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Google Cloud Platform (GCP) Guide ⏪

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A guide for getting started with Google Cloud including the Tools and Applications that will make you a better and more efficient engineer with Google Cloud. ⏪

Note: You can easily convert this markdown file to a PDF in [VSCode](#) using this handy extension [Markdown PDF](#).



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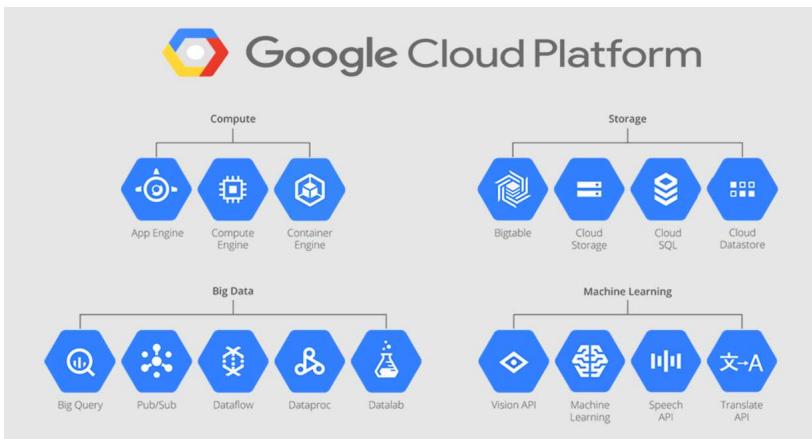
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[Google Cloud Platform](#) is a public cloud platform that lets you build, deploy, and scale applications, websites, and services on the same infrastructure as Google.



Google Cloud Platform (GCP) Architecture. Source: [Google Cloud](#)

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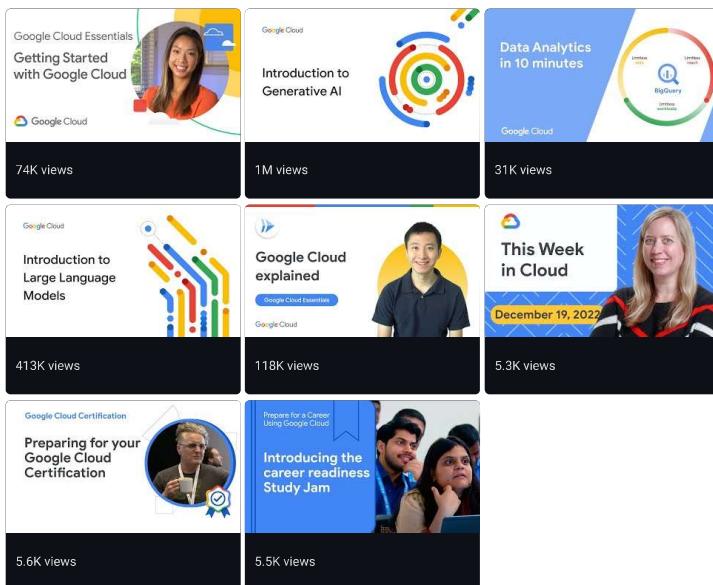
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Google Cloud Tools

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[Cloud SDK](#) is a client tool used to manage Google Cloud resources and applications with command-line tools and libraries. The Cloud SDK contains gcloud, gsutil, and bq command-line tools, which you can use to access [Compute Engine](#), [Cloud Storage](#), [BigQuery](#), and more.

[Google Cloud Shell](#) is a free admin machine with browser-based command-line access for managing your infrastructure and applications on Google Cloud Platform.

[Cloud Code](#) is a client tool that writes, debugs, and run cloud-native applications, locally or in the cloud—quickly and easily. Extensions to IDEs such as Visual Studio Code and IntelliJ are provided to let you rapidly iterate, debug, and deploy code to Kubernetes.

[gcloud](#) is a CLI (command line interface) manages authentication, local configuration, developer workflow, interactions with Google Cloud APIs.

[gsutil](#) is a Python application that lets you access Cloud Storage from the command line.

[Compute Engine](#) is a secure and customizable compute service that lets you create and run virtual machines on Google's infrastructure.

[App Engine](#) is a client tool that lets you build and run applications on Google's infrastructure. It automatically scales to support sudden traffic spikes without provisioning, patching, or monitoring.

[Google Kubernetes Engine \(GKE\)](#) is a managed, production-ready environment for deploying containerized applications.

[GKE Policy Automation](#) - Tool and policy library for validating GKE clusters against configuration best practices.

[Click to Deploy Charts Repo](#) - Source for Google Click to Deploy solutions listed on [Google Cloud Marketplace](#). Provide several examples with detailed READMEs on how-to install in a [Google Kubernetes Engine](#) cluster.

[Cloud Storage](#) is a Object storage for companies of all sizes. Where store any amount of data and retrieve it as often as you would like to.

[BigQuery](#) is a serverless, highly scalable, and cost-effective multi-cloud data warehouse designed for business agility.

[Cloud Bigtable](#) is Google's fully managed NoSQL Big Data database service. It's the same database that powers many core Google services, including Search, Analytics, Maps, and Gmail.

[Cloud SQL](#) is a tool that makes it easy to set up, manage, and administer your Postgres databases on Google Cloud.

[Cloud Datastore](#) is a schemaless database, which allows you to worry less about making changes to your underlying data structure as your application evolves.

[Cloud Pub/Sub](#) is a messaging middleware for traditional service integration or a simple communication medium for modern microservices.

[Cloud Dataflow](#) is a tool that brings streaming events to Google Cloud's AI Platform and TensorFlow Extended (TFX) to enable predictive analytics, fraud detection, real-time personalization, and other advanced analytics.

[Cloud Dataproc](#) is a fully managed and highly scalable service for running Apache Spark, Apache Flink, Presto, and 30+ open source tools and frameworks.

[Cloud DataLab](#) is a tool that provides a productive, interactive, and integrated tool to explore, visualize, analyze and transform data, bringing together the power of Python, SQL, JavaScript, and the Google Cloud Platform with services such as BigQuery and Storage.

[Cloud Vision API](#) is a library that offers powerful pre-trained machine learning models through REST and RPC APIs.

[Cloud Speech API](#) is a library that enables developers to convert audio to text by applying powerful neural network models. The API recognizes over 80 languages and variants, to support your global user base.

[Cloud Build](#) is a continuous build, test, and deploy software across all languages and in multiple environments—including VMs, serverless, Kubernetes, and Firebase.

[Anthos](#) is a modern application management platform that provides a consistent development and operations experience for cloud and on-premises environments.

[Terraformer](#) is a CLI tool to generate(tf/json and tfstate) terraform files from existing infrastructure (reverse Terraform).

[Forseti](#) - Scan your GCP resources to ensure that access controls are set as you intended and protected against unsafe changes.

[StartupOS](#) - A monorepo with examples for using Google's Open Source tools and deploying to the cloud.

[Jenkins on Google Cloud](#) is a client tool that helps speed up, scale, and security from your Jenkins pipeline.

[Tekton on Google Cloud](#) is a client tool that standardizes CI/CD pipelines across languages, and tools on premises or in the cloud with a Kubernetes native open source framework.

[Artifact Registry](#) is a client tool to manage container images and language packages such as Maven and npm all in one place, fully integrated with Google Cloud's tooling and runtimes.

[Cloud Deployment Manager](#) is a client that creates and manages cloud resources with simple templates. Specify all the resources needed for applications in a declarative format using yaml.

[Red Hat OpenShift on Google Cloud](#) is a fully-managed and jointly supported Red Hat OpenShift offering that enables you to deploy stateful and stateless apps with nearly any language, framework, database, or service. It gives you a hosted environment entirely on Google Cloud. A hybrid environment where you maintain part of your workload on-premises or in a private hosting environment and migrate the rest to Google Cloud.

[VSCode Bigquery Data View](#) is an VSCode extension aims to bring most of the functionality of Bigquery to Visual Studio Code. Allowing the user to authenticate (using the gcloud CLI); list projects, dataset, and tables; view table content; and run queries.

[vscode-bigquery](#) is a Visual Studio Code (VS Code) extension that can query Google Cloud Platform's BigQuery analytics database from, and return results to, your editor.

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[Open Container Initiative](#) is an open governance structure for the express purpose of creating open industry standards around container formats and runtimes.

[Buildah](#) is a command line tool to build Open Container Initiative (OCI) images. It can be used with Docker, Podman, Kubernetes.

[Podman](#) is a daemonless, open source, Linux native tool designed to make it easy to find, run, build, share and deploy applications using Open Containers Initiative (OCI) Containers and Container Images. Podman provides a command line interface (CLI) familiar to anyone who has used the Docker Container Engine.

[Containerd](#) is a daemon that manages the complete container lifecycle of its host system, from image transfer and storage to container execution and supervision to low-level storage to network attachments and beyond. It is available for Linux and Windows.

[OKD](#) is a community distribution of Kubernetes optimized for continuous application development and multi-tenant deployment. OKD adds developer and operations-centric tools on top of Kubernetes to enable rapid application development, easy deployment and scaling, and long-term lifecycle maintenance for small and large teams.

[Red Hat OpenShift](#) is an open source container application platform based on the Kubernetes container orchestrator for enterprise app development and deployment in the hybrid cloud Red Hat OpenShift, the open hybrid cloud platform built on Kubernetes.

[OpenShift CLI \(oc\)](#) is a command line interface tool that extends the capabilities of kubectl with [many convenience functions](#) that make interacting with both Kubernetes and OpenShift clusters easier.

[OpenShift Serverless CLI \(kn\)](#) is a command line interface tool to deploy serverless applications, then you'll want access and control via the kn command.

[OpenShift Pipelines CLI \(tkn\)](#) is a command line interface tool for using Tekton to provide cloud-native CI/CD functionality within the cluster. The tkn command is used to manage the functionality from the CLI.

[Red Hat CodeReady Containers](#) is an option to host a local, all-in-one OpenShift 4 cluster on your workstation. CodeReady Containers replaces [minishift](#), used to run OpenShift 3 clusters on your workstation, as a quick and easy method of creating test and development clusters.

[Helm CLI](#) is a command line interface tool for deploying and managing Kubernetes applications to your clusters.

[OpenShift Hive](#) is an operator which runs as a service on top of Kubernetes/OpenShift. The Hive service can be used to provision and perform initial configuration of OpenShift 4 clusters.

[OpenShift Service Mesh](#) is a tool that provides a layer on top of OpenShift for securely connecting services in a consistent manner. This provides centralized control, security and observability across your services without having to modify your applications.

[Red Hat OpenShift Service on AWS \(ROSA\)](#) is a fully-managed and jointly supported Red Hat OpenShift offering that combines the power of Red Hat OpenShift, the industry's most comprehensive enterprise Kubernetes platform, and the AWS public cloud.

[Red Hat® Quay](#) is a secure, private container registry that builds, analyzes and distributes container images. It provides a high level of automation and customization.

[Kata Operator](#) is an operator to perform lifecycle management (install/upgrade/uninstall) of [Kata Runtime](#) on Openshift as well as Kubernetes cluster.

[Ansible](#) is a simple IT automation engine that automates cloud provisioning, configuration management, application deployment, intra-service orchestration, and many other IT needs. It uses a very simple language (YAML, in the form of Ansible Playbooks) that allows you to describe your automation jobs in a way that approaches plain English. Ansible works on Linux (Red Hat Enterprise Linux(RHEL) and Ubuntu) and Microsoft Windows.

[Ansible cmdnb](#) is a tool that takes the output of Ansible's fact gathering and converts it into a static HTML overview page containing system configuration information.

[Ansible Inventory Grapher](#) visually displays inventory inheritance hierarchies and at what level a variable is defined in inventory.

[Ansible Playbook Grapher](#) is a command line tool to create a graph representing your Ansible playbook tasks and roles.

[Ansible Shell](#) is an interactive shell for Ansible with built-in tab completion for all the modules.

[Ansible Silo](#) is a self-contained Ansible environment by [Docker](#).

[Ansigenome](#) is a command line tool designed to help you manage your Ansible roles.

[ARA](#) is a records Ansible playbook runs and makes the recorded data available and intuitive for users and systems by integrating with Ansible as a callback plugin.

[OAuth2 for Go](#) is an oauth2 package contains a client implementation for OAuth 2.0 spec.

