

Open Source Software Paradigms

Lecture - 05

Open Source OS, Databases and Development Frameworks

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Learning Objectives

By the end of this lecture, you will be able to:

- ☞ Identify key open source operating systems and their primary use cases.
- ☞ Compare different types of open source databases (SQL vs. NoSQL) and their strengths.
- ☞ Evaluate open source development frameworks for mobile and web applications.
- ☞ Understand the role of open source software in modern cloud and enterprise infrastructure.

Contents

- 👉 Open Source Operating Systems
- 👉 Open Source Databases
- 👉 Open Source Mobile Development Frameworks
- 👉 Open Source Web Development Frameworks

Open Source Operating Systems (OS)

- Open source operating systems (OS) are software platforms whose source code is made publicly available for anyone to view, modify, and distribute.
- This promotes collaboration and innovation within the community.
- Open source operating systems are highly favored for servers, mobile devices, and embedded systems.
- In the modern cloud-centric world, open source operating systems provide the most stable, secure, and flexible foundation.

Open Source Operating Systems (OS)

Characteristics

- **Modular Architecture:** Allows components to be developed and upgraded independently.
- **Portability:** Can be installed and run on a vast range of hardware architectures (x86, ARM, etc.).
- **Multi-User** and **Multi-Tasking:** Designed to efficiently manage resources for multiple users and simultaneously run many processes.
- **Compatibility:** Often designed to be compatible with other standards, such as UNIX.

Popular Open Source Operating Systems (OS)

Linux Kernel

- ☞ The foundation for virtually all open source OS distributions.
- ☞ Created by Linus Torvalds in 1991.
- ☞ A **kernel**, not a full operating system.
- ☞ It's the core that manages CPU, memory, and devices.
- ☞ It has **monolithic kernel**, but with loadable kernel modules for flexibility.
- ☞ Powers everything from servers, supercomputers, Android, and embedded devices.

Popular Open Source Operating Systems (OS)

GNU/Linux

- GNU/Linux is the user-friendly OS built around the Linux kernel.
- It includes:
 - The Linux Kernel
 - Package Management System (e.g., APT, YUM, Pacman)
 - GNU tools and libraries
 - A desktop environment (GUI)

Popular Open Source Operating Systems (OS)

GNU/Linux

- Linux is the undisputed champion of cloud infrastructure, powering over 90% of public cloud workloads (2025 data) [\[1\]](#).
- Its lightweight kernel and security model make it ideal for containerization and server environments.
- Popular distributions like Ubuntu, Fedora, and Debian offer highly tailored environments, from bleeding-edge developer workstations to hardened enterprise servers.

Popular Open Source Operating Systems (OS)

Linux Distributions ("Distros")

Desktop & server

Ubuntu	Fedora	CentOS	Zorin OS
Linux Mint	Parrot	Kali Linux	Arch Linux
Debian	Arch Linux	Elementary OS	

Popular Open Source Operating Systems (OS)

Linux Distributions ("Distros")

Enterprise

Red Hat Enterprise Linux (RHEL),

SUSE Linux Enterprise Server (SLES)

Ubuntu Server

CentOS / Rocky Linux

AlmaLinux

Fedora

Embedded systems

Raspbian

Yocto

Buildroot

OpenWrt

FreeRTOS

Popular Open Source Operating Systems (OS)

FreeBSD

- A free and open source Unix-like OS derived from BSD (Berkeley Software Distribution).
- Known for its performance, advanced networking, and security features.
- **Use Cases:** Servers, networking appliances, and desktops.

OpenBSD

- A security-focused derivative of BSD.
- Emphasizes code correctness, security, and code simplicity.
- **Use Cases:** Firewalls, security appliances, and general-purpose servers.

NetBSD

- Another BSD variant focused on portability.
- Works on a wide range of hardware platforms.
- **Use Cases:** Embedded systems, servers, and desktops.

