CMPE 220

Class 26 – Cloud Operating Systems

Types of Operating Systems

- Batch / Single-Process (early computers – 1940s-50s)
- Multi-Programming Systems ("modern" computers – last 1960s)
- Multi-Processor Systems
- Distributed Operating Systems
- Network Operating Systems
- Embedded Systems
- Real-Time Systems
- Cloud Systems
- Mobile Systems

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What is a Cloud Operating System?

- Also known as a “virtual operating system,” a cloud operating system is specifically designed to function within a cloud computing and/or virtualization environment.
- A cloud operating system manages the operation, execution and processes of virtual machines, virtual servers and virtual infrastructure, as well as the back-end hardware and software resources.
- Similar to a **distributed operating system**

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Comparison of Operating Systems

- All provide a means of sharing resources across a communications network
- **Network Operating System:** access to remote resources is explicit
- **Distributed Operating System:** access to remote resources is implicit – programs may not know about locality of references
- **Cloud Operating system:** manages the operation, execution and processes of *virtual machines*, virtual servers and virtual infrastructure, as well as the back-end hardware and software resources.

Essentials of Cloud Computing

- National Institute of Standards and Technology (NIST):
  1. **On-Demand Self-Service** – customer / client configured through a web interface
  2. **Broad Network Access** – assess anywhere
  3. **Resource Polling** – share physical resources
  4. **Rapid Elasticity** – scale quickly on demand
  5. **Measured Service** – a pay-as-you-use model