[Crane]rane is a FinOps Platform for Cloud Resource Analytics and Economics in Kubernetes clusters. The goal is not only help user to manage cloud cost easier but also ensure the quality of applications.) is a FinOps Platform for Cloud Resource Analytics and Economics in Kubernetes clusters. The goal is not only help user to manage cloud cost easier but also ensure the quality of applications.

[kube-bench](#) is a tool that checks whether Kubernetes is deployed securely by running the checks documented in the [CIS Kubernetes Benchmark](#).

[GitHub](#) provides hosting for software development version control using Git. It offers all of the distributed version control and source code management functionality of Git as well as adding its own features. It provides access control and several collaboration features such as bug tracking, feature requests, task management, and wikis for every project.

[GitHub Codespaces](#) is an integrated development environment(IDE) on GitHub. That allows developers to develop entirely in the cloud using Visual Studio and Visual Studio Code.

[GitHub Actions](#) will automate, customize, and execute your software development workflows right in your repository with GitHub Actions. You can discover, create, and share actions to perform any job you'd like, including CI/CD, and combine actions in a completely customized workflow.[GitHub Actions for Azure](#) you can create workflows that you can set up in your repository to build, test, package, release and deploy to Azure.Learn more about all other integrations with Azure.

[GitLab](#) is a web-based DevOps lifecycle tool that provides a Git-repository manager providing wiki, issue-tracking and CI/CD pipeline features, using an open-source license, developed by GitLab Inc.

[Jenkins](#) is a free and open source automation server. Jenkins helps to automate the non-human part of the software development process, with continuous integration and facilitating technical aspects of continuous delivery.

[Bitbucket](#) is a web-based version control repository hosting service owned by Atlassian, for source code and development projects that use either Mercurial or Git revision control systems. Bitbucket offers both commercial plans and free accounts. It offers free accounts with an unlimited number of private repositories. Bitbucket integrates with other Atlassian software like Jira, HipChat, Confluence and Bamboo.

[Bamboo](#) is a continuous integration (CI) server that can be used to automate the release management for a software application, creating a continuous delivery pipeline.

[Codecov](#) is the leading, dedicated code coverage solution. It provides highly integrated tools to group, merge, archive and compare coverage reports. Whether your team is comparing changes in a pull request or reviewing a single commit, Codecov will improve the code review workflow and quality.

[Drone](#) is a Continuous Delivery system built on container technology. Drone uses a simple YAML configuration file, a superset of docker-compose, to define and execute Pipelines inside Docker containers.

[Travis CI](#) is a hosted continuous integration service used to build and test software projects hosted at GitHub.

[Circle CI](#) is a continuous integration and continuous delivery platform that helps software teams work smarter, faster.

[Zuul-Cl](#) is a program that drives continuous integration, delivery, and deployment systems with a focus on project gating and interrelated projects. Using the same [Ansible playbooks](#) to deploy your system and run your tests.

[Artifactory](#) is a Universal Artifact Repository Manager developed by JFrog. It supports all major packages, enterprise ready security, clustered, HA, Docker registry, multi-site replication and scalable.

[Azure DevOps](#) is a set of services for teams to share code, track work, and ship software; CLIs Build, deploy, diagnose, and manage multi-platform, scalable apps and services; Azure Pipelines Continuously build, test, and deploy to any platform and cloud; Azure Lab Services Set up labs for classrooms, trials, development and testing, and other scenarios.

[Team City](#) is a build management and continuous integration server from JetBrains.

[Shipable](#) simplifies DevOps and makes it systematic with an Assembly Line platform that is heterogeneous, flexible, and provides complete visibility across your DevOps workflows.

[Spinaker](#) is an open source, multi-cloud continuous delivery platform for releasing software changes with high velocity and confidence.

[Selenium](#) is a free (open source) automated testing suite for web applications across different browsers and platforms.

[Cucumber](#) is a tool based on Behavior Driven Development (BDD) framework which is used to write acceptance tests for the web application. It allows automation of functional validation in easily readable and understandable format (like plain English) to Business Analysts, Developers, and Testers.

[JUnit](#) is a unit testing framework for the Java programming language.

[Mocha](#) is a JavaScript test framework for Node.js programs, featuring browser support, asynchronous testing, test coverage reports, and use of any assertion library.

[Karma](#) is a simple tool that allows you to execute JavaScript code in multiple real browsers.

[Jasmine](#) is an open source testing framework for JavaScript. It aims to run on any JavaScript-enabled platform, to not intrude on the application nor the IDE, and to have easy-to-read syntax.

[Maven](#) is a build automation tool used primarily for Java projects. Maven can also be used to build and manage projects written in C#, Ruby, Scala, and other languages. The Maven project is hosted by the Apache Software Foundation.

[Gradle](#) is an open-source build-automation system that builds upon the concepts of Apache Ant and Apache Maven and introduces a Groovy-based domain-specific language instead of the XML form used by Apache Maven for declaring the project configuration.

[Chef](#) is an effortless Infrastructure Suite offers visibility into security and compliance status across all infrastructure and makes it easy to detect and correct issues long before they reach production.

[Puppet](#) is an open source tool that makes continuous integration and delivery of your software on traditional or containerized infrastructure easy by pulling together all your existing tools and giving you flexibility to deploy your way.

[Kubelinit](#) provides Ansible playbooks and roles for the deployment and configuration of multiple Kubernetes distributions.

[Salt](#) is Python-based, open-source software for event-driven IT automation, remote task execution, and configuration management. Supporting the "Infrastructure as Code" approach to data center system and network deployment and management, configuration automation, SecOps orchestration, vulnerability remediation, and hybrid cloud control.

[Terraform](#) is an open-source infrastructure as code software tool created by HashiCorp. It enables users to define and provision a datacenter infrastructure using a high-level configuration language known as Hashicorp Configuration Language (HCL), or optionally JSON.

[Consul](#) is a service networking solution to connect and secure services across any runtime platform and public or private cloud.

[Packer](#) is lightweight, runs on every major operating system, and is highly performant, creating machine images for multiple platforms in parallel. Packer does not replace configuration management like Chef or Puppet. In fact, when building images, Packer is able to use tools like Chef or Puppet to install software onto the image.

[Nomad](#) is a highly available, distributed, data-center aware cluster and application scheduler designed to support the modern datacenter with support for long-running services, batch jobs, and much more.

[Vagrant](#) is a tool for building and managing virtual machine environments in a single workflow. With an easy-to-use workflow and focus on automation, Vagrant lowers development environment setup time and increases production parity.

[Vault](#) is a tool for securely accessing secrets. A secret is anything that you want to tightly control access to, such as API keys, passwords, certificates, and more. Vault provides a unified interface to any secret, while providing tight access control and recording a detailed audit log.

[CFEngine](#) is an open-source configuration management system, written by Mark Burgess. Its primary function is to provide automated configuration and maintenance of large-scale computer systems, including the unified management of servers, desktops, consumer and industrial devices, embedded networked devices, mobile smartphones, and tablet computers.

[Octpus Deploy](#) is the deployment automation server for your entire team, designed to make it easy to orchestrate releases and deploy applications, whether on-premises or in the cloud.

[Kubernetes](#) is an open-source container-orchestration system for automating application deployment, scaling, and management. It was originally designed by Google, and is now maintained by the Cloud Native Computing Foundation.

[Docker](#) is a set of platform as a service products that use OS-level virtualization to deliver software in packages called containers. Containers are isolated from one another and bundle their own software, libraries and configuration files; they can communicate with each other through well-defined channels. All containers are run by a single operating-system kernel and are thus more lightweight than virtual machines.

[PowerShell/PowerShell Core](#) is a cross-platform (Windows, Linux, and macOS) automation and configuration tool/framework that works well with your existing tools and is optimized for dealing with structured data (e.g. JSON, CSV, XML, etc.), REST APIs, and object models. It includes a command-line shell, an associated scripting language and a framework for processing cmdlets.

[Hyper-V](#) creates virtual machines on Windows 10. Hyper-V can be enabled in many ways including using the Windows 10 control panel, PowerShell or using the Deployment Imaging Servicing and Management tool (DISM).

[Cloud Hypervisor](#) is an open source Virtual Machine Monitor (VMM) that runs on top of [KVM](#). The project focuses on exclusively running modern, cloud workloads, on top of a limited set of hardware architectures and platforms. Cloud workloads refers to those that are usually run by customers inside a cloud provider. Cloud Hypervisor is implemented in [Rust](#) and is based on the [rust-vmm](#) crates.

[VMware vSphere Hypervisor](#) is a bare-metal hypervisor that virtualizes servers; allowing you to consolidate your applications while saving time and money managing your IT infrastructure.

[VMware vSphere](#) is the industry-leading compute virtualization platform, and your first step to application modernization. It has been rearchitected with native Kubernetes to allow customers to modernize the 70 million+ workloads now running on vSphere.

[VMware Tanzu](#) is a centralized management platform for consistently operating and securing your Kubernetes infrastructure and modern applications across multiple teams and private/public clouds.

[Rancher](#) is a complete software stack for teams adopting containers. It addresses the operational and security challenges of managing multiple Kubernetes clusters, while providing DevOps teams with integrated tools for running containerized workloads.

[K3s](#) is a highly available, certified Kubernetes distribution designed for production workloads in unattended, resource-constrained, remote locations or inside IoT appliances.

[Rook](#) is an open source cloud-native storage orchestrator for Kubernetes that turns distributed storage systems into self-managing, self-scaling, self-healing storage services. It automates the tasks of a storage administrator: deployment, bootstrapping, configuration, provisioning, scaling, upgrading, migration, disaster recovery, monitoring, and resource management.

[Apache Mesos](#) is a cluster manager that provides efficient resource isolation and sharing across distributed applications, or frameworks. It can run Hadoop, Jenkins, Spark, Aurora, and other frameworks on a dynamically shared pool of nodes.

[Apache Spark](#) is a unified analytics engine for big data processing, with built-in modules for streaming, SQL, machine learning and graph processing.

[Apache Hadoop](#) is a framework that allows for the distributed processing of large data sets across clusters of computers using simple programming models. It is designed to scale up from single servers to thousands of machines, each offering local computation and storage. Rather than rely on hardware to deliver high-availability, the library itself is designed to detect and handle failures at the application layer, so delivering a highly-available service on top of a cluster of computers, each of which may be prone to failures.

[Microsoft Azure](#) is a cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services through Microsoft-managed data centers.

[Azure Functions](#) is a solution for easily running small pieces of code, or "functions," in the cloud. You can write just the code you need for the problem at hand, without worrying about a whole application or the infrastructure to run it.

[Rkt](#) is a pod-native container engine for Linux. It is composable, secure, and built on standards.

[Helm](#) is the Kubernetes Package Manager.

[Kubespray](#) is a tool that combines Kubernetes and Ansible to easily install Kubernetes clusters that can be deployed on [AWS](#), [GCE](#), [Azure](#), [OpenStack](#), [vSphere](#), [Packet](#) (bare metal), Oracle Cloud Infrastructure (Experimental), or Baremetal

[OKD](#) is a community distribution of Kubernetes optimized for continuous application development and multi-tenant deployment. OKD adds developer and operations-centric tools on top of Kubernetes to enable rapid application development, easy deployment and scaling, and long-term lifecycle maintenance for small and large teams.

[Odo](#) is a fast, iterative, and straightforward CLI tool for developers who write, build, and deploy applications on Kubernetes and OpenShift.

[Knative](#) is a Kubernetes-based platform to build, deploy, and manage modern serverless workloads. Knative takes care of the operational overhead details of networking, autoscaling (even to zero), and revision tracking.

[Etcd](#) is a distributed key-value store that provides a reliable way to store data that needs to be accessed by a distributed system or cluster of machines. Etcd is used as the backend for service discovery and stores cluster state and configuration for Kubernetes.

[OpenStack](#) is a free and open-source software platform for cloud computing, mostly deployed as infrastructure-as-a-service that controls large pools of compute, storage, and networking resources throughout a datacenter, managed through a dashboard or via the OpenStack API. OpenStack works with popular enterprise and open source technologies making it ideal for heterogeneous infrastructure.

[Cloud Foundry](#) is an open source, multi cloud application platform as a service that makes it faster and easier to build, test, deploy and scale applications, providing a choice of clouds, developer frameworks, and application services. It is an open source project and is available through a variety of private cloud distributions and public cloud instances.