Popular Open Source Operating Systems (OS)

ReactOS

- An open source operating system designed to be binary-compatible with Windows.
- Allows users to run Windows applications without a Windows OS.
- **Use Cases:** Users seeking a free alternative to Windows.

Chromium OS

- An open source OS designed for Chromebooks and other web-centric devices.
- Lightweight, fast booting, and focused on web applications.
- **Use Cases:** Cloud computing and lightweight desktop environments.

Open Source Web servers and Databases

Popular Open Source Web servers



Apache HTTP Server

- Most widely used web server.
- Highly customizable and extensible.
- Supports a wide range of modules and features.
- Ideal for complex websites and applications.

Image source: The Apache Software Foundation, "Apache HTTP server logo (2019-present)," Wikimedia Commons. [Online]. Available: https://commons.wikimedia.org/wiki/File:Apache_HTTP_server_logo_%282019-present%29.svg. [Accessed: 02-Oct-2025].

Popular Open Source Web servers

The Nginx logo is displayed in a bold, green, sans-serif font. The letters are stylized, with the 'N' and 'G' having a unique geometric shape, and the 'X' being composed of two intersecting lines.

Nginix

- Known for its high performance and efficiency.
- Often used as a reverse proxy or load balancer.
- Excellent for handling high traffic and static content.
- Well-suited for modern web applications.

Image source: Logo.wine, "nginx Logo Download," [Online]. Available: <https://www.logo.wine/logo/Nginx>. [Accessed: 02-Oct-2025].

Popular Open Source Web servers



Apache Tomcat

Apache Tomcat

- Java-based web server and servlet container.
- Used for deploying Java web applications.
- Highly scalable and reliable.
- Good choice for enterprise-level applications.

Image source: Icon Icons, "Apache Tomcat Logo," [Online]. Available: <https://icon-icons.com/icon/apache-tomcat-logo/167851>. [Accessed: 02-Oct-2025].

Popular Open Source Web servers



OpenLightSpeed

- An open source version of the LiteSpeed web server, which is known for its speed and efficiency.
- Offers excellent performance, particularly under high load, and includes features like caching.
- Commonly used for high-traffic websites and applications requiring fast performance.

Image source: LiteSpeed Technologies Inc., "Branding – OpenLiteSpeed," [Online]. Available: <https://openlitespeed.org/branding/>. [Accessed: 02-Oct-2025].

Popular Open Source **SQL** Databases

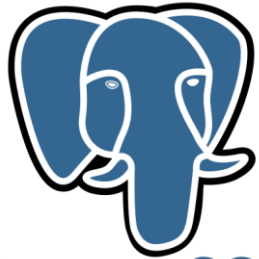


MySQL

- Widely used, easy to learn and manage.
- Supports a variety of storage engines (InnoDB, MyISAM, etc.).
- Good for web applications and small to medium-sized databases.

Image source: Bgasparotto, "mysql-logo," [Online]. Available: <https://bgasparotto.com/install-mysql-server-5-6-ubuntu/mysql-logo>. [Accessed: 02-Oct-2025].

Popular Open Source **SQL** Databases



PostgreSQL

PostgreSQL

- Powerful and feature-rich, with advanced data types and object-relational capabilities.
- Known for its reliability, performance, and security.
- Suitable for complex applications and large-scale deployments.

Image source: Bgasparotto, "mysql-logo," [Online]. Available: <https://bgasparotto.com/install-mysql-server-5-6-ubuntu/mysql-logo>. [Accessed: 02-Oct-2025].

Popular Open Source **SQL** Databases



MariaDB

- MariaDB is an open-source relational database management system (RDBMS) that is a fork of MySQL.
- It was created by the original developers of MySQL after concerns about Oracle's acquisition of MySQL.
- MariaDB aims to maintain compatibility with MySQL, making it easier for users to migrate between the two.

Image source: MariaDB, "Official MariaDB Logos," [Online]. Available: <https://mariadb.com/about-us/logos/>. [Accessed: 02-Oct-2025].

