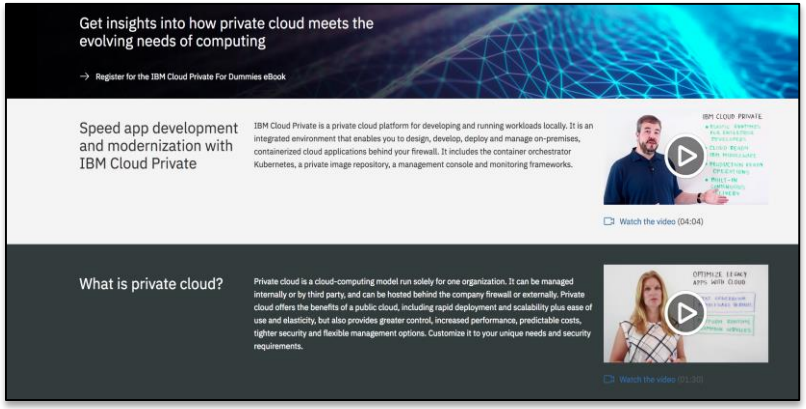
Scale-out Cluster/Cloud Power AC and LC



Hyperconverged Power CS powered by Nutanix

Invisible Infrastructure: Right Workload, Right Platform

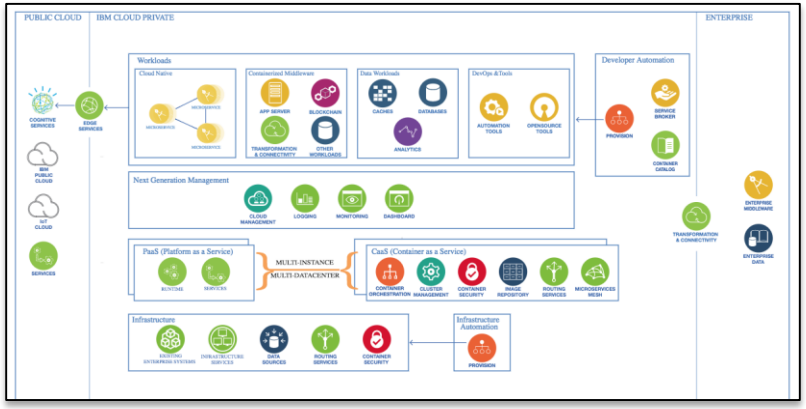
IBM Cloud Private – Digital Assets



Home Page

- Private cloud overview
- Intro videos
- IBM Cloud Private for Dummies book

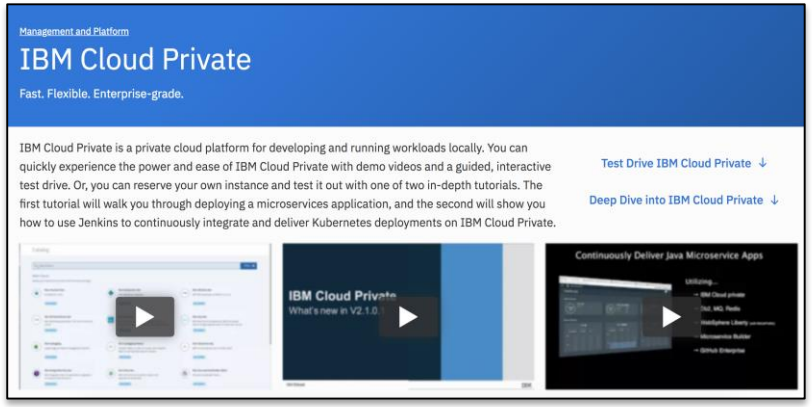
http://ibm.biz/ICP-Home



Garage Method

- Reference architectures
- Best practices

http://ibm.biz/ICP-Garage



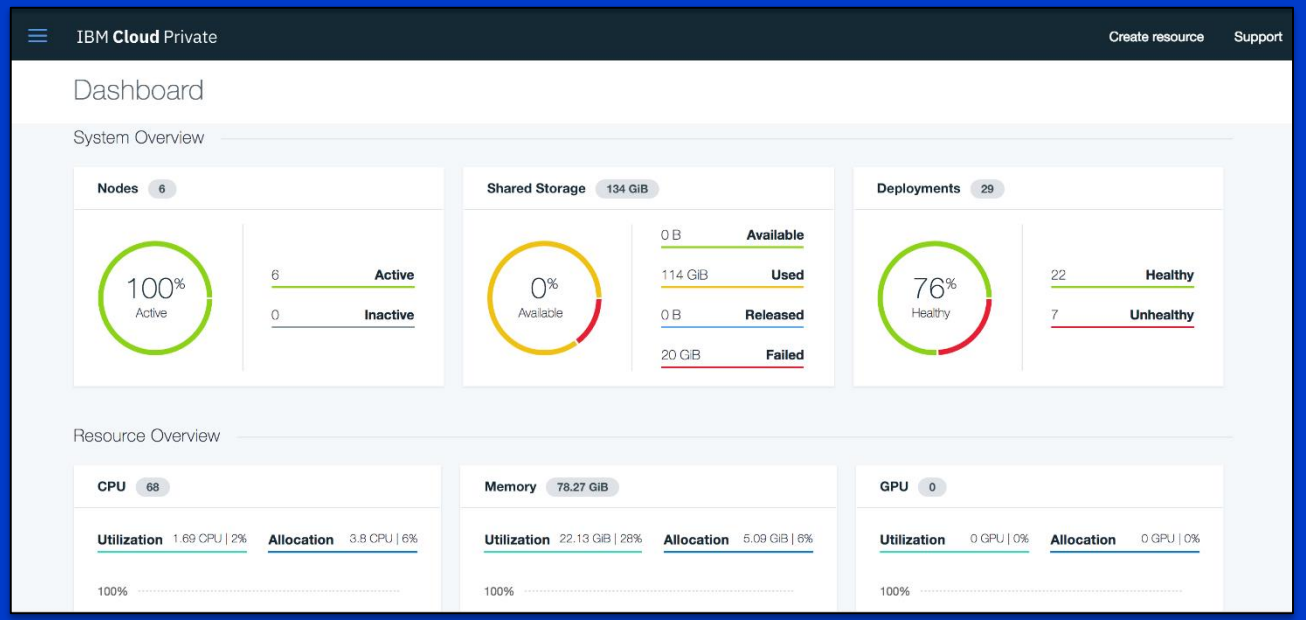
Digital Technical Engagement

- Guided demos
- Proof of Technology

http://ibm.biz/ICP-DTE

Try IBM Cloud Private

Free Community Edition



http://ibm.biz/Try-IBMCloudPrivate

IBM and Red Hat Join Forces to Accelerate Hybrid Cloud Adoption

Announced on May 8th, 2018

Certified IBM middleware on IBM Cloud Private for deployment on Red Hat containers and Red Hat OpenShift

IBM middleware Integrated with open source under one common platform, fully supported from hypervisor through app

IBM middleware deployable everywhere that Red Hat is supported

Development lifecycle extended from inception to production, with built-in management plane for continuous delivery and operation

Professional services to advise and implement IBM Cloud Garage Methods and Red Hat Innovation Labs

"With this news, we will be certifying our private cloud platform – IBM Cloud Private – as well as IBM middleware including WebSphere, MQ and Db2, and other key IBM software, to run on Red Hat Enterprise Linux via Red Hat OpenShift Container Platform."

- Arvind Krishna, Senior Vice President, Hybrid Cloud; Director, IBM Research

Summary

- Building your own private Db2 Cloud is simpler than in the past
- You can still go on your own but it’s harder than you think
- Leverage IaaS offerings like IBM Hyperconverged System powered by Nutanix
- Or for a full private cloud environment that you can install on your infrastructure or cloud vendor of choice, look into IBM Cloud Private

Deploying Db2 in Your Own Private Cloud

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