[Splunk](#) software is used for searching, monitoring, and analyzing machine-generated big data, via a Web-style interface.

[Prometheus](#) is a free software application used for event monitoring and alerting. It records real-time metrics in a time series database (allowing for high dimensionality) built using a HTTP pull model, with flexible queries and real-time alerting.

[Loki](#) is a horizontally-scalable, highly-available, multi-tenant log aggregation system inspired by Prometheus. It is designed to be very cost effective and easy to operate. It does not index the contents of the logs, but rather a set of labels for each log stream.

[Thanos](#) is a set of components that can be composed into a highly available metric system with unlimited storage capacity, which can be added seamlessly on top of existing Prometheus deployments.

[Container Storage Interface \(CSI\)](#) is an API that lets container orchestration platforms like Kubernetes seamlessly communicate with stored data via a plug-in.

[OpenEBS](#) is a Kubernetes-based tool to create stateful applications using Container Attached Storage.

[ElasticSearch](#) is a search engine based on the Lucene library. It provides a distributed, multitenant-capable full-text search engine with an HTTP web interface and schema-free JSON documents. Elasticsearch is developed in Java.

[Logstash](#) is a tool for managing events and logs. When used generically, the term encompasses a larger system of log collection, processing, storage and searching activities.

[Kibana](#) is an open source data visualization plugin for Elasticsearch. It provides visualization capabilities on top of the content indexed on an Elasticsearch cluster. Users can create bar, line and scatter plots, or pie charts and maps on top of large volumes of data.

[New Relic](#) is a SaaS-based monitoring tool that fully supports the way DevOps teams work in the modern enterprise by streamlining your workflows with today's collaboration software and orchestration tools like Puppet, Chef, and Ansible.

[Nagios](#) is a free and open source computer-software application that monitors systems, networks and infrastructure. Nagios offers monitoring and alerting services for servers, switches, applications and services. It alerts users when things go wrong and alerts them a second time when the problem has been resolved.

[SonarQube](#) is an open-source platform developed by SonarSource for continuous inspection of code quality to perform automatic reviews with static analysis of code to detect bugs, code smells, and security vulnerabilities on 20+ programming languages.

[Genie](#) is a federated job orchestration engine developed by Netflix. Genie provides REST APIs to run a variety of big data jobs like Hadoop, Pig, Hive, Spark, Presto, Sqoop and more. It also provides APIs for managing the metadata of many distributed processing clusters and the commands and applications which run on them.

[Inviso](#) is a lightweight tool that provides the ability to search for Hadoop jobs, visualize the performance, and view cluster utilization.

[Fenzo](#) is a scheduler Java library for Apache Mesos frameworks that supports plugins for scheduling optimizations and facilitates cluster autoscaling.

[Dynomite](#) is a thin, distributed dynamo layer for different storage engines and protocols, which includes [Redis](#) and [Memcached](#). Dynomite supports multi-datacenter replication and is designed for High Availability(HA).

[Dyno](#) is a tool that is used to scale a Java client application utilizing [Dynomite](#).

[Raigad](#) is a process/tool that runs alongside Elasticsearch to automate backup/recovery, Deployments and Centralized Configuration management.

[Priam](#) is a process/tool that runs alongside Apache Cassandra to automate backup/recovery, Deployments and Centralized Configuration management.

[Chaos Monkey](#) is a resiliency tool used to randomly terminates virtual machine instances and containers that run inside of your production environment. Chaos Monkey should work with any backend that [Spinnaker](#) supports (AWS, Google Compute Engine, Microsoft Azure, Kubernetes, and Cloud Foundry).

[Falcor](#) is a JavaScript library for efficient data fetching. Falcor lets you represent all your remote data sources as a single domain model via a virtual JSON graph, whether in memory on the client or over the network on the server.

[Restify](#) is a framework, utilizing [connect](#) style middleware for building REST APIs.

[Traefik](#) is an open source Edge Router that makes publishing your services a fun and easy experience. It receives requests on behalf of your system and finds out which components are responsible for handling them. What sets Traefik apart, besides its many features, is that it automatically discovers the right configuration for your services.

[Jira](#) is a proprietary issue tracking product developed by Atlassian that allows bug tracking and agile project management.

[Pivotal Tracker](#) is the agile project management tool of choice for developers around the world for real-time collaboration around a shared, prioritized backlog.

Networking

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[The Red Hat Certified Specialist in Security: Linux](#)

[Linux Professional Institute LPIC-3 Enterprise Security Certification](#)

[Cybersecurity Training and Courses from IBM Skills](#)

[Cybersecurity Courses and Certifications by Offensive Security](#)

[Citrix Certified Associate – Networking\(CCA-N\)](#)

[Citrix Certified Professional – Virtualization\(CCP-V\)](#)

[CCNP Routing and Switching](#)

[Certified Information Security Manager\(CISM\)](#)

[Wireshark Certified Network Analyst \(WCNA\)](#)

[Juniper Networks Certification Program Enterprise \(JNCP\)](#)

[Networking courses and specializations from Coursera](#)

[Network & Security Courses from Udemy](#)

[Network & Security Courses from edX](#)

Networking Tools & Concepts

[Qt Network Authorization](#) is a tool that provides a set of APIs that enable Qt applications to obtain limited access to online accounts and HTTP services without exposing users' passwords.

[cURL](#) is a computer software project providing a library and command-line tool for transferring data using various network protocols(HTTP, HTTPS, FTP, FTPS, SCP, SFTP, TFTP, DICT, TELNET, LDAP LDAPS, MQTT, POP3, POP3S, RTMP, RTMPS, RTSP, SCP, SFTP, SMB, SMBS, SMTP or SMTPS). cURL is also used in cars, television sets, routers, printers, audio equipment, mobile phones, tablets, settop boxes, media players and is the Internet transfer engine for thousands of software applications in over ten billion installations.

[cURL Fuzzer](#) is a quality assurance testing for the curl project.

[DoH](#) is a stand-alone application for DoH (DNS-over-HTTPS) name resolves and lookups.

[Authelia](#) is an open-source highly-available authentication server providing single sign-on capability and two-factor authentication to applications running behind [NGINX](#).

[nginx\(engine x\)](#) is an HTTP and reverse proxy server, a mail proxy server, and a generic TCP/UDP proxy server, originally written by Igor Sysoev.

[Proxmox Virtual Environment\(VE\)](#) is a complete open-source platform for enterprise virtualization. It includes a built-in web interface that you can easily manage VMs and containers, software-defined storage and networking, high-availability clustering, and multiple out-of-the-box tools on a single solution.

[Wireshark](#) is a very popular network protocol analyzer that is commonly used for network troubleshooting, analysis, and communications protocol development. Learn more about the other useful [Wireshark Tools](#) available.

[HTTPie](#) is a command-line HTTP client. Its goal is to make CLI interaction with web services as human-friendly as possible. HTTPie is designed for testing, debugging, and generally interacting with APIs & HTTP servers.

[HTTPStat](#) is a tool that visualizes curl statistics in a simple layout.

[Wuzz](#) is an interactive cli tool for HTTP inspection. It can be used to inspect/modify requests copied from the browser's network inspector with the "copy as curl" feature.

[Websocat](#) is a command-line client for WebSockets, like netcat (or curl) for ws:// with advanced socat-like functions.

- Connection: In networking, a connection refers to pieces of related information that are transferred through a network. This generally infers that a connection is built before the data transfer (by following the procedures laid out in a protocol) and then is deconstructed at the end of the data transfer.
- Packet: A packet is, generally speaking, the most basic unit that is transferred over a network. When communicating over a network, packets are the envelopes that carry your data (in pieces) from one end point to the other.

Packets have a header portion that contains information about the packet including the source and destination, timestamps, network hops. The main portion of a packet contains the actual data being transferred. It is sometimes called the body or the payload.

- Network Interface: A network interface can refer to any kind of software interface to networking hardware. For instance, if you have two network cards in your computer, you can control and configure each network interface associated with them individually.

A network interface may be associated with a physical device, or it may be a representation of a virtual interface. The "loop-back" device, which is a virtual interface to the local machine, is an example of this.

- LAN: LAN stands for "local area network". It refers to a network or a portion of a network that is not publicly accessible to the greater internet. A home or office network is an example of a LAN.
- WAN: WAN stands for "wide area network". It means a network that is much more extensive than a LAN. While WAN is the relevant term to use to describe large, dispersed networks in general, it is usually meant to mean the internet, as a whole. If an interface is connected to the WAN, it is generally assumed that it is reachable through the internet.
- Protocol: A protocol is a set of rules and standards that basically define a language that devices can use to communicate. There are a great number of protocols in use extensively in networking, and they are often implemented in different layers.

Some low level protocols are TCP, UDP, IP, and ICMP. Some familiar examples of application layer protocols, built on these lower protocols, are HTTP (for accessing web content), SSH, TLS/SSL, and FTP.

- Port: A port is an address on a single machine that can be tied to a specific piece of software. It is not a physical interface or location, but it allows your server to be able to communicate using more than one application.
- Firewall: A firewall is a program that decides whether traffic coming into a server or going out should be allowed. A firewall usually works by creating rules for which type of traffic is acceptable on which ports. Generally, firewalls block ports that are not used by a specific application on a server.
- NAT: Network address translation is a way to translate requests that are incoming into a routing server to the relevant devices or servers that it knows about in the LAN. This is usually implemented in physical LANs as a way to route requests through one IP address to the necessary backend servers.
- VPN: Virtual private network is a means of connecting separate LANs through the internet, while maintaining privacy. This is used as a means of connecting remote systems as if they were on a local network, often for security reasons.

Network Layers

While networking is often discussed in terms of topology in a horizontal way, between hosts, its implementation is layered in a vertical fashion throughout a computer or network. This means is that there are multiple technologies and protocols that are built on top of each other in order for communication to function more easily. Each successive, higher layer abstracts the raw data a little bit more, and makes it simpler to use for applications and users. It also allows you to leverage lower layers in new ways without having to invest the time and energy to develop the protocols and applications that handle those types of traffic.

As data is sent out of one machine, it begins at the top of the stack and filters downwards. At the lowest level, actual transmission to another machine takes place. At this point, the data travels back up through the layers of the other computer. Each layer has the ability to add its own "wrapper" around the data that it receives from the adjacent layer, which will help the layers that come after decide what to do with the data when it is passed off.

One method of talking about the different layers of network communication is the OSI model. OSI stands for [Open Systems Interconnect](#). This model defines seven separate layers. The layers in this model are:

- Application: The application layer is the layer that the users and user-applications most often interact with. Network communication is discussed in terms of availability of resources, partners to communicate with, and data synchronization.
- Presentation: The presentation layer is responsible for mapping resources and creating context. It is used to translate lower level networking data into data that applications expect to see.
- Session: The session layer is a connection handler. It creates, maintains, and destroys connections between nodes in a persistent way.

- Transport: The transport layer is responsible for handing the layers above it a reliable connection. In this context, reliable refers to the ability to verify that a piece of data was received intact at the other end of the connection. This layer can resend information that has been dropped or corrupted and can acknowledge the receipt of data to remote computers.
- Network: The network layer is used to route data between different nodes on the network. It uses addresses to be able to tell which computer to send information to. This layer can also break apart larger messages into smaller chunks to be reassembled on the opposite end.
- Data Link: This layer is implemented as a method of establishing and maintaining reliable links between different nodes or devices on a network using existing physical connections.
- Physical: The physical layer is responsible for handling the actual physical devices that are used to make a connection. This layer involves the bare software that manages physical connections as well as the hardware itself (like Ethernet).

The TCP/IP model, more commonly known as the Internet protocol suite, is another layering model that is simpler and has been widely adopted. It defines the four separate layers, some of which overlap with the OSI model:

- Application: In this model, the application layer is responsible for creating and transmitting user data between applications. The applications can be on remote systems, and should appear to operate as if locally to the end user. The communication takes place between peers network.
- Transport: The transport layer is responsible for communication between processes. This level of networking utilizes ports to address different services. It can build up unreliable or reliable connections depending on the type of protocol used.
- Internet: The internet layer is used to transport data from node to node in a network. This layer is aware of the endpoints of the connections, but does not worry about the actual connection needed to get from one place to another. IP addresses are defined in this layer as a way of reaching remote systems in an addressable manner.
- Link: The link layer implements the actual topology of the local network that allows the internet layer to present an addressable interface. It establishes connections between neighboring nodes to send data.

