Software Defined Systems

Week 11 Real-world Applications and Case Studies

Lecturer: Biniam Behailu

Addis Ababa Science and Technology University

Addis Ababa, Ethiopia

Contents

Real-world Applications and Case Studies

Learning objectives

- Understand the role of SDS in various sectors.
- Analyze case studies demonstrating SDS applications.
- Explore the offerings of major cloud providers.
- Recognize security challenges and compliance needs.
- Discuss future trends in cloud computing and SDS.

Real-World Applications of SDS

- Software Defined Systems are making waves across multiple industries, each finding unique applications that cater to their specific needs.
    - Healthcare
    - Finance
    - Media
- Common applications include data backup and disaster recovery solutions, as organizations prioritize data integrity and availability in their operations.

Real-world Applications of Cloud Providers

Amazon Web Services(AWS)

Google Cloud Platform(GCP)

Microsoft Azure

IBM Cloud

- AWS is one of the world's leading cloud providers, with a global network of data centers (AWS Regions).
- AWS operates on a pay-as-you-go model and provide on-demand computing resources, storage, databases, networking, machine learning, and other services to individuals, businesses, and governments.

Software-Defined Networking in AWS

Amazon Virtual Private Cloud(VPC)

- Creates isolated virtual networks within AWS.
- Customize IP address ranges, subnets, and route tables.
- Enhance security with network access control lists (ACLs) and security groups.

Elastic Load Balancing(ELB)

- Automatically distribute incoming application traffic across multiple targets (EC2 instances, containers).
- Improve application availability and fault tolerance.
- Support for both static and dynamic scaling.

Software-Defined Storage in AWS

Amazon Simple Storage Service (S3)

- Object storage service that offers high durability and availability.
- Store and retrieve any amount of data from anywhere on the web.
- Features like versioning, lifecycle management, and cross-region replication.

Amazon Elastic Block Store (EBS)

- Block storage designed for use with Amazon EC2.
- Offers various volume types for different performance needs (e.g., SSD, HDD).
- Snapshots for backup and recovery, allowing point-in-time recovery.

Containerization and Orchestration

Amazon ECS/EKS

- **Amazon ECS** - A fully managed container orchestration service for deploying and managing Docker containers.
- **Amazon EKS** - Managed Kubernetes service that simplifies running Kubernetes on AWS.

AWS Fargate

- Serverless compute engine for containers.
- Automatically provisions and manages servers, allowing focus on application development.
- Supports both ECS and EKS for seamless integration.

Serverless Architectures

Amazon Lambda

- Execute code in response to events without provisioning servers.
- Supports multiple programming languages (Node.js, Python, Java, etc.).
- Automatically scales based on demand, charging only for execution time.

Amazon API Gateway

- Create, publish, and manage APIs for serverless applications.
- Integrates seamlessly with AWS Lambda for backend processing.
- Provides features like throttling, monitoring, and API versioning.

Monitoring and Management

Amazon CloudWatch

- Provides monitoring and observability for AWS resources and applications.
- Set alarms, visualize logs, and create dashboards for real-time insights.
- Automated responses to changes in resource status.

AWS Systems Manager

- Centralized management service for AWS resources.
- Features like Patch Manager, Inventory, and Run Command for operational efficiency.
- Helps automate common administrative tasks and improve compliance.

Security and Compliance

AWS IAM (Identity and Access Management)

- Manage users, groups, and permissions to AWS resources.
- Implement fine-grained access control with policies.
- Support for multi-factor authentication (MFA) for enhanced security.

AWS Config

- Continuous monitoring of AWS resource configurations.
- Helps assess compliance with internal and external policies.
- Provides change tracking and remediation capabilities.

DevOps and CI/CD

AWS CodePipeline

- Automate the build, test, and deploy phases of applications.
- Integrate with other AWS services like CodeCommit, CodeBuild, and Lambda.
- Enable rapid delivery of features and updates.

AWS CodeBuild

- Fully managed build service that compiles source code, runs tests, and produces packages.
- Scales automatically to handle multiple builds concurrently.
- Integrates with CodePipeline for continuous delivery.

Google Cloud Platform(GCP)

- Google Cloud Platform (GCP) is a suite of cloud computing services that runs on the same infrastructure that Google uses internally for its end-user products.
- Many companies prefer GCP because it can be up to 20% cheaper for storing data and databases compared to other cloud providers like AWS.

Software-Defined Networking in GCP

- **Google Virtual Private Cloud** (**VPC**) - Isolated, customizable network environments.
- **Cloud Load Balancing** - Global, automated load balancing across resources.

Software-Defined Storage in GCP

- **Google Cloud StorageV** - Scalable object storage for any amount of data.
- **Persistent Disks** - Durable block storage for VM instances.