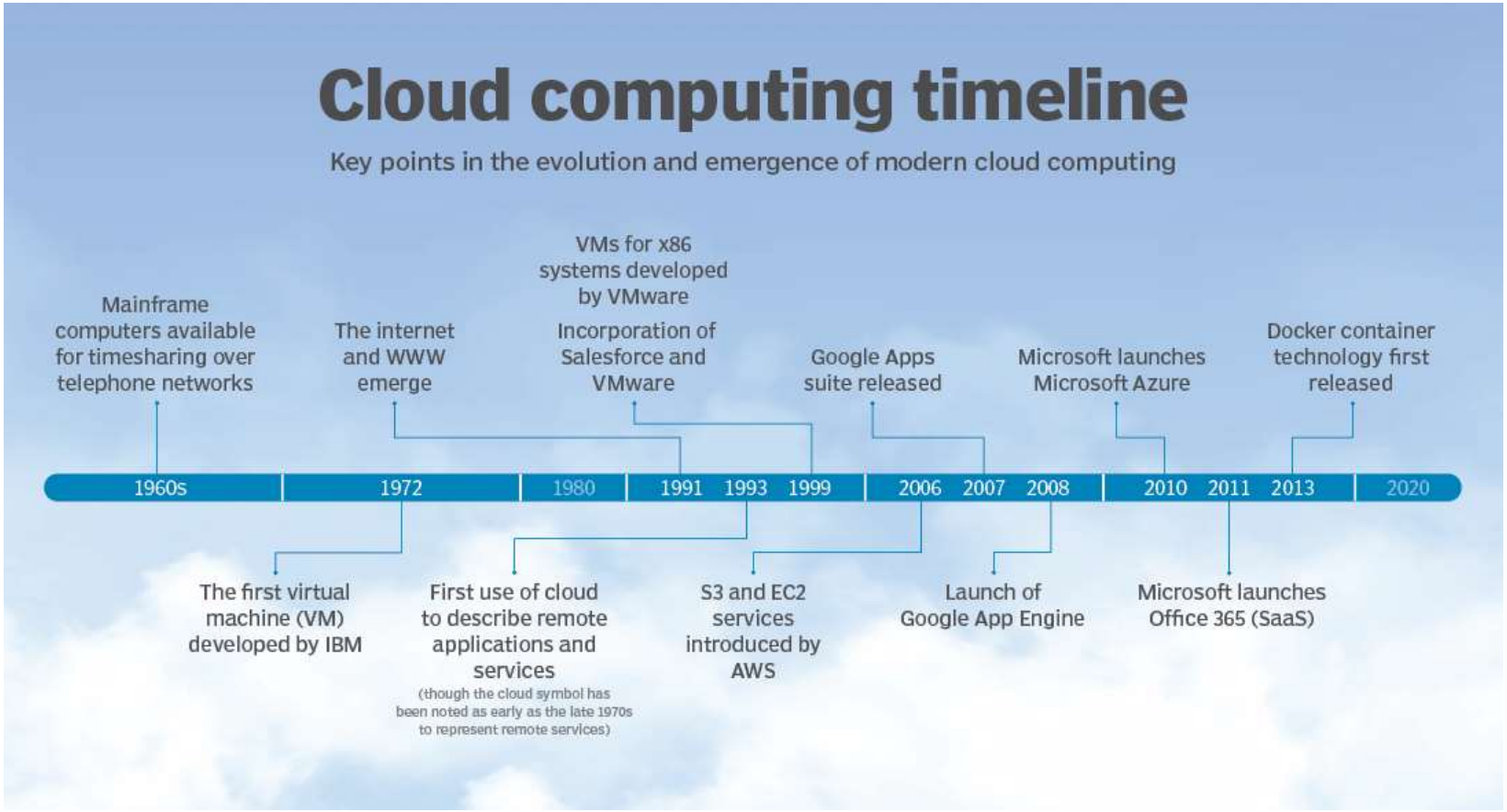
Additional Characteristics

- **Resiliency and Availability** - the ability of a service to recover quickly from any disruption
- **Flexibility** – scale without service disruption
- **Remote Access / Work** - Remote workers can safely and quickly access corporate data and applications

The first Cloud OS?

- The term cloud came into widespread use in 2006 when Amazon launched AWS with the Elastic Compute Cloud (EC2) service.

A History of Cloud Computing



Larry Ellison on Cloud Computing

- The interesting thing about cloud computing is that we've redefined cloud computing to include everything that we already do. … The computer industry is the only industry that is more fashion-driven than women's fashion.

  Maybe I'm an idiot, but I have no idea what anyone is talking about. What is it? It's complete gibberish. It's insane. When is this idiocy going to stop?

Larry Ellison on Cloud Computing

- We'll make cloud computing announcements because, you know, if orange is the new pink, we'll make orange blouses.

  I mean, I'm not gonna fight this thing … well, maybe we'll do an ad. Uh, I don't understand what we would do differently in the light of cloud computing, other than market … you know, change the wording on some of our ads.

Larry Ellison on Cloud Computing

- I started NetSuite. NetSuite was my idea.

  I called up Evan Goldberg and said, ‘We’re going to do ERP on the Internet, software-as-a-service.’

  Six months later Marc Benioff, finding out what NetSuite was doing, and kind of copied it.

Larry Ellison on Cloud Computing

- I like the words [cloud computing].

  It's a charismatic brand. And people do need to simplify their existing data centers and deliver services in simpler ways.