Interfaces

Interfaces are networking communication points for your computer. Each interface is associated with a physical or virtual networking device. Typically, your server will have one configurable network interface for each Ethernet or wireless internet card you have. In addition, it will define a virtual network interface called the "loopback" or localhost interface. This is used as an interface to connect applications and processes on a single computer to other applications and processes. You can see this referenced as the "lo" interface in many tools.

Network Protocols

Networking works by piggybacks on a number of different protocols on top of each other. In this way, one piece of data can be transmitted using multiple protocols encapsulated within one another.

Media Access Control(MAC) is a communications protocol that is used to distinguish specific devices. Each device is supposed to get a unique MAC address during the manufacturing process that differentiates it from every other device on the internet. Addressing hardware by the MAC address allows you to reference a device by a unique value even when the software on top may change the name for that specific device during operation. Media access control is one of the only protocols from the link layer that you are likely to interact with on a regular basis.

The **IP protocol** is one of the fundamental protocols that allow the internet to work. IP addresses are unique on each network and they allow machines to address each other across a network. It is implemented on the internet layer in the IP/TCP model. Networks can be linked together, but traffic must be routed when crossing network boundaries. This protocol assumes an unreliable network and multiple paths to the same destination that it can dynamically change between. There are a number of different implementations of the protocol. The most common implementation today is IPv4, although IPv6 is growing in popularity as an alternative due to the scarcity of IPv4 addresses available and improvements in the protocols capabilities.

ICMP: internet control message protocol is used to send messages between devices to indicate the availability or error conditions. These packets are used in a variety of network diagnostic tools, such as ping and traceroute. Usually ICMP packets are transmitted when a packet of a different kind meets some kind of a problem. Basically, they are used as a feedback mechanism for network communications.

TCP: Transmission control protocol is implemented in the transport layer of the IP/TCP model and is used to establish reliable connections. TCP is one of the protocols that encapsulates data into packets. It then transfers these to the remote end of the connection using the methods available on the lower layers. On the other end, it can check for errors, request certain pieces to be resent, and reassemble the information into one logical piece to send to the application layer. The protocol builds up a connection prior to data transfer using a system called a three-way handshake. This is a way for the two ends of the communication to acknowledge the request and agree upon a method of ensuring data reliability. After the data has been sent, the connection is torn down using a similar four-way handshake. TCP is the protocol of choice for many of the most popular uses for the internet, including WWW, FTP, SSH, and email. It is safe to say that the internet we know today would not be here without TCP.

UDP: User datagram protocol is a popular companion protocol to TCP and is also implemented in the transport layer. The fundamental difference between UDP and TCP is that UDP offers unreliable data transfer. It does not verify that data has been received on the other end of the connection. This might sound like a bad thing, and for many purposes, it is. However, it is also extremely important for some functions. It's not required to wait for confirmation that the data was received and forced to resend data, UDP is much faster than TCP. It does not establish a connection with the remote host, it simply fires off the data to that host and doesn't care if it is accepted or not. Since UDP is a simple transaction, it is useful for simple communications like querying for network resources. It also doesn't maintain a state, which makes it great for transmitting data from one machine to many real-time clients. This makes it ideal for VOIP, games, and other applications that cannot afford delays.

HTTP: Hypertext transfer protocol is a protocol defined in the application layer that forms the basis for communication on the web. HTTP defines a number of functions that tell the remote system what you are requesting. For instance, GET, POST, and DELETE all interact with the requested data in a different way.

FTP: File transfer protocol is in the application layer and provides a way of transferring complete files from one host to another. It is inherently insecure, so it is not recommended for any externally facing network unless it is implemented as a public, download-only resource.

DNS: Domain name system is an application layer protocol used to provide a human-friendly naming mechanism for internet resources. It is what ties a domain name to an IP address and allows you to access sites by name in your browser.

SSH: Secure shell is an encrypted protocol implemented in the application layer that can be used to communicate with a remote server in a secure way. Many additional technologies are built around this protocol because of its end-to-end encryption and ubiquity. There are many other protocols that we haven't covered that are equally important. However, this should give you a good overview of some of the fundamental technologies that make the internet and networking possible.

[REST\(Representational State Transfer\)](#) is an architectural style for providing standards between computer systems on the web, making it easier for systems to communicate with each other.

[JSON Web Token \(JWT\)](#) is a compact URL-safe means of representing claims to be transferred between two parties. The claims in a JWT are encoded as a JSON object that is digitally signed using JSON Web Signature (JWS).

[OAuth 2.0](#) is an open source authorization framework that enables applications to obtain limited access to user accounts on an HTTP service, such as Amazon, Google, Facebook, Microsoft, Twitter GitHub, and DigitalOcean. It works by delegating user authentication to the service that hosts the user account, and authorizing third-party applications to access the user account.

Virtualization ↗

[KVM \(for Kernel-based Virtual Machine\)](#) is a full virtualization solution for Linux on x86 hardware containing virtualization extensions ([Intel VT](#) or [AMD-V](#)). It consists of a loadable kernel module, kvm.ko, that provides the core virtualization infrastructure and a processor specific module, kvm-intel.ko or kvm-amd.ko.

[QEMU](#) is a fast processor emulator using a portable dynamic translator. QEMU emulates a full system, including a processor and various peripherals. It can be used to launch a different Operating System without rebooting the PC or to debug system code.

[Hyper-V](#) enables running virtualized computer systems on top of a physical host. These virtualized systems can be used and managed just as if they were physical computer systems, however they exist in virtualized and isolated environment. Special software called a hypervisor manages access between the virtual systems and the physical hardware resources. Virtualization enables quick deployment of computer systems, a way to quickly restore systems to a previously known good state, and the ability to migrate systems between physical hosts.

[VirtManager](#) is a graphical tool for managing virtual machines via libvirt. Most usage is with QEMU/KVM virtual machines, but Xen and libvirt LXC containers are well supported. Common operations for any libvirt driver should work.

[oVirt](#) is an open-source distributed virtualization solution, designed to manage your entire enterprise infrastructure. oVirt uses the trusted KVM hypervisor and is built upon several other community projects, including libvirt, Gluster, PatternFly, and Ansible. Founded by Red Hat as a community project on which Red Hat Enterprise Virtualization is based allowing for centralized management of virtual machines, compute, storage and networking resources, from an easy-to-use web-based front-end with platform independent access.

[Xen](#) is focused on advancing virtualization in a number of different commercial and open source applications, including server virtualization, Infrastructure as a Services (IaaS), desktop virtualization, security applications, embedded and hardware appliances, and automotive/aviation.

[Ganeti](#) is a virtual machine cluster management tool built on top of existing virtualization technologies such as Xen or KVM and other open source software. Once installed, the tool assumes management of the virtual instances (Xen DomU).

[Packer](#) is an open source tool for creating identical machine images for multiple platforms from a single source configuration. Packer is lightweight, runs on every major operating system, and is highly performant, creating machine images for multiple platforms in parallel. Packer does not replace configuration management like Chef or Puppet. In fact, when building images, Packer is able to use tools like Chef or Puppet to install software onto the image.

[Vagrant](#) is a tool for building and managing virtual machine environments in a single workflow. With an easy-to-use workflow and focus on automation, Vagrant lowers development environment setup time, increases production parity, and makes the "works on my machine" excuse a relic of the past. It provides easy to configure, reproducible, and portable work environments built on top of industry-standard technology and controlled by a single consistent workflow to help maximize the productivity and flexibility of you and your team.

[VMware Workstation](#) is a hosted hypervisor that runs on x64 versions of Windows and Linux operating systems; it enables users to set up virtual machines on a single physical machine, and use them simultaneously along with the actual machine.

[VirtualBox](#) is a powerful x86 and AMD64/Intel64 virtualization product for enterprise as well as home use. Not only is VirtualBox an extremely feature rich, high performance product for enterprise customers.

Databases

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Database Learning Resources

[SQL](#) is a standard language for storing, manipulating and retrieving data in relational databases.

[SQL Tutorial by W3Schools](#)

[Learn SQL Skills Online from Coursera](#)

[SQL Courses Online from Udemy](#)

[SQL Online Training Courses from LinkedIn Learning](#)

[Learn SQL For Free from Codecademy](#)

[GitLab's SQL Style Guide](#)

[OracleDB SQL Style Guide Basics](#)

[Tableau CRM: BI Software and Tools](#)

[Databases on AWS](#)

[Best Practices and Recommendations for SQL Server Clustering in AWS EC2](#)

[Connecting from Google Kubernetes Engine to a Cloud SQL instance](#)

[Educational Microsoft Azure SQL resources](#)

[MySQL Certifications](#)

[SQL vs. NoSQL Databases: What's the Difference?](#)

[What is NoSQL?](#)

Databases and Tools ↗

[Tableau](#) is a Data Visualization software used in relational databases, cloud databases, and spreadsheets. Tableau was acquired by [Salesforce in August 2019](#).

[DataGrip](#) is a professional DataBase IDE developed by Jet Brains that provides context-sensitive code completion, helping you to write SQL code faster. Completion is aware of the tables structure, foreign keys, and even database objects created in code you're editing.

[RStudio](#) is an integrated development environment for R and Python, with a console, syntax-highlighting editor that supports direct code execution, and tools for plotting, history, debugging and workspace management.

[MySQL](#) is a fully managed database service to deploy cloud-native applications using the world's most popular open source database.

[PostgreSQL](#) is a powerful, open source object-relational database system with over 30 years of active development that has earned it a strong reputation for reliability, feature robustness, and performance.

[Amazon DynamoDB](#) is a key-value and document database that delivers single-digit millisecond performance at any scale. It is a fully managed, multiregion, multimaster, durable database with built-in security, backup and restore, and in-memory caching for internet-scale applications.

[FoundationDB](#) is an open source distributed database designed to handle large volumes of structured data across clusters of commodity servers. It organizes data as an ordered key-value store and employs ACID transactions for all operations. It is especially well-suited for read/write workloads but also has excellent performance for write-intensive workloads. FoundationDB was acquired by [Apple in 2015](#).

[CouchbaseDB](#) is an open source distributed [multi-model NoSQL document-oriented database](#). It creates a key-value store with managed cache for sub-millisecond data operations, with purpose-built indexers for efficient queries and a powerful query engine for executing SQL queries.

[IBM DB2](#) is a collection of hybrid data management products offering a complete suite of AI-empowered capabilities designed to help you manage both structured and unstructured data on premises as well as in private and public cloud environments. Db2 is built on an intelligent common SQL engine designed for scalability and flexibility.

[MongoDB](#) is a document database meaning it stores data in JSON-like documents.

[OracleDB](#) is a powerful fully managed database helps developers manage business-critical data with the highest availability, reliability, and security.

[MariaDB](#) is an enterprise open source database solution for modern, mission-critical applications.

[SQLite](#) is a C-language library that implements a small, fast, self-contained, high-reliability, full-featured, SQL database engine. SQLite is the most used database engine in the world. SQLite is built into all mobile phones and most computers and comes bundled inside countless other applications that people use every day.

[SQLite Database Browser](#) is an open source SQL tool that allows users to create, design and edits SQLite database files. It lets users show a log of all the SQL commands that have been issued by them and by the application itself.

[dbWatch](#) is a complete database monitoring/management solution for SQL Server, Oracle, PostgreSQL, Sybase, MySQL and Azure. Designed for proactive management and automation of routine maintenance in large scale on-premise, hybrid/cloud database environments.

[Cosmos DB Profiler](#) is a real-time visual debugger allowing a development team to gain valuable insight and perspective into their usage of Cosmos DB database. It identifies over a dozen suspicious behaviors from your application's interaction with Cosmos DB.

[Adminer](#) is an SQL management client tool for managing databases, tables, relations, indexes, users. Adminer has support for all the popular database management systems such as MySQL, MariaDB, PostgreSQL, SQLite, MS SQL, Oracle, Firebird, SimpleDB, Elasticsearch and MongoDB.

[DBeaver](#) is an open source database tool for developers and database administrators. It offers supports for JDBC compliant databases such as MySQL, Oracle, IBM DB2, SQL Server, Firebird, SQLite, Sybase, Teradata, Firebird, Apache Hive, Phoenix, and Presto.

[DbVisualizer](#) is a SQL management tool that allows users to manage a wide range of databases such as Oracle, Sybase, SQL Server, MySQL, H3, and SQLite.