Containerization and Orchestration

- **Google Kubernetes Engine** (**GKE**) - Managed Kubernetes service for container orchestration.
- **Cloud Run** - Serverless platform for running containerized applications.

Serverless Architectures

- **Cloud Functions** - Event-driven serverless compute service.
- **Cloud Run** - Managed platform to run containers without managing servers.

Monitoring and Management

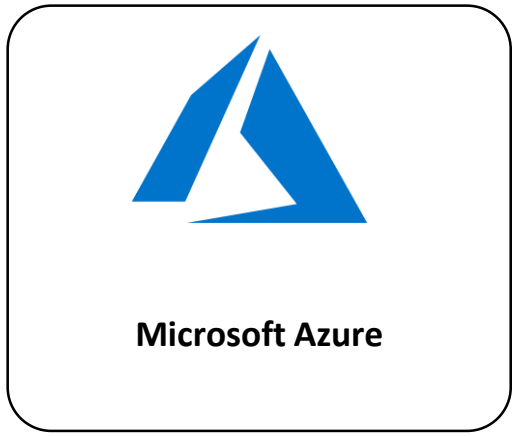
- **Google Cloud Monitoring** - Real-time monitoring and observability.
- **Cloud Operations Suite** - Unified monitoring, logging, and management.

Security and Compliance

- **Identity and Access Management** (**IAM**) - Manage access to resources.
- **Google Cloud Security Command Center** - Centralized security management.

DevOps and CI/CD

- **Cloud Build** - Continuous integration and delivery service.
- **Cloud Source Repositories** - Managed Git repositories for version control.



- Microsoft Azure is a comprehensive cloud computing platform offering a wide range of services for building, deploying, and managing applications through Microsoft data centers.
- It has management, access and development of applications and services to individuals, companies, and governments through its global infrastructure.

Software-Defined Networking in MS Azure

Azure Virtual Network (VNet)

- Create isolated, customizable network environments for your applications.
- Define IP address ranges, subnets, and routing tables to control traffic flow.
- Enable secure communication between Azure resources and on-premises networks via VPN or ExpressRoute.

Azure Load Balancer

- Automatically distribute incoming network traffic across multiple virtual machines or services.
- Supports both internal and external load balancing, ensuring high availability.
- Offers health monitoring to ensure that traffic is only routed to healthy instances.

Software-Defined Storage in Azure

Azure Blob Storage

- Scalable object storage solution designed for unstructured data like images, videos, and backups.
- Features multiple storage tiers (Hot, Cool, Archive) to optimize costs based on access patterns.

Azure Disk Storage

- Provides managed disk options for virtual machines with various performance characteristics.
- Offers Standard HDD, Standard SSD, and Premium SSD types to match workload needs.

Containerization and Orchestration

Azure Kubernetes Service (AKS)

- A fully managed Kubernetes service that simplifies deploying, managing, and scaling containerized applications.
- Offers built-in monitoring, scaling, and security features to enhance operational efficiency.
- Supports seamless integration with Azure DevOps and CI/CD pipelines for automated deployments.

Azure Container Instances (ACI)

- Run containers in a serverless environment without managing servers, enabling quick deployment of applications.
- Ideal for scenarios requiring burst workloads or for running applications without long-term infrastructure commitments.

Serverless Architectures

Azure Functions

- An event-driven compute service that allows you to run code in response to triggers without managing infrastructure.
- Ideal for tasks such as data processing, API backends, and integrating with other Azure services.

Azure Logic Apps

- A powerful tool for automating workflows and integrating applications through a visual designer.
- Supports complex workflows with conditional logic, loops, and error handling for robust process automation.

Monitoring and Management

Azure Monitor

- Provides comprehensive monitoring and diagnostics for applications and infrastructure.
- Offers powerful analytics tools to visualize performance data and identify trends over time.

Azure Security Center

- Acts as a unified security management system, providing threat protection across Azure resources.
- Continuously assesses your security posture, identifying vulnerabilities and offering remediation recommendations.
- Integrates with Azure Sentinel for advanced threat detection and response capabilities.

Security and Compliance

Azure Active Directory (AAD)

- A cloud-based identity and access management service that helps secure user access to resources.
- Supports single sign-on (SSO), multi-factor authentication (MFA), and conditional access policies to enhance security.
- Integrates with various applications, allowing you to manage user access centrally.

Azure Policy

- Enables you to create, assign, and manage policies to enforce compliance across Azure resources.
- Provides auditing capabilities to monitor compliance and take corrective actions when needed.