Larry Ellison on Cloud Computing

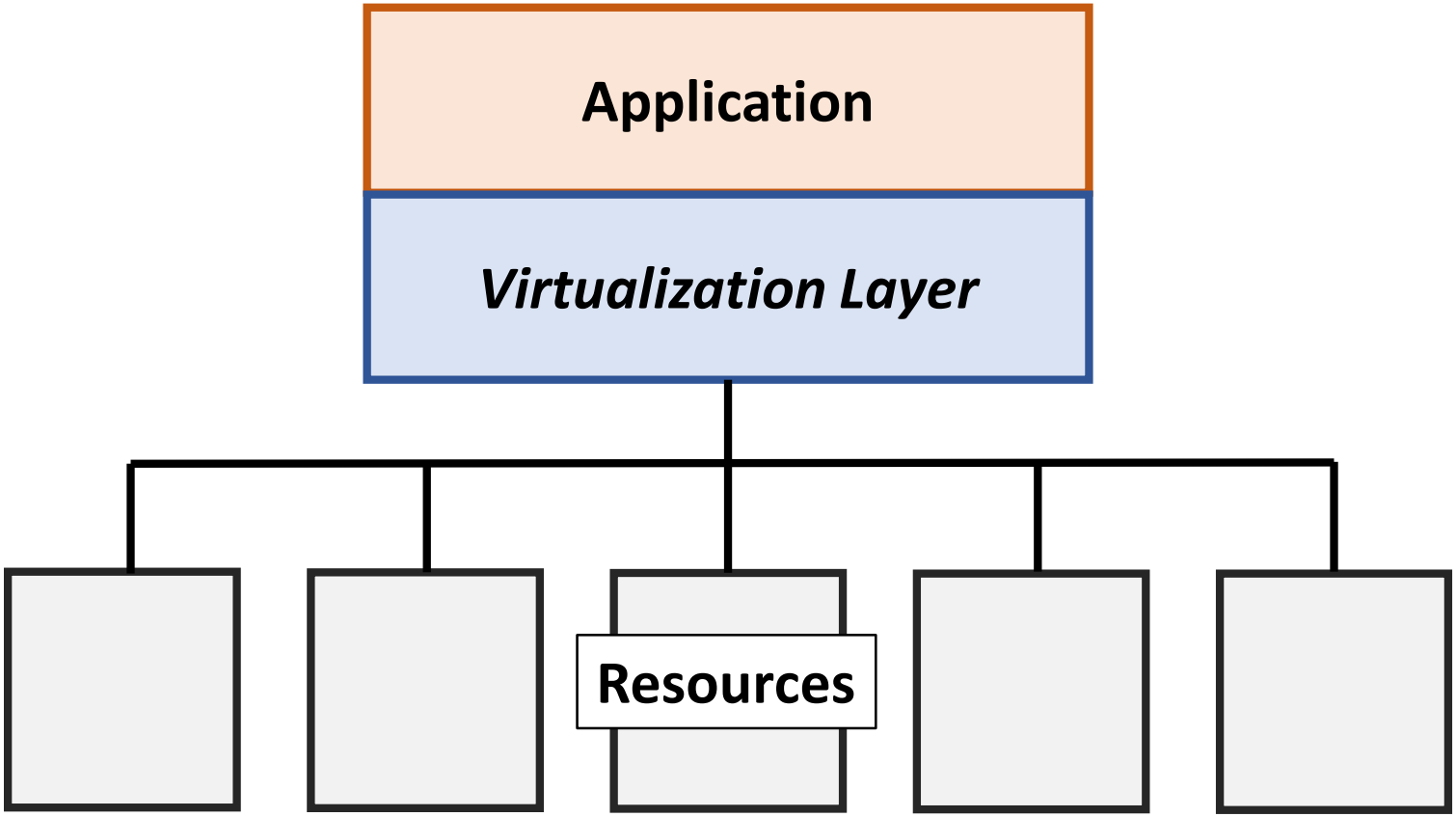
- Virtually every important cloud service on the planet earth runs on the Oracle database.

  Salesforce runs on Oracle. SAP Hana powers the cloud? I'm going to try and be nice, but it's so hard.

  Whose cloud are they talking about? I have no idea what runs and how, but it ain't their cloud – it runs on Oracle.

  It's rude, but it's the truth. It's kind of funny.

Cloud Architecture



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Virtualization Layer

- System Emulation
  - allows multiple operating systems to coexist on a single "system," or a single OS to span multiple "systems."
- Job Distribution
- File System Request Distribution
  - File Migration - File is copied to local machine, accessed, then copied back (requires a file locking mechanism)
- I/O Request Distribution
- Database Request Distribution

Advantages of Cloud Computing

- Scalability / business agility
- Resilience / fault tolerance
  - Hardware and data availability
- Resistance to obsolescence
- Centralized security
- Cost?