[AppDynamics Database](#) is a management product for Microsoft SQL Server. With AppDynamics you can monitor and trend key performance metrics such as resource consumption, database objects, schema statistics and more, allowing you to proactively tune and fix issues in a High-Volume Production Environment.

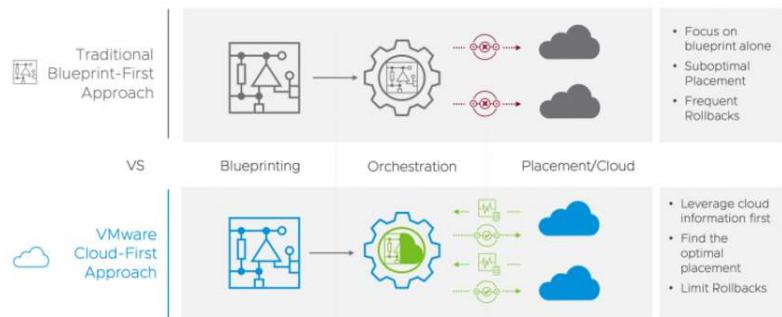
[Toad](#) is a SQL Server DBMS toolset developed by Quest. It increases productivity by using extensive automation, intuitive workflows, and built-in expertise. This SQL management tool resolve issues, manage change and promote the highest levels of code quality for both relational and non-relational databases.

[Lepide SQL Server](#) is an open source storage manager utility to analyse the performance of SQL Servers. It provides a complete overview of all configuration and permission changes being made to your SQL Server environment through an easy-to-use, graphical user interface.

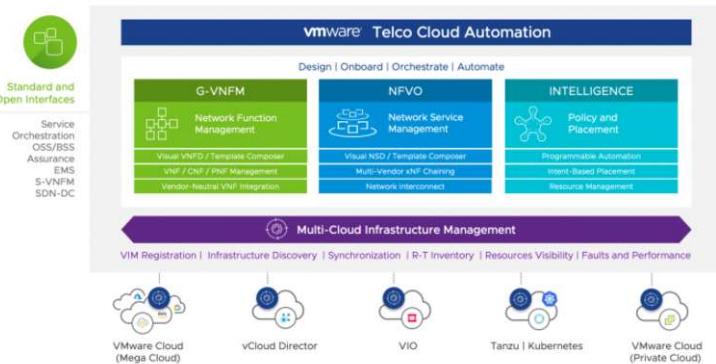
[Sequel Pro](#) is a fast MacOS database management tool for working with MySQL. This SQL management tool helpful for interacting with your database by easily to adding new databases, new tables, and new rows.

Telco 5G ☺

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VMware Cloud First Approach. Source: [VMware](#), 2020.



VMware Telco Cloud Automation Components. Source: [VMware](#), 2020.

Telco Learning Resources ↗

[HPE\(Hewlett Packard Enterprise\) Telco Blueprints overview](#)

[Network Functions Virtualization Infrastructure \(NFVI\) by Cisco](#)

[Introduction to vCloud NFV Telco Edge from VMware](#)

[VMware Telco Cloud Automation\(TCA\) Architecture Overview](#)

[5G Telco Cloud from VMware](#)

[Maturing OpenStack Together To Solve Telco Needs from Red Hat](#)

[Red Hat telco ecosystem program](#)

[OpenStack for Telcos by Canonical](#)

[Open source NFV platform for 5G from Ubuntu](#)

[Understanding 5G Technology from Verizon](#)

[Verizon and Unity partner to enable 5G & MEC gaming and enterprise applications](#)

[Understanding 5G Technology from Intel](#)

[Understanding 5G Technology from Qualcomm](#)

[Telco Acceleration with Xilinx](#)

[VIMs on OSM Public Wiki](#)

[Amazon EC2 Overview and Networking Introduction for Telecom Companies](#)

[Citrix Certified Associate – Networking\(CCA-N\)](#)

[Citrix Certified Professional – Virtualization\(CCP-V\)](#)

[CCNP Routing and Switching](#)

[Certified Information Security Manager\(CISM\)](#)

[Wireshark Certified Network Analyst \(WCNA\)](#)

[Juniper Networks Certification Program Enterprise \(JNCP\)](#)

[Cloud Native Computing Foundation Training and Certification Program](#)

Tools ↗

[Open Stack](#) is an open source cloud platform, deployed as infrastructure-as-a-service (IaaS) to orchestrate data center operations on bare metal, private cloud hardware, public cloud resources, or both (hybrid/multi-cloud architecture). OpenStack includes advance use of virtualization & SDN for network traffic optimization to handle the core cloud-computing services of compute, networking, storage, identity, and image services.

[StarlingX](#) is a complete cloud infrastructure software stack for the edge used by the most demanding applications in industrial IOT, telecom, video delivery and other ultra-low latency use cases.

[Airship](#) is a collection of open source tools for automating cloud provisioning and management. Airship provides a declarative framework for defining and managing the life cycle of open infrastructure tools and the underlying hardware.

[Network functions virtualization \(NFV\)](#) is the replacement of network appliance hardware with virtual machines. The virtual machines use a hypervisor to run networking software and processes such as routing and load balancing. NFV allows for the separation of communication services from dedicated hardware, such as routers and firewalls. This separation means network operations can provide new services dynamically and without installing new hardware. Deploying network components with network functions virtualization only takes hours compared to months like with traditional networking solutions.

[Software Defined Networking \(SDN\)](#) is an approach to networking that uses software-based controllers or application programming interfaces (APIs) to communicate with underlying hardware infrastructure and direct traffic on a network. This model differs from that of traditional networks, which use dedicated hardware devices (routers and switches) to control network traffic.

[Virtualized Infrastructure Manager \(VIM\)](#) is a service delivery and reduce costs with high performance lifecycle management Manage the full lifecycle of the software and hardware comprising your NFV infrastructure (NFVI), and maintaining a live inventory and allocation plan of both physical and virtual resources.

[Management and Orchestration\(MANO\)](#) is an ETSI-hosted initiative to develop an Open Source NFV Management and Orchestration (MANO) software stack aligned with ETSI NFV. Two of the key components of the ETSI NFV architectural framework are the NFV Orchestrator and VNF Manager, known as NFV MANO.

[Magma](#) is an open source software platform that gives network operators an open, flexible and extendable mobile core network solution. Their mission is to connect the world to a faster network by enabling service providers to build cost-effective and extensible carrier-grade networks. Magma is 3GPP generation (2G, 3G, 4G or upcoming 5G networks) and access network agnostic (cellular or WiFi). It can flexibly support a radio access network with minimal development and deployment effort.

[OpenRAN](#) is an intelligent Radio Access Network(RAN) integrated on general purpose platforms with open interface between software defined functions. Open RANecosystem enables enormous flexibility and interoperability with a complete openness to multi-vendor deployments.

[Open vSwitch\(OVS\)](#)is an open source production quality, multilayer virtual switch licensed under the open source Apache 2.0 license. It is designed to enable massive network automation through programmatic extension, while still supporting standard management interfaces and protocols (NetFlow, sFlow, IPFIX, RSPAN, CLI, LACP, 802.1ag).

[Edge](#) is a distributed computing framework that brings enterprise applications closer to data sources such as IoT devices or local edge servers. This proximity to data at its source can deliver strong business benefits, including faster insights, improved response times and better bandwidth availability.

[Multi-access edge computing \(MEC\)](#) is an Industry Specification Group (ISG) within ETSI to create a standardized, open environment which will allow the efficient and seamless integration of applications from vendors, service providers, and third-parties across multi-vendor Multi-access Edge Computing platforms.

[Virtualized network functions\(VNFs\)](#) is a software application used in a Network Functions Virtualization (NFV) implementation that has well defined interfaces, and provides one or more component networking functions in a defined way. For example, a security VNF provides Network Address Translation (NAT) and firewall component functions.

[Cloud-Native Network Functions\(CNF\)](#) is a network function designed and implemented to run inside containers. CNFs inherit all the cloud native architectural and operational principles including Kubernetes(K8s) lifecycle management, agility, resilience, and observability.

[Physical Network Function\(PNF\)](#) is a physical network node which has not undergone virtualization. Both PNFs and VNFs (Virtualized Network Functions) can be used to form an overall Network Service.

[Network functions virtualization infrastructure\(NFVI\)](#) is the foundation of the overall NFV architecture. It provides the physical compute, storage, and networking hardware that hosts the VNFs. Each NFVI block can be thought of as an NFVI node and many nodes can be deployed and controlled geographically.

Open Source Security

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[Open Source Security Foundation \(OpenSSF\)](#) is a cross-industry collaboration that brings together leaders to improve the security of open source software by building a broader community, targeted initiatives, and best practices. The OpenSSF brings together open source security initiatives under one foundation to accelerate work through cross-industry support. Along with the Core Infrastructure Initiative and the Open Source Security Coalition, and will include new working groups that address vulnerability disclosures, security tooling and more.

Security Standards, Frameworks and Benchmarks

[STIGs Benchmarks - Security Technical Implementation Guides](#)

[CIS Benchmarks - CIS Center for Internet Security](#)

NIST - Current FIPS

ISO Standards Catalogue

Common Criteria for Information Technology Security Evaluation (CC) is an international standard (ISO / IEC 15408) for computer security. It allows an objective evaluation to validate that a particular product satisfies a defined set of security requirements.

ISO 22301 is the international standard that provides a best-practice framework for implementing an optimised BCMS (business continuity management system).

ISO27001 is the international standard that describes the requirements for an ISMS (information security management system). The framework is designed to help organizations manage their security practices in one place, consistently and cost-effectively.

ISO 27701 specifies the requirements for a PIMS (privacy information management system) based on the requirements of ISO 27001. It is extended by a set of privacy-specific requirements, control objectives and controls. Companies that have implemented ISO 27001 will be able to use ISO 27701 to extend their security efforts to cover privacy management.

EU GDPR (General Data Protection Regulation) is a privacy and data protection law that supersedes existing national data protection laws across the EU, bringing uniformity by introducing just one main data protection law for companies/organizations to comply with.

CCPA (California Consumer Privacy Act) is a data privacy law that took effect on January 1, 2020 in the State of California. It applies to businesses that collect California residents' personal information, and its privacy requirements are similar to those of the EU's GDPR (General Data Protection Regulation).

Payment Card Industry (PCI) Data Security Standards (DSS) is a global information security standard designed to prevent fraud through increased control of credit card data.

SOC 2 is an auditing procedure that ensures your service providers securely manage your data to protect the interests of your company/organization and the privacy of their clients.

NIST CSF is a voluntary framework primarily intended for critical infrastructure organizations to manage and mitigate cybersecurity risk based on existing best practice.

Security Tools ↗

AppArmor is an effective and easy-to-use Linux application security system. AppArmor proactively protects the operating system and applications from external or internal threats, even zero-day attacks, by enforcing good behavior and preventing both known and unknown application flaws from being exploited. AppArmor supplements the traditional Unix discretionary access control (DAC) model by providing mandatory access control (MAC). It has been included in the mainline Linux kernel since version 2.6.36 and its development has been supported by Canonical since 2009.

SELinux is a security enhancement to Linux which allows users and administrators more control over access control. Access can be constrained on such variables as which users and applications can access which resources. These resources may take the form of files. Standard Linux access controls, such as file modes (-rwxr-xr-x) are modifiable by the user and the applications which the user runs. Conversely, SELinux access controls are determined by a policy loaded on the system which may not be changed by careless users or misbehaving applications.

Control Groups(Cgroups) is a Linux kernel feature that allows you to allocate resources such as CPU time, system memory, network bandwidth, or any combination of these resources for user-defined groups of tasks (processes) running on a system.

EarlyOOM is a daemon for Linux that enables users to more quickly recover and regain control over their system in low-memory situations with heavy swap usage.

Libgcrypt is a general purpose cryptographic library originally based on code from GnuPG.

Kali Linux is an open source project that is maintained and funded by Offensive Security, a provider of world-class information security training and penetration testing services.

Pi-hole is a DNS sinkhole that protects your devices from unwanted content, without installing any client-side software, intended for use on a private network. It is designed for use on embedded devices with network capability, such as the Raspberry Pi, but it can be used on other machines running Linux and cloud implementations.