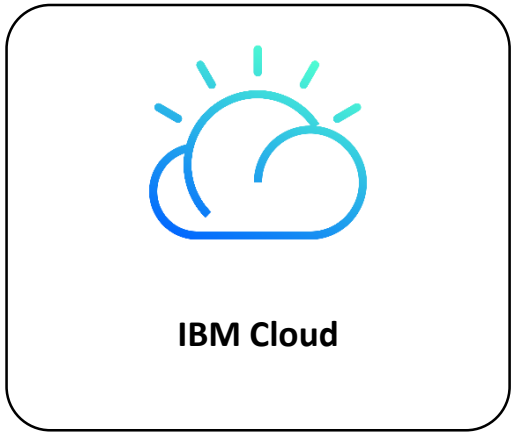
DevOps and CI/CD

Azure DevOps

- A comprehensive suite that supports the entire software development lifecycle, facilitating collaboration among teams.
- Includes Azure Repos for version control, Azure Boards for project management, and Azure Artifacts for package management.

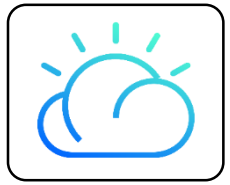
Azure Pipelines

- Automates the build, test, and deployment processes, enabling faster delivery of features and bug fixes.
- Integrates easily with third-party services, enabling a seamless development workflow.



- IBM Cloud is a comprehensive cloud computing platform offering infrastructure, platform, and software services.
- The platform provides modern cloud platform capabilities, including artificial intelligence (AI) for analytics or automation, advanced security, compliance, data protection and scalability [1].

Software-Defined Networking in IBM Cloud



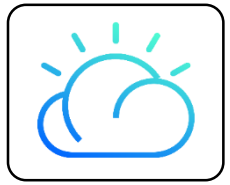
IBM Cloud Virtual Private Cloud (VPC)

- Create isolated, customizable network environments tailored to your applications.
- Define IP address ranges, subnets, and routing tables to manage traffic effectively.
- Enable secure connections between cloud resources and on-premises data centers via VPN.

IBM Cloud Load Balancer

- Distribute incoming application traffic across multiple servers to ensure high availability.
- Supports both global and regional load balancing, optimizing performance.
- Offers health checks to route traffic only to healthy instances.

Software-Defined Storage in IBM Cloud



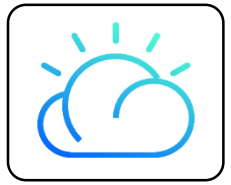
IBM Cloud Object Storage

- Scalable storage solution designed for unstructured data, such as images and backups.
- Features multiple storage classes for specific use cases (Standard, Vault, Cold).Supports lifecycle policies for automatic data management and cost optimization.

IBM Cloud Block Storage

- Provides persistent storage for virtual machines with high performance and reliability.
- Offers various performance tiers, including SSD options for demanding workloads.
- Features snapshots and replication for data protection and disaster recovery.

Containerization and Orchestration



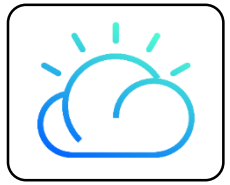
IBM Cloud Kubernetes Service (IKS)

- A fully managed Kubernetes service that simplifies deploying, managing, and scaling containerized applications.
- Offers integrated security and monitoring features to enhance operational efficiency.
- Supports seamless integration with CI/CD tools for automated deployments.

IBM Cloud Code Engine

- Run containerized workloads in a serverless environment, allowing for quick and efficient application deployment.
- Ideal for applications that experience variable workloads or need rapid scaling.
- Supports multiple programming languages and frameworks, enhancing developer flexibility.

Serverless Architectures



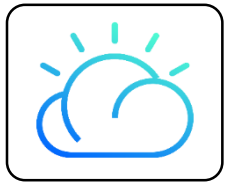
IBM Cloud Functions

- An event-driven compute service that allows you to run code in response to events without provisioning servers.
- Supports various programming languages, including Node.js, Python, and Java.
- Ideal for tasks like real-time data processing, API backends, and automation.

IBM Cloud Event Streams

- A fully managed message broker service based on Apache Kafka.
- Enables real-time data streaming and integration between applications and services.
- Supports event-driven architectures by allowing applications to react to changes instantly.

Monitoring and Management



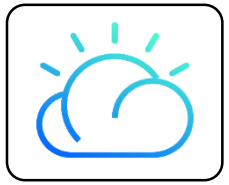
IBM Cloud Monitoring

- Comprehensive monitoring solution that provides insights into applications and infrastructure.
- Enables real-time performance tracking and alerting based on specific metrics.
- Offers dashboards for visualizing resource utilization and application health.

IBM Cloud Log Analysis

- Analyze logs from across your IBM Cloud resources to identify performance issues and security threats.
- Integrates with monitoring tools to provide a centralized view of application performance.
- Supports advanced analytics to derive insights and optimize resource usage.