- Enables new business models

Business Models

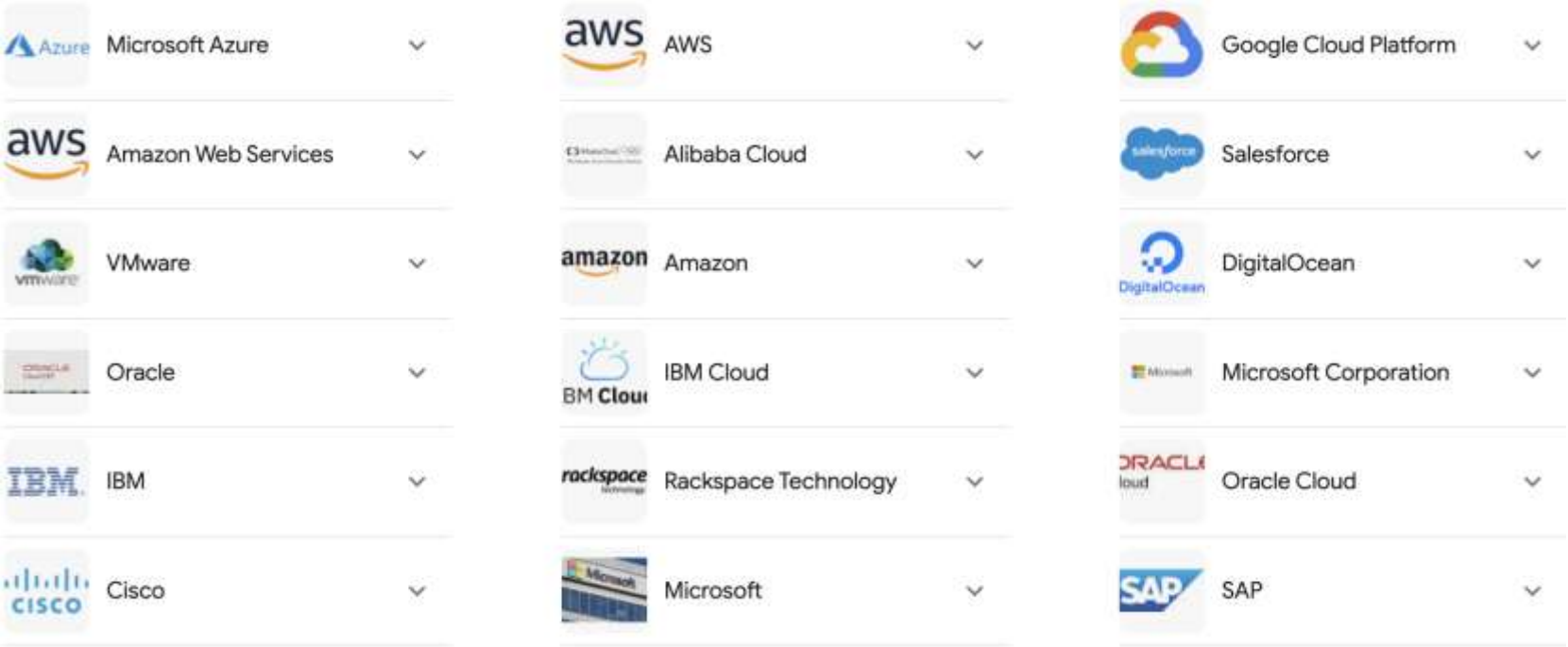
- **Software as a Service** – a third-party provider manages software applications used by the business or other entity. This includes the hardware, database and other tools that support an application
  - Web-based / Thin client
  - Scott McNealy: "The Network is the Computer"
- **Platform as a Service** – the cloud model delivers a complete platform that's used to develop, run and manage applications and services. It includes all compute, networking, storage, middleware and tools via the third-party cloud provider you select.
- **Infrastructure as a Service** - incorporates third-party virtual machines within a cloud computing environment. IaaS provides the physical data center along with the fundamental network, compute and storage resources.