[Aircrack-ng](#) is a network software suite consisting of a detector, packet sniffer, WEP and WPA/WPA2-PSK cracker and analysis tool for 802.11 wireless LANs. It works with any wireless network interface controller whose driver supports raw monitoring mode and can sniff 802.11a, 802.11b and 802.11g traffic.

[Burm Suite](#) is a leading range of cybersecurity tools.

[KernelCI](#) is a community-based open source distributed test automation system focused on upstream kernel development. The primary goal of KernelCI is to use an open testing philosophy to ensure the quality, stability and long-term maintenance of the Linux kernel.

[Continuous Kernel Integration project](#) helps find bugs in kernel patches before they are committed to an upstream kernel tree. We are team of kernel developers, kernel testers, and automation engineers.

[eBPF](#) is a revolutionary technology that can run sandboxed programs in the Linux kernel without changing kernel source code or loading kernel modules. By making the Linux kernel programmable, infrastructure software can leverage existing layers, making them more intelligent and feature-rich without continuing to add additional layers of complexity to the system.

[Cilium](#) uses eBPF to accelerate getting data in and out of L7 proxies such as Envoy, enabling efficient visibility into API protocols like HTTP, gRPC, and Kafka.

[Hubble](#) is a Network, Service & Security Observability for Kubernetes using eBPF.

[Istio](#) is an open platform to connect, manage, and secure microservices. Istio's control plane provides an abstraction layer over the underlying cluster management platform, such as Kubernetes and Mesos.

[Certgen](#) is a convenience tool to generate and store certificates for Hubble Relay mTLS.

[Scapy](#) is a python-based interactive packet manipulation program & library.

[syzkaller](#) is an unsupervised, coverage-guided kernel fuzzer.

[SchedViz](#) is a tool for gathering and visualizing kernel scheduling traces on Linux machines.

[oss-fuzz](#) aims to make common open source software more secure and stable by combining modern fuzzing techniques with scalable, distributed execution.

[OSSEC](#) is a free, open-source host-based intrusion detection system. It performs log analysis, integrity checking, Windows registry monitoring, rootkit detection, time-based alerting, and active response.

[Metasploit Project](#) is a computer security project that provides information about security vulnerabilities and aids in penetration testing and IDS signature development.

[Wfuzz](#) was created to facilitate the task in web applications assessments and it is based on a simple concept: it replaces any reference to the FUZZ keyword by the value of a given payload.

[Nmap](#) is a security scanner used to discover hosts and services on a computer network, thus building a "map" of the network.

[Patchwork](#) is a web-based patch tracking system designed to facilitate the contribution and management of contributions to an open-source project.

[pfSense](#) is a free and open source firewall and router that also features unified threat management, load balancing, multi WAN, and more.

[Snowpatch](#) is a continuous integration tool for projects using a patch-based, mailing-list-centric git workflow. This workflow is used by a number of well-known open source projects such as the Linux kernel.

[Snort](#) is an open-source, free and lightweight network intrusion detection system (NIDS) software for Linux and Windows to detect emerging threats.

[Wireshark](#) is a free and open-source packet analyzer. It is used for network troubleshooting, analysis, software and communications protocol development, and education.

[OpenSCAP](#) is U.S. standard maintained by [National Institute of Standards and Technology \(NIST\)](#). It provides multiple tools to assist administrators and auditors with assessment, measurement, and enforcement of security baselines. OpenSCAP maintains great flexibility and interoperability by reducing the costs of performing security audits. Whether you want to evaluate DISA STIGs, NIST's USGCB, or Red Hat's Security Response Team's content, all are supported by OpenSCAP.

[Tink](#) is a multi-language, cross-platform, open source library that provides cryptographic APIs that are secure, easy to use correctly, and harder to misuse.

[OWASP](#) is an online community, produces freely-available articles, methodologies, documentation, tools, and technologies in the field of web application security.

[Open Vulnerability and Assessment Language](#) is a community effort to standardize how to assess and report upon the machine state of computer systems. OVAL includes a language to encode system details, and community repositories of content. Tools and services that use OVAL provide enterprises with accurate, consistent, and actionable information to improve their security.

[ClamAV](#) is an open source antivirus engine for detecting trojans, viruses, malware & other malicious threats.

Open Source Security Learning Resources

[Microsoft Open Source Software Security](#)

[Cloudflare Open Source Security](#)

[The Seven Properties of Highly Secure Devices](#)

[How Layer 7 of the Internet Works](#)

[The 7 Kinds of Security](#)

[The Libgcrypt Reference Manual](#)

[The Open Web Application Security Project\(OWASP\) Foundation Top 10](#)

[Best Practices for Using Open Source Code from The Linux Foundation](#)

[AWS Certified Security - Specialty Certification](#)

[Microsoft Certified: Azure Security Engineer Associate](#)

[Google Cloud Certified Professional Cloud Security Engineer](#)

[Cisco Security Certifications](#)

[The Red Hat Certified Specialist in Security: Linux](#)

[Linux Professional Institute LPIC-3 Enterprise Security Certification](#)

[Cybersecurity Training and Courses from IBM Skills](#)

[Cybersecurity Courses and Certifications by Offensive Security](#)

[RSA Certification Program](#)

[Check Point Certified Security Expert\(CCSE\) Certification](#)

[Check Point Certified Security Administrator\(CCSA\) Certification](#)

[Check Point Certified Security Master \(CCSM\) Certification](#)

[Certified Cloud Security Professional\(CCSP\) Certification](#)

[Certified Information Systems Security Professional \(CISSP\) Certification](#)

[CCNP Routing and Switching](#)

[Certified Information Security Manager\(CISM\)](#)

[Wireshark Certified Network Analyst \(WCNA\)](#)

[Juniper Networks Certification Program Enterprise \(JNCP\)](#)

[Security Training Certifications and Courses from Udemy](#)

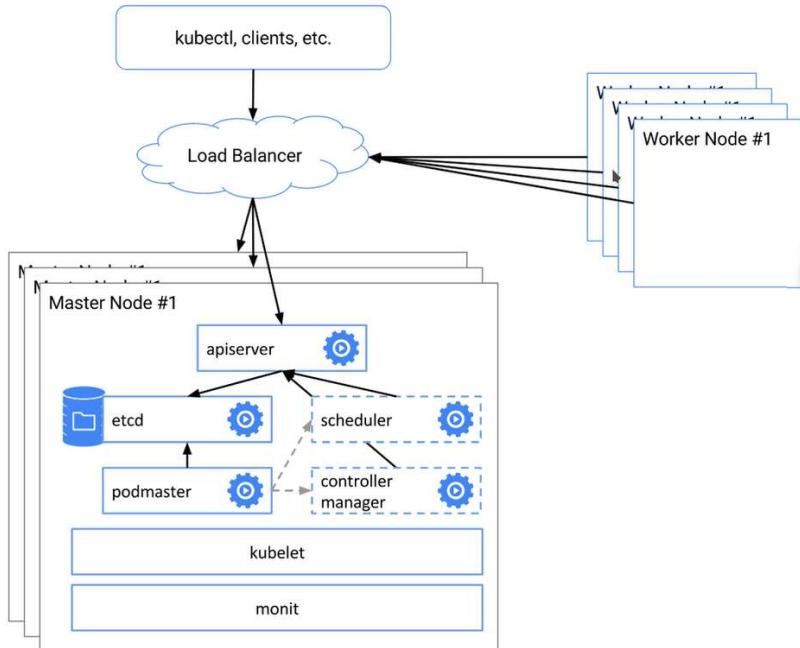
[Security Training Certifications and Courses from Coursera](#)

[Security Certifications Training from Pluarlsight](#)

Kubernetes

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[Kubernetes \(K8s\)](#) is an open-source system for automating deployment, scaling, and management of containerized applications.



Building Highly-Availability(HA) Clusters with kubeadm. Source: [Kubernetes.io](#)

[Google Kubernetes Engine \(GKE\)](#) is a managed, production-ready environment for running containerized applications.

[Azure Kubernetes Service \(AKS\)](#) is serverless Kubernetes, with a integrated continuous integration and continuous delivery (CI/CD) experience, and enterprise-grade security and governance. Unite your development and operations teams on a single platform to rapidly build, deliver, and scale applications with confidence.

[Amazon EKS](#) is a tool that runs Kubernetes control plane instances across multiple Availability Zones to ensure high availability.

[AWS Controllers for Kubernetes \(ACK\)](#) is a new tool that lets you directly manage AWS services from Kubernetes. ACK makes it simple to build scalable and highly-available Kubernetes applications that utilize AWS services.

[Container Engine for Kubernetes \(OKE\)](#) is an Oracle-managed container orchestration service that can reduce the time and cost to build modern cloud native applications. Unlike most other vendors, Oracle Cloud Infrastructure provides Container Engine for Kubernetes as a free service that runs on higher-performance, lower-cost compute.

[Anthos](#) is a modern application management platform that provides a consistent development and operations experience for cloud and on-premises environments.

[Red Hat OpenShift](#) is a fully managed Kubernetes platform that provides a foundation for on-premises, hybrid, and multicloud deployments.

[OKD](#) is a community distribution of Kubernetes optimized for continuous application development and multi-tenant deployment. OKD adds developer and operations-centric tools on top of Kubernetes to enable rapid application development, easy deployment and scaling, and long-term lifecycle maintenance for small and large teams.

[Odo](#) is a fast, iterative, and straightforward CLI tool for developers who write, build, and deploy applications on Kubernetes and OpenShift.

[Kata Operator](#) is an operator to perform lifecycle management (install/upgrade/uninstall) of [Kata Runtime](#) on Openshift as well as Kubernetes cluster.

[Thanos](#) is a set of components that can be composed into a highly available metric system with unlimited storage capacity, which can be added seamlessly on top of existing Prometheus deployments.

[OpenShift Hive](#) is an operator which runs as a service on top of Kubernetes/OpenShift. The Hive service can be used to provision and perform initial configuration of OpenShift 4 clusters.

[Rook](#) is a tool that turns distributed storage systems into self-managing, self-scaling, self-healing storage services. It automates the tasks of a storage administrator: deployment, bootstrapping, configuration, provisioning, scaling, upgrading, migration, disaster recovery, monitoring, and resource management.

[VMware Tanzu](#) is a centralized management platform for consistently operating and securing your Kubernetes infrastructure and modern applications across multiple teams and private/public clouds.

[Kubespray](#) is a tool that combines Kubernetes and Ansible to easily install Kubernetes clusters that can be deployed on [AWS](#), [GCE](#), [Azure](#), [OpenStack](#), [vSphere](#), [Packet](#) (bare metal), Oracle Cloud Infrastructure (Experimental), or Baremetal.

[Kubelint](#) provides Ansible playbooks and roles for the deployment and configuration of multiple Kubernetes distributions.

[Rancher](#) is a complete software stack for teams adopting containers. It addresses the operational and security challenges of managing multiple Kubernetes clusters, while providing DevOps teams with integrated tools for running containerized workloads.

[K3s](#) is a highly available, certified Kubernetes distribution designed for production workloads in unattended, resource-constrained, remote locations or inside IoT appliances.

[Helm](#) is a Kubernetes Package Manager tool that makes it easier to install and manage Kubernetes applications.

[Knative](#) is a Kubernetes-based platform to build, deploy, and manage modern serverless workloads. Knative takes care of the operational overhead details of networking, autoscaling (even to zero), and revision tracking.

[KubeFlow](#) is a tool dedicated to making deployments of machine learning (ML) workflows on Kubernetes simple, portable and scalable.

[Kubebox](#) is a Terminal and Web console for Kubernetes.

[Kubsec](#) is a Security risk analysis for Kubernetes resources.

[Replex](#) is a Kubernetes Governance and Cost Management for the Cloud-Native Enterprise.

[Virtual Kubelet](#) is an open-source [Kubernetes kubelet](#) implementation that masquerades as a kubelet.

[Telepresence](#) is a fast, local development for Kubernetes and OpenShift microservices.

[Weave Scope](#) is a tool that automatically detects processes, containers, hosts. No kernel modules, no agents, no special libraries, no coding. It seamless integration with Docker, Kubernetes, DCOS and AWS ECS.

[Nuclio](#) is a high-performance "serverless" framework focused on data, I/O, and compute intensive workloads. It is well integrated with popular data science tools, such as [Jupyter](#) and [Kubeflow](#); supports a variety of data and streaming sources; and supports execution over CPUs and GPUs.