Security and Compliance



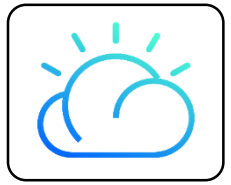
IBM Cloud Identity and Access Management (IAM)

- Manage user access and permissions for IBM Cloud resources.
- Supports multi-factor authentication (MFA) and role-based access control (RBAC) to enhance security.
- Centralized user management for streamlined access control.

IBM Cloud Security and Compliance Center

- Provides tools and resources to ensure compliance with industry regulations and best practices.
- Offers automated compliance reporting and vulnerability management.

DevOps and CI/CD



IBM Cloud Continuous Delivery

- A suite of tools that supports the entire software development lifecycle, from planning to deployment.
- Includes IBM Cloud Pipelines for automating build, test, and deployment processes.
- Facilitates collaboration among teams to enhance development efficiency.

IBM Cloud Container Registry

- A managed Docker container registry that allows you to store and manage container images securely.
- Integrates with CI/CD pipelines to streamline the deployment of containerized applications.

AWS vs GCP vs MS Azure vs IBM Cloud

Provider	Key Features	Strengths	Ideal Use Cases
AWS	Extensive services, global reach, EC2, S3	Service diversity, scalability	Startups, scalable applications
GCP	Data analytics, AI integration, Compute Engine	Strong in data analytics and machine learning	Data-driven applications
Azure	Microsoft integration, hybrid cloud, Virtual Machines	Enterprise support, hybrid capabilities	Enterprises, Windows-centric environments
IBM Cloud	Hybrid solutions, AI, blockchain	Focus on enterprise needs	Regulated industries, AI solutions

Case study in Healthcare

Company

- Mount Sinai Health System

Challenge

- Managing and analyzing vast amounts of patient data while ensuring compliance with healthcare regulations.

Solution

- Mount Sinai implemented a software-defined data center (SDDC) using VMware and IBM Cloud.
- This setup allowed them to centralize their data storage and utilize advanced analytics tools.

Case study in Healthcare

Implementation

- Data integration with electronic health record (EHR) systems
- Use of AI and machine learning for predictive analytics
- Robust security measures to ensure compliance

Outcome

- Enhanced patient care through data-driven insights
- Improved operational efficiency with reduced data retrieval times
- Significant cost savings through optimized resource allocation

Case study in Retail

Company

- Walmart

Challenge

- Data Management, Scalability, Customer Experience

Solution

- Walmart decided to partner with Google Cloud Platform (GCP) to leverage its advanced data analytics and machine learning capabilities.
- Data Integration, BigQuery, Machine Learning

Case study in Healthcare

Implementation

- Walmart migrated its data to GCP, ensuring secure and efficient data management.
- Leveraged BigQuery to analyze customer data in real-time, allowing for timely insights and decision-making.
- Personalization: product recommendations, improving the shopping experience for customers.

Outcome

- Enhanced patient care through data-driven insights
- Improved operational efficiency with reduced data retrieval times
- Significant cost savings through optimized resource allocation

Conclusion and Call to Action

- Software-defined systems transform industries.
- Enhance data management, security, and efficiency.
- Drive innovation and improve user experiences across sectors.

Test Your Knowledge

1. What is a significant outcome of implementing software-defined systems in organizations?

A) Decreased data security

B) Improved operational efficiency

C) Increased manual processes

D) Higher maintenance costs

Test Your Knowledge

1. What is a significant outcome of implementing software-defined systems in organizations?

A) Decreased data security

B) Improved operational efficiency

C) Increased manual processes

D) Higher maintenance costs

Reason: Software-defined systems streamline processes and resource management, leading to enhanced operational efficiency and allowing organizations to respond quickly to changing demands.

Test Your Knowledge

2. Which cloud service was used by Mount Sinai Health System to centralize data storage?

A) Google Cloud Storage

B) Microsoft Azure Blob Storage

C) VMware and IBM Cloud

D) Oracle Cloud Infrastructure

Test Your Knowledge

2. Which cloud service was used by Mount Sinai Health System to centralize data storage?

A) Google Cloud Storage

B) Microsoft Azure Blob Storage

C) VMware and IBM Cloud

D) Oracle Cloud Infrastructure

Reason: Mount Sinai implemented a Software-Defined Data Center using VMware and IBM Cloud to centralize their data storage and improve data management efficiency.

References

1. C. Hashemi-Pour, K. Casey, and B. Posey, "What is IBM Cloud?," TechTarget, Feb. 20, 2025. [Online]. Available: https://www.techtarget.com/searchcloudcomputing/definition/IBM-Bluemix. [Accessed: May 23, 2025].

Thank you!

Lecturer: Biniam Behailu

Addis Ababa Science and Technology University

Addis Ababa, Ethiopia