Typical Cloud Services

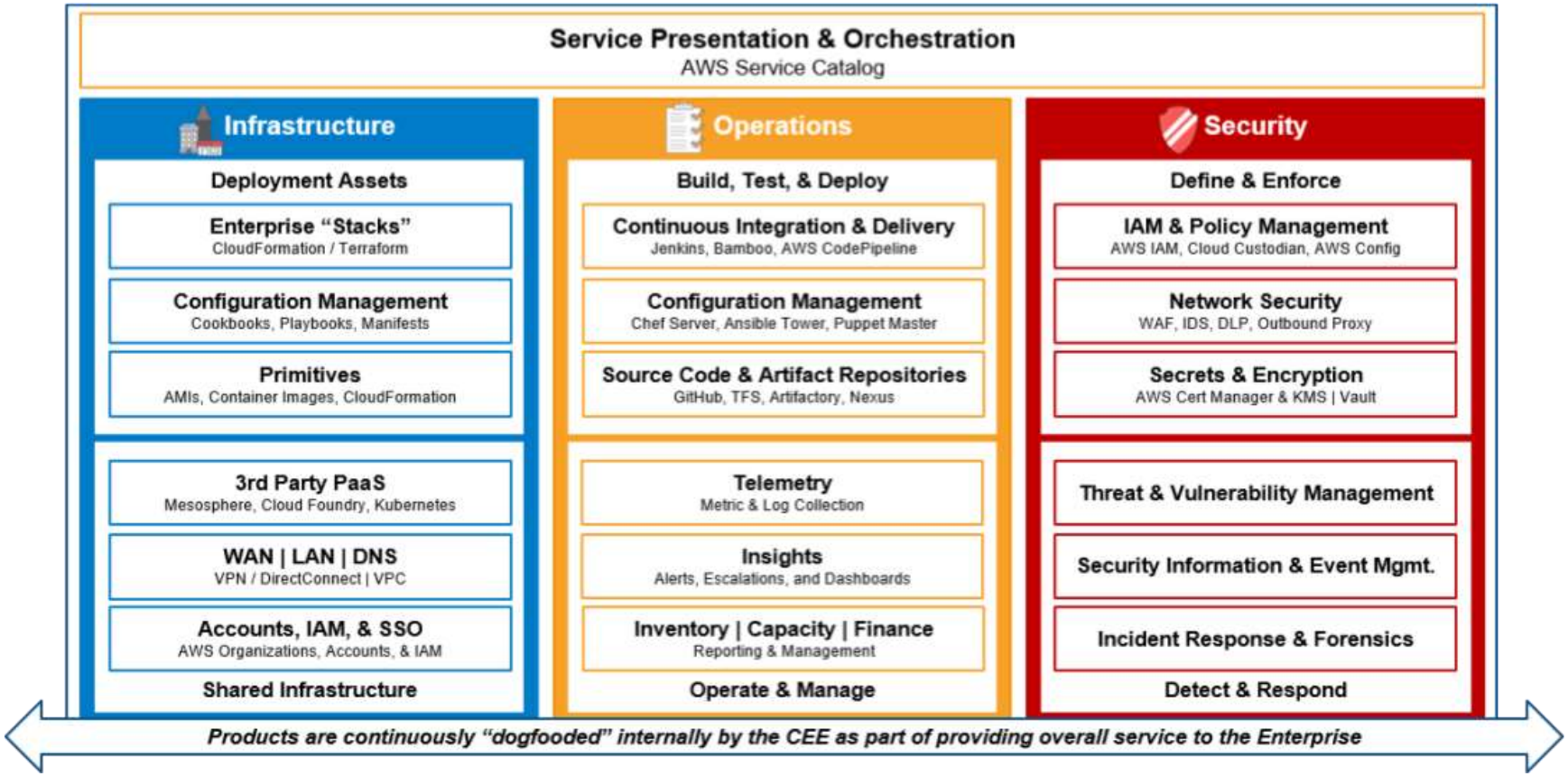
- Application Hosting
- File Sharing
- Database Services
- Email Services

- *Transparent* scaling and access across a network

Major Cloud Computing Providers



Commercial Cloud Services



What Operating Systems?

- Major vendors use proprietary operating systems, usually based on Linux
  - **Amazon Web Services:** Amazon Linux 2 (AL2)
  - **Google Cloud:** CentOS
  - **Oracle Cloud:** Oracle Linux
  - **Microsoft Azure:** Azure HostOS (Windows) / Microsoft Hyper-V (hypervisor)