[Supergiant Control](#) is a tool that manages the lifecycle of clusters on your infrastructure and allows deployment of applications via HELM. Its deployment and configuration workflows will help you to get up and running with Kubernetes faster.

[Supergiant Capacity - Beta](#) is a tool that ensures that the right hardware is available for the required resource load of your Kubernetes cluster at any given time. This helps prevent over-provisioning of your container environment and overspending on your hardware budget.

[Test suite for Kubernetes](#) is a test suite consists of two Helm charts for network bandwith testing and load testing a Kuberntes cluster.

[Keel](#) is a Kubernetes Operator to automate Helm, DaemonSet, StatefulSet & Deployment updates.

[Kube Monkey](#) is an implementation of Netflix's Chaos Monkey for Kubernetes clusters. It randomly deletes Kubernetes (k8s) pods in the cluster encouraging and validating the development of failure-resilient services.

[Kube State Metrics \(KSM\)](#) is a simple service that listens to the Kubernetes API server and generates metrics about the state of the objects. It's not focused on the health of the individual Kubernetes components, but rather on the health of the various objects inside, such as deployments, nodes and pods.

[Sonobuoy](#) is a diagnostic tool that makes it easier to understand the state of a Kubernetes cluster by running a choice of configuration tests in an accessible and non-destructive manner.

[PowerfulSeal](#) is a powerful testing tool for your Kubernetes clusters, so that you can detect problems as early as possible.

[Test Infra](#) is a repository contains tools and configuration files for the testing and automation needs of the Kubernetes project.

[cAdvisor \(Container Advisor\)](#) is a tool that provides container users an understanding of the resource usage and performance characteristics of their running containers. It is a running daemon that collects, aggregates, processes, and exports information about running containers. Specifically, for each container it keeps resource isolation parameters, historical resource usage, histograms of complete historical resource usage and network statistics.

[Etcd](#) is a distributed key-value store that provides a reliable way to store data that needs to be accessed by a distributed system or cluster of machines. Etcd is used as the backend for service discovery and stores cluster state and configuration for Kubernetes.

[OpenEBS](#) is a Kubernetes-based tool to create stateful applications using Container Attached Storage.

[Container Storage Interface \(CSI\)](#) is an API that lets container orchestration platforms like Kubernetes seamlessly communicate with stored data via a plug-in.

[MicroK8s](#) is a tool that delivers the full Kubernetes experience. In a Fully containerized deployment with compressed over-the-air updates for ultra-reliable operations. It is supported on Linux, Windows, and MacOS.

[Charmed Kubernetes](#) is a well integrated, turn-key, conformant Kubernetes platform, optimized for your multi-cloud environments developed by Canonical.

[Grafana Kubernetes App](#) is a toll that allows you to monitor your Kubernetes cluster's performance. It includes 4 dashboards, Cluster, Node, Pod/Container and Deployment. It allows for the automatic deployment of the required Prometheus exporters and a default scrape config to use with your in cluster Prometheus deployment.

[KubeEdge](#) is an open source system for extending native containerized application orchestration capabilities to hosts at Edge. It is built upon kubernetes and provides fundamental infrastructure support for network, app, deployment and metadata synchronization between cloud and edge.

[Lens](#) is the most powerful IDE for people who need to deal with Kubernetes clusters on a daily basis. It has support for MacOS, Windows and Linux operating systems.

[kind](#) is a tool for running local Kubernetes clusters using Docker container "nodes". It was primarily designed for testing Kubernetes itself, but may be used for local development or CI.

[Flux CD](#) is a tool that automatically ensures that the state of your Kubernetes cluster matches the configuration you've supplied in Git. It uses an operator in the cluster to trigger deployments inside Kubernetes, which means that you don't need a separate continuous delivery tool.

Kubernetes Learning Resources

[Getting Kubernetes Certifications](#)

[Getting started with Kubernetes on AWS](#)

[Kubernetes on Microsoft Azure](#)

[Intro to Azure Kubernetes Service](#)

[Getting started with Google Cloud](#)

[Getting started with Kubernetes on Red Hat](#)

[Getting started with Kubernetes on IBM](#)

[YAML basics in Kubernetes](#)

[Elastic Cloud on Kubernetes](#)

[Docker and Kubernetes](#)

[Deploy a model to an Azure Kubernetes Service cluster](#)

[Simplify Machine Learning Inference on Kubernetes with Amazon SageMaker Operators](#)

[Running Apache Spark on Kubernetes](#)

[Kubernetes Across VMware vRealize Automation](#)

[VMware Tanzu Kubernetes Grid](#)

[All the Ways VMware Tanzu Works with AWS](#)

[VMware Tanzu Education](#)

[Using Ansible in a Cloud-Native Kubernetes Environment](#)

[Managing Kubernetes \(K8s\) objects with Ansible](#)

[Setting up a Kubernetes cluster using Vagrant and Ansible](#)

[Running MongoDB with Kubernetes](#)

[Kubernetes Fluentd](#)

[Understanding the new GitLab Kubernetes Agent](#)

[Kubernetes Contributors](#)

[KubeAcademy from VMware](#)

Machine Learning

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ML frameworks & applications

[TensorFlow](#) is an end-to-end open source platform for machine learning. It has a comprehensive, flexible ecosystem of tools, libraries and community resources that lets researchers push the state-of-the-art in ML and developers easily build and deploy ML powered applications.

[Tensorman](#) is a utility for easy management of Tensorflow containers by developed by [System76](#). Tensorman allows Tensorflow to operate in an isolated environment that is contained from the rest of the system. This virtual environment can operate independent of the base system, allowing you to use any version of Tensorflow on any version of a Linux distribution that supports the Docker runtime.

[Keras](#) is a high-level neural networks API, written in Python and capable of running on top of TensorFlow, CNTK, or Theano. It was developed with a focus on enabling fast experimentation. It is capable of running on top of TensorFlow, Microsoft Cognitive Toolkit, R, Theano, or PlaidML.

[PyTorch](#) is a library for deep learning on irregular input data such as graphs, point clouds, and manifolds. Primarily developed by Facebook's AI Research lab.

[Amazon SageMaker](#) is a fully managed service that provides every developer and data scientist with the ability to build, train, and deploy machine learning (ML) models quickly. SageMaker removes the heavy lifting from each step of the machine learning process to make it easier to develop high quality models.

[Azure Databricks](#) is a fast and collaborative Apache Spark-based big data analytics service designed for data science and data engineering. Azure Databricks, sets up your Apache Spark environment in minutes, autoscale, and collaborate on shared projects in an interactive workspace. Azure Databricks supports Python, Scala, R, Java, and SQL, as well as data science frameworks and libraries including TensorFlow, PyTorch, and scikit-learn.

[Microsoft Cognitive Toolkit \(CNTK\)](#) is an open-source toolkit for commercial-grade distributed deep learning. It describes neural networks as a series of computational steps via a directed graph. CNTK allows the user to easily realize and combine popular model types such as feed-forward DNNs, convolutional neural networks (CNNs) and recurrent neural networks (RNNs/LSTMs). CNTK implements stochastic gradient descent (SGD, error backpropagation) learning with automatic differentiation and parallelization across multiple GPUs and servers.

[Apache Airflow](#) is an open-source workflow management platform created by the community to programmatically author, schedule and monitor workflows. Install. Principles. Scalable. Airflow has a modular architecture and uses a message queue to orchestrate an arbitrary number of workers. Airflow is ready to scale to infinity.

[Open Neural Network Exchange\(ONNX\)](#) is an open ecosystem that empowers AI developers to choose the right tools as their project evolves. ONNX provides an open source format for AI models, both deep learning and traditional ML. It defines an extensible computation graph model, as well as definitions of built-in operators and standard data types.

[Apache MXNet](#) is a deep learning framework designed for both efficiency and flexibility. It allows you to mix symbolic and imperative programming to maximize efficiency and productivity. At its core, MXNet contains a dynamic dependency scheduler that automatically parallelizes both symbolic and imperative operations on the fly. A graph optimization layer on top of that makes symbolic execution fast and memory efficient. MXNet is portable and lightweight, scaling effectively to multiple GPUs and multiple machines. Support for Python, R, Julia, Scala, Go, Javascript and more.

[AutoGluon](#) is toolkit for Deep learning that automates machine learning tasks enabling you to easily achieve strong predictive performance in your applications. With just a few lines of code, you can train and deploy high-accuracy deep learning models on tabular, image, and text data.

[Anaconda](#) is a very popular Data Science platform for machine learning and deep learning that enables users to develop models, train them, and deploy them.

[PlaidML](#) is an advanced and portable tensor compiler for enabling deep learning on laptops, embedded devices, or other devices where the available computing hardware is not well supported or the available software stack contains unpalatable license restrictions.

[OpenCV](#) is a highly optimized library with focus on real-time computer vision applications. The C++, Python, and Java interfaces support Linux, MacOS, Windows, iOS, and Android.

[Scikit-Learn](#) is a Python module for machine learning built on top of SciPy, NumPy, and matplotlib, making it easier to apply robust and simple implementations of many popular machine learning algorithms.

[Weka](#) is an open source machine learning software that can be accessed through a graphical user interface, standard terminal applications, or a Java API. It is widely used for teaching, research, and industrial applications, contains a plethora of built-in tools for standard machine learning tasks, and additionally gives transparent access to well-known toolboxes such as scikit-learn, R, and Deeplearning4j.

[Caffe](#) is a deep learning framework made with expression, speed, and modularity in mind. It is developed by Berkeley AI Research (BAIR)/The Berkeley Vision and Learning Center (BVLC) and community contributors.

[Theano](#) is a Python library that allows you to define, optimize, and evaluate mathematical expressions involving multi-dimensional arrays efficiently including tight integration with NumPy.

[nGraph](#) is an open source C++ library, compiler and runtime for Deep Learning. The nGraph Compiler aims to accelerate developing AI workloads using any deep learning framework and deploying to a variety of hardware targets. It provides the freedom, performance, and ease-of-use to AI developers.

[NVIDIA cuDNN](#) is a GPU-accelerated library of primitives for [deep neural networks](#). cuDNN provides highly tuned implementations for standard routines such as forward and backward convolution, pooling, normalization, and activation layers. cuDNN accelerates widely used deep learning frameworks, including [Caffe2](#), [Chainer](#), [Keras](#), [MATLAB](#), [MxNet](#), [PyTorch](#), and [TensorFlow](#).

[Jupyter Notebook](#) is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text. Jupyter is used widely in industries that do data cleaning and transformation, numerical simulation, statistical modeling, data visualization, data science, and machine learning.

[Apache Spark](#) is a unified analytics engine for large-scale data processing. It provides high-level APIs in Scala, Java, Python, and R, and an optimized engine that supports general computation graphs for data analysis. It also supports a rich set of higher-level tools including Spark SQL for SQL and DataFrames, MLlib for machine learning, GraphX for graph processing, and Structured Streaming for stream processing.

[Apache Spark Connector for SQL Server and Azure SQL](#) is a high-performance connector that enables you to use transactional data in big data analytics and persists results for ad-hoc queries or reporting. The connector allows you to use any SQL database, on-premises or in the cloud, as an input data source or output data sink for Spark jobs.

[Apache PredictionIO](#) is an open source machine learning framework for developers, data scientists, and end users. It supports event collection, deployment of algorithms, evaluation, querying predictive results via REST APIs. It is based on scalable open source services like Hadoop, HBase (and other DBs), Elasticsearch, Spark and implements what is called a Lambda Architecture.

[Cluster Manager for Apache Kafka\(CMAK\)](#) is a tool for managing [Apache Kafka](#) clusters.

[BigDL](#) is a distributed deep learning library for Apache Spark. With BigDL, users can write their deep learning applications as standard Spark programs, which can directly run on top of existing Spark or Hadoop clusters.

[Koalas](#) is project makes data scientists more productive when interacting with big data, by implementing the pandas DataFrame API on top of Apache Spark.

[Apache Spark™ MLflow](#) is an open source platform to manage the ML lifecycle, including experimentation, reproducibility, deployment, and a central model registry. MLflow currently offers four components:

MLflow Tracking: Record and query experiments: code, data, config, and results.

MLflow Projects: Package data science code in a format to reproduce runs on any platform.

MLflow Models: Deploy machine learning models in diverse serving environments.

Model Registry: Store, annotate, discover, and manage models in a central repository.