Popular Open Source **NO-SQL** Databases



MongoDB

- MongoDB is a popular open-source NoSQL database management system that uses a document-oriented data model.
- It is designed for scalability and flexibility, making it suitable for a wide range of applications.

Image source: 1000logos.net, "MongoDB logo and symbol, meaning, history, PNG," [Online]. Available: <https://1000logos.net/mongodb-logo/>. [Accessed: 02-Oct-2025].

Popular Open Source **NO-SQL** Databases



Redis

- Redis is a powerful, open-source, in-memory data structure store that functions as a database, cache, and message broker.
- It's known for its speed and flexibility, making it an excellent choice for various applications.

Image source: Wikimedia Commons, "File:Logo-redis.svg," [Online]. Available: <https://commons.wikimedia.org/wiki/File:Logo-redis.svg>. [Accessed: 02-Oct-2025].

Popular Open Source **NO-SQL** Databases



Apache Cassandra

- Apache Cassandra is a highly scalable, distributed NoSQL database designed to handle large amounts of data across many commodity servers, providing high availability with no single point of failure.

Image source: Wikimedia Commons, "File:Cassandra logo.svg," [Online]. Available: https://commons.wikimedia.org/wiki/File:Cassandra_logo.svg. [Accessed: 02-Oct-2025].

Popular Open Source **NO-SQL** Databases



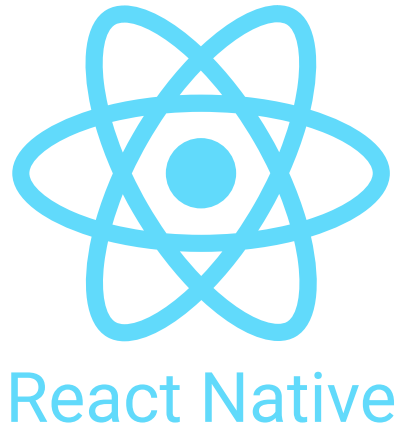
Neo4j

- Neo4j is a popular open-source graph database management system that is designed to handle highly connected data with ease.
- It uses a property graph model, allowing for rich data representation and complex queries.

Image source: Wikimedia Commons, "File:Neo4j-logo color.png," [Online]. Available: https://commons.wikimedia.org/wiki/File:Neo4j-logo_color.png. [Accessed: 02-Oct-2025].

Open Source Mobile Development Frameworks

Open Source Mobile Development Frameworks (**Cross platform**)



React Native

- React Native is an open-source framework developed by Facebook for building mobile applications using JavaScript and React.
- It allows developers to create natively rendered mobile apps for iOS and Android from a single codebase.

Image source: WorldVectorLogo, "React Native Logo," [Online]. Available: <https://worldvectorlogo.com/logo/react-native-1>. [Accessed: 02-Oct-2025].

Open Source Mobile Development Frameworks (**Cross platform**)



Flutter

- Developed by Google, it uses Dart programming language to build native apps for iOS and Android.
- Known for its high performance, beautiful UI, and hot reload feature.

Image source: Flutter, "Brand," [Online]. Available: <https://flutter.dev/brand>. [Accessed: 02-Oct-2025].

Open Source Mobile Development Frameworks (**Cross platform**)



Ionic

- Uses web technologies (HTML, CSS, and JavaScript) to build hybrid mobile apps.
- Leverages web development skills and offers a wide range of plugins and components.

Image source: Wikimedia Commons, "File:Ionic Logo.svg," [Online]. Available: https://commons.wikimedia.org/wiki/File:Ionic_Logo.svg. [Accessed: 02-Oct-2025].

Open Source Mobile Development Frameworks (**Cross platform**)



.NET MAUI (Multi-platform App UI)

- It is a powerful framework that allows you to build native mobile and desktop apps with a single shared codebase using C# and XAML.
- This means you can create apps for Android, iOS, macOS, and Windows from a single project.