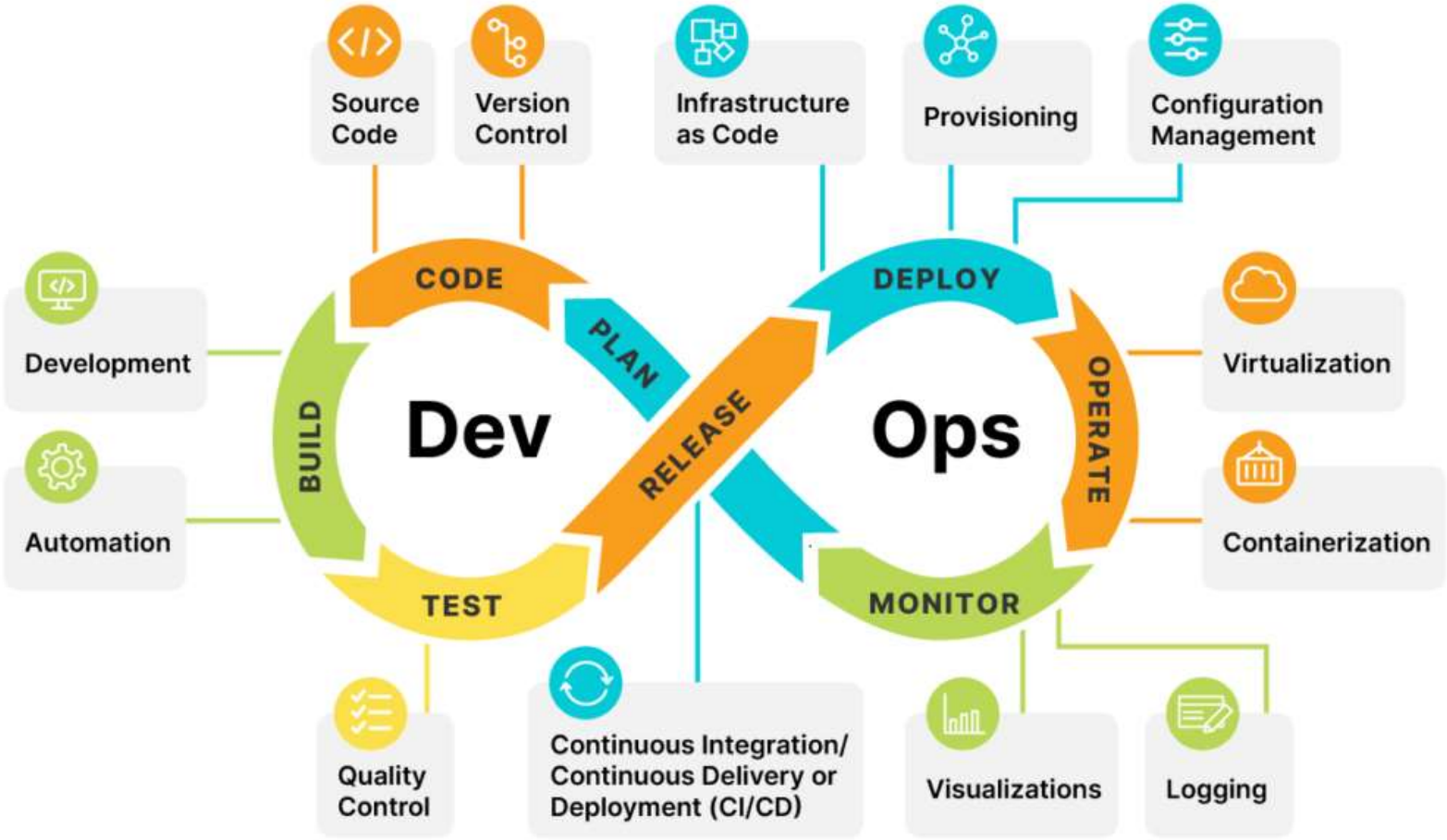
A Few Commercial Cloud Operating Systems

- **Netvibes** – a web application / data analysis platform
- **Amoeba OS** - a general-purpose distributed operating system that takes a collection of machines and works as one integrated system.
- **Slap OS** - applies simple language for managing and provisioning operating systems. It combines grid computing and enterprise resource modelling, and any user can use it as a platform for selling software or services.
- **EyeOS** – a platform for web applications commonly written in PHP, XML, and JavaScript.
- **OSv** – a Linux-based “thin os” optimized for high performance.
- **Ghost** - Global Hosted Operating System – primarilly for file sharing.
- **Cloudo** – provides a virtual development environment
- **Joli OS** – a web operating system optimized for end-user experience

Developing Applications for the Cloud

- Cloud OS virtualization makes underlying architecture transparent to the user application
- System Software (e.g. web servers, database servers) may be optimized for the cloud
- Instrument the application for tuning
- Take a DevOps approach to application deployment

DevOps


Source Code
Version Control
Infrastructure as Code
Provisioning
Configuration Management
Development
Automation
CODE
PLAN
BUILD
Dev
RELEASE
Ops
DEPLOY
OPERATE
TEST
MONITOR
Virtualization
Containerization
Quality Control
Continuous Integration/ Continuous Delivery or Deployment (CI/CD)
Visualizations
Logging