[Eclipse Deeplearning4J \(DL4J\)](#) is a set of projects intended to support all the needs of a JVM-based(Scala, Kotlin, Clojure, and Groovy) deep learning application. This means starting with the raw data, loading and preprocessing it from wherever and whatever format it is in to building and tuning a wide variety of simple and complex deep learning networks.

[Numba](#) is an open source, NumPy-aware optimizing compiler for Python sponsored by Anaconda, Inc. It uses the LLVM compiler project to generate machine code from Python syntax. Numba can compile a large subset of numerically-focused Python, including many NumPy functions. Additionally, Numba has support for automatic parallelization of loops, generation of GPU-accelerated code, and creation of ufuncs and C callbacks.

[Chainer](#) is a Python-based deep learning framework aiming at flexibility. It provides automatic differentiation APIs based on the define-by-run approach (dynamic computational graphs) as well as object-oriented high-level APIs to build and train neural networks. It also supports CUDA/cuDNN using [CuPy](#) for high performance training and inference.

[cuML](#) is a suite of libraries that implement machine learning algorithms and mathematical primitives functions that share compatible APIs with other RAPIDS projects. cuML enables data scientists, researchers, and software engineers to run traditional tabular ML tasks on GPUs without going into the details of CUDA programming. In most cases, cuML's Python API matches the API from scikit-learn.

ML Learning Resources

[Machine Learning by Stanford University from Coursera](#)

[Machine Learning Courses Online from Coursera](#)

[Machine Learning Courses Online from Udemy](#)

[Learn Machine Learning with Online Courses and Classes from edX](#)

Node.js Development

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[Node.js Documentation](#)

Node.js Learning Resources

[Node.js](#) is a JavaScript runtime built on Chrome's V8 JavaScript engine that lets developers write command line tools and server-side scripts outside of a browser.

[Node.js Build Working Group](#) maintains and controls infrastructure used for continuous integration (CI), releases, benchmarks, web hosting (of nodejs.org and other Node.js web properties) and more.

[The OpenJS Foundation](#) is made up of 32 open source JavaScript projects including Appium, Dojo, Electron, jQuery, Node.js, and webpack. The foundation's mission is to support the healthy growth of JavaScript and web technologies by providing a neutral organization to host and sustain projects, as well as collaboratively fund activities that benefit the ecosystem as a whole.

[Set up NodeJS on WSL 2](#)

[Getting started with Node.js in Google Cloud](#)

[Getting Started with Node.js in AWS](#)

[Node.js App Hosting & Deployment in Microsoft Azure](#)

[The Node.js best practices list](#)

[Introduction to Node.js by W3Schools](#)

[The Node.js Community Committee](#)

[Node.js Mentorship Program Initiative](#)

[Node.js tutorial in Visual Studio Code](#)

[Server-side Development with NodeJS, Express and MongoDB on Coursera](#)

Node.js Tools

[NPM](#) is the company behind Node package manager, the npm Registry, and npm CLI.

[node-gyp](#) is a cross-platform command-line tool written in Node.js for compiling native addon modules for Node.js. It contains a vendored copy of the gyp-next project that was previously used by the Chromium team, extended to support the development of Node.js native addons.

[nvm](#) is a version manager for node.js, designed to be installed per-user, and invoked per-shell. nvm works on any POSIX-compliant shell (sh, dash, ksh, zsh, bash), in particular on these platforms: unix, macOS, and windows WSL.

[node-docker](#) is the official Node.js docker image, made with love by the node community.

[Mocha](#) is a simple, flexible, fun JavaScript test framework for Node.js & The Browser.

[AVA](#) is a test runner for Node.js with a concise API, detailed error output, embrace of new language features and process isolation that lets you develop with confidence.

[egg](#) is a born to build better enterprise frameworks and apps with Node.js & Koa.

[mysqljs](#) is a pure node.js JavaScript Client implementing the MySQL protocol.

[axios](#) is a promise based HTTP client for the browser and node.js.

[Fastify](#) is a fast and low overhead web framework, for Node.js.

[Express](#) is a fast, unopinionated, minimalist web framework for node.

[Meteor](#) is an ultra-simple environment for building modern web applications with JavaScript.

[NW.js](#) is an app runtime based on Chromium and node.js. You can write native apps in HTML and JavaScript with NW.js. It also lets you call Node.js modules directly from the DOM and enables a new way of writing native applications with all Web technologies.

[PM2](#) is a production process manager for Node.js applications with a built-in load balancer. It allows you to keep applications alive forever, to reload them without downtime and to facilitate common system admin tasks.

[NestJS](#) is a framework for building efficient, scalable Node.js web applications. It uses modern JavaScript, is built with TypeScript and combines elements of OOP (Object Oriented Programming), FP (Functional Programming), and FRP (Functional Reactive Programming).

[jenkins-nodejs](#) is a Jenkins plugin for Node.js that provides the NodeJS auto-installer, allowing to create as many NodeJS installations "profiles" as you want.

[Strapi](#) is an open source Node.js Headless CMS to easily build customisable APIs.

[Standard](#) is a JavaScript Style Guide, with linter & automatic code fixer.

[React Starter Kit](#) is an isomorphic web app boilerplate for web development built on top of [Node.js](#), [Express](#), [GraphQL](#) and [React](#), containing modern web development tools such as [Webpack](#), [Babel](#) and [Browsersync](#). Helping you to stay productive following the best practices.

[Hexo](#) is a A fast, simple & powerful blog framework, powered by Node.js.

Java Development

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[Start building with Java on Google Cloud](#)

[Java Documentation](#)

Java Learning Resources

[Java](#) is a popular programming language and development platform(JDK). It reduces costs, shortens development timeframes, drives innovation, and improves application services. With millions of developers running more than 51 billion Java Virtual Machines worldwide.

[The Eclipse Foundation](#) is home to a worldwide community of developers, the Eclipse IDE, Jakarta EE and over 375 open source projects, including runtimes, tools and frameworks for Java and other languages.

[Getting Started with Java](#)

[Oracle Java certifications from Oracle University](#)

[Google Developers Training](#)

[Google Developers Certification](#)

[Java Tutorial by W3Schools](#)

[Building Your First Android App in Java](#)

[Getting Started with Java in Visual Studio Code](#)

[Google Java Style Guide](#)

[AOSP Java Code Style for Contributors](#)

[Chromium Java style guide](#)

[Get Started with OR-Tools for Java](#)

[Getting started with Java Tool Installer task for Azure Pipelines](#)

[Gradle User Manual](#)

Tools

[Java SE](#) contains several tools to assist in program development and debugging, and in the monitoring and troubleshooting of production applications.

[JDK Development Tools](#) includes the Java Web Start Tools (javaws) Java Troubleshooting, Profiling, Monitoring and Management Tools (jcmd, jconsole, jmc, jvisualvm); and Java Web Services Tools (schemagen, wsigen, wsimport, xjc).

[Android Studio](#) is the official integrated development environment for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. Available on Windows, macOS, Linux, Chrome OS.

[IntelliJ IDEA](#) is an IDE for Java, but it also understands and provides intelligent coding assistance for a large variety of other languages such as Kotlin, SQL, JPQL, HTML, JavaScript, etc., even if the language expression is injected into a String literal in your Java code.

[NetBeans](#) is an IDE provides Java developers with all the tools needed to create professional desktop, mobile and enterprise applications. Creating, Editing, and Refactoring. The IDE provides wizards and templates to let you create Java EE, Java SE, and Java ME applications.

[Java Design Patterns](#) is a collection of the best formalized practices a programmer can use to solve common problems when designing an application or system.

[Elasticsearch](#) is a distributed RESTful search engine built for the cloud written in Java.

[RxJava](#) is a Java VM implementation of [Reactive Extensions](#): a library for composing asynchronous and event-based programs by using observable sequences. It extends the [observer pattern](#) to support sequences of data/events and adds operators that allow you to compose sequences together declaratively while abstracting away concerns about things like low-level threading, synchronization, thread-safety and concurrent data structures.

[Guava](#) is a set of core Java libraries from Google that includes new collection types (such as multimap and multiset), immutable collections, a graph library, and utilities for concurrency, I/O, hashing, caching, primitives, strings, and more! It is widely used on most Java projects within Google, and widely used by many other companies as well.

[okhttp](#) is a HTTP client for Java and Kotlin developed by Square.

[Retrofit](#) is a type-safe HTTP client for Android and Java developed by Square.

[LeakCanary](#) is a memory leak detection library for Android developed by Square.

[Apache Spark](#) is a unified analytics engine for large-scale data processing. It provides high-level APIs in Scala, Java, Python, and R, and an optimized engine that supports general computation graphs for data analysis. It also supports a rich set of higher-level tools including Spark SQL for SQL and DataFrames, MLlib for machine learning, GraphX for graph processing, and Structured Streaming for stream processing.

[Apache Flink](#) is an open source stream processing framework with powerful stream- and batch-processing capabilities with elegant and fluent APIs in Java and Scala.

[Fastjson](#) is a Java library that can be used to convert Java Objects into their JSON representation. It can also be used to convert a JSON string to an equivalent Java object.

[libGDX](#) is a cross-platform Java game development framework based on OpenGL (ES) that works on Windows, Linux, Mac OS X, Android, your WebGL enabled browser and iOS.

[Jenkins](#) is the leading open-source automation server. Built with Java, it provides over 1700 [plugins](#) to support automating virtually anything, so that humans can actually spend their time doing things machines cannot.

[DBeaver](#) is a free multi-platform database tool for developers, SQL programmers, database administrators and analysts. Supports any database which has JDBC driver (which basically means - ANY database). EE version also supports non-JDBC datasources (MongoDB, Cassandra, Redis, DynamoDB, etc).

[Redisson](#) is a Redis Java client with features of In-Memory Data Grid. Over 50 Redis based Java objects and services: Set, Multimap, SortedSet, Map, List, Queue, Deque, Semaphore, Lock, AtomicLong, Map Reduce, Publish / Subscribe, Bloom filter, Spring Cache, Tomcat, Scheduler, JCache API, Hibernate, MyBatis, RPC, and local cache.

[GraalVM](#) is a universal virtual machine for running applications written in JavaScript, Python, Ruby, R, JVM-based languages like Java, Scala, Clojure, Kotlin, and LLVM-based languages such as C and C++.

[Gradle](#) is a build automation tool for multi-language software development. From mobile apps to microservices, from small startups to big enterprises, Gradle helps teams build, automate and deliver better software, faster. Write in Java, C++, Python or your language of choice.

[Apache Groovy](#) is a powerful, optionally typed and dynamic language, with static-typing and static compilation capabilities, for the Java platform aimed at improving developer productivity thanks to a concise, familiar and easy to learn syntax. It integrates smoothly with any Java program, and immediately delivers to your application powerful features, including scripting capabilities, Domain-Specific Language authoring, runtime and compile-time meta-programming and functional programming.

[JaCoCo](#) is a free code coverage library for Java, which has been created by the Eclemma team based on the lessons learned from using and integration existing libraries for many years.

[Apache JMeter](#) is used to test performance both on static and dynamic resources, Web dynamic applications. It also used to simulate a heavy load on a server, group of servers, network or object to test its strength or to analyze overall performance under different load types.

[JUnit](#) is a simple framework to write repeatable tests. It is an instance of the xUnit architecture for unit testing frameworks.

[Mockito](#) is the most popular Mocking framework for unit tests written in Java.

[SpotBugs](#) is a program which uses static analysis to look for bugs in Java code.

[SpringBoot](#) is a great tool that helps you to create Spring-powered, production-grade applications and services with absolute minimum fuss. It takes an opinionated view of the Spring platform so that new and existing users can quickly get to the bits they need.

[YourKit](#) is a technology leader, creator of the most innovative and intelligent tools for profiling Java & .NET applications.

Go Development

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[Start building with Go on Google Cloud](#)

[Go Documentation](#)

Go Learning Resources

[Go](#) is an open source programming language that makes it easy to build simple, reliable, and efficient software.

[Golang Contribution Guide](#)

[Google Developers Training](#)

[Google Developers Certification](#)

[Uber's Go Style Guide](#)

[GitLab's Go standards and style guidelines](#)

[Effective Go](#)

[Go: The Complete Developer's Guide \(Golang\) on Udemy](#)

[Getting Started with Go on Coursera](#)

[Programming with Google Go on Coursera](#)

[Learning Go Fundamentals on Pluralsight](#)