Image source: Horus Studio, "Migration from Xamarin to .NET MAUI," [Online]. Available: <https://www.horus.com.uy/net-maui-migration>. [Accessed: 02-Oct-2025].

Open Source Mobile Development Frameworks (**Platform Specific**)



Android Development Frameworks

- **Android SDK:** The official development kit for building Android applications, including APIs for accessing device features.
- **Jetpack Compose:** A modern toolkit for building native Android UIs in a declarative way.
- **Android NDK:** A set of tools that allows developers to implement parts of their app using native code languages such as C and C++.

Image source: World Vector Logo, "Logo Android," [Online]. Available: <https://worldvectorlogo.com/logo/logo-android-new>. [Accessed: 02-Oct-2025].

Open Source Mobile Development Frameworks (**Platform Specific**)



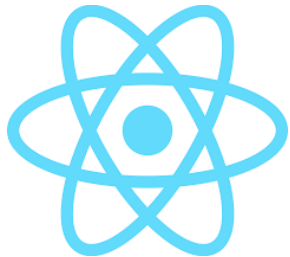
SwiftUI

- Apple's latest framework for building user interfaces across all Apple platforms.
- It uses a declarative syntax and integrates seamlessly with the Swift programming language.

Image source: Icons8, "SwiftUI color icon in PNG, SVG," [Online]. Available: https://icons8.com/icon/_BTyk4vBumjx/swiftui. [Accessed: 02-Oct-2025].

Open Source Web Development Frameworks

Open Source Web Development Frameworks (**Frontend Frameworks**)



React

- An opensource JavaScript library for building user interfaces, maintained by Facebook.
- It allows developers to create reusable UI components.

Image source: Wikimedia Commons, "File:React-icon.svg," [Online]. Available: <https://commons.wikimedia.org/wiki/File:React-icon.svg>. [Accessed: 02-Oct-2025].

Open Source Web Development Frameworks (**Frontend Frameworks**)



Vue.js

- A progressive JavaScript framework for building user interfaces.
- Vue can also function as a web application framework when used in combination with modern tooling and supporting libraries.

Image source: Wikimedia Commons, "File:Vue.js Logo 2.svg," [Online]. Available: https://commons.wikimedia.org/wiki/File:Vue.js_Logo_2.svg. [Accessed: 02-Oct-2025].

Open Source Web Development Frameworks (**Frontend Frameworks**)



Angular

- A platform for building mobile and desktop web applications.
- Developed by Google, it provides a comprehensive set of tools and libraries for front-end development.

Image source: Wikimedia Commons, "File:Angular full color logo.svg," [Online]. Available: https://commons.wikimedia.org/wiki/File:Angular_full_color_logo.svg. [Accessed: 02-Oct-2025].

Open Source Web Development Frameworks (**Backend Frameworks**)



Node.js

- While technically a runtime environment, Node.js allows developers to build server-side applications using JavaScript.
- Frameworks like Express.js are built on top of it.
- It runs on the V8 JavaScript engine, which is the same engine that powers Google Chrome.

Image source: Wikimedia Commons, "File:Node.js logo.svg," [Online]. Available: https://commons.wikimedia.org/wiki/File:Node.js_logo.svg. [Accessed: 02-Oct-2025].

Open Source Web Development Frameworks (**Backend Frameworks**)



Express.js

- A minimal and flexible Node.js web application framework that provides a robust set of features for web and mobile applications.
- It is designed to simplify the process of building web applications and APIs by providing a robust set of features.

Image source: UXWing, "Express JS Icon SVG Vector & PNG Free Download," [Online]. Available: <https://uxwing.com/express-js-icon/>. [Accessed: 02-Oct-2025].

Open Source Web Development Frameworks (**Backend Frameworks**)



Django

- A high-level Python web framework that encourages rapid development and clean, pragmatic design.
- It includes an ORM and comes with built-in admin interfaces.
- It follows the model-template-view (MTV) architectural pattern and is designed to make web development easier and faster by providing a robust set of features out of the box.

Image source: UXWing, "Express JS Icon SVG Vector & PNG Free Download," [Online]. Available: <https://uxwing.com/express-js-icon/>. [Accessed: 02-Oct-2025].

Open Source Web Development Frameworks (**Backend Frameworks**)



Spring Boot

- A Java-based framework that simplifies the process of setting up and developing new Spring applications, particularly for building RESTful APIs.
- The framework comes with thorough documentation, making it easier for developers to get started and find solutions.

Image source: UXWing, "Spring Boot Icon SVG Vector & PNG Free Download," [Online]. Available: <https://uxwing.com/spring-boot-icon/>. [Accessed: 02-Oct-2025].

Open Source Web Development Frameworks (**Backend Frameworks**)

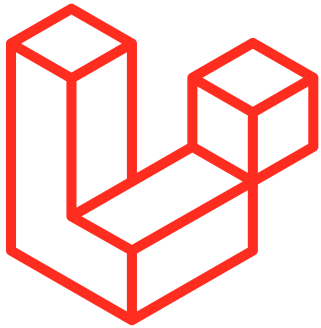


ASP.NET Core

- A cross-platform, high-performance framework for building modern cloud-based web applications.
- While ASP.NET itself is not fully open-source, ASP.NET Core is.

Image source: Wikimedia Commons, "File:.NET Core Logo.svg," [Online]. Available: https://commons.wikimedia.org/wiki/File:.NET_Core_Logo.svg. [Accessed: 02-Oct-2025].

Open Source Web Development Frameworks (**Backend Frameworks**)



Laravel

- A modern, powerful, and expressive open-source PHP web application framework.
- Intuitive implementation for database interactions
- Lightweight yet powerful templating with template inheritance
- Artisan CLI: Powerful command-line interface for automation

Image source: "Download Laravel Logo in SVG Vector or PNG File Format," Logo.wine, [Online]. Available: <https://www.logo.wine/logo/Laravel>. [Accessed: 02-Oct-2025].

Open Source Web Development Frameworks (**Backend Frameworks**)



Ruby on Rails

- Full-stack web application framework written in Ruby
- Follows MVC (Model-View-Controller) architecture
- Open source (MIT License)

Image source: Wikimedia Commons, "File:Ruby On Rails Logo.svg," [Online]. Available: https://commons.wikimedia.org/wiki/File:Ruby_On_Rails_Logo.svg. [Accessed: 02-Oct-2025].

Summary

Key Takeaways

- OS: Linux & BSD form the stable, secure foundation of modern computing.
- Databases: SQL for structured data, NoSQL for scale & flexibility.
- Frameworks: Cross-platform and native tools for efficient development.
- Impact: Open source is the default engine for innovation.

Brain Teaser

1. Which of the following BEST describes the fundamental relationship between the Linux kernel and a GNU/Linux distribution like Ubuntu?

A. The Linux kernel is a user-friendly interface built on top of the GNU/Linux distribution.

B. The Linux kernel is the core that manages hardware, and the distribution packages it with system software and tools to create a complete OS.

C. GNU/Linux is a kernel, and Linux is a set of utilities that run on top of it.

D. They are competing operating systems with similar goals.

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Brain Teaser

2. A company's primary requirement for their new mobile app is to achieve a truly native look, feel, and performance on both iOS and Android while maximizing code reuse. Which framework should they prioritize?

A. Ionic

B. NET MAUI

C. Android SDK

D. React Native

Brain Teaser

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A. Ionic

B. NET MAUI

C. Android SDK

D. React Native allows developers to use a single codebase (JavaScript) to build mobile apps that render using native components on both iOS and Android, providing a native user experience.

Thank you!

"Open source software is a testament to the power of collaboration; it transforms ideas into innovations, empowering individuals and communities to build a better future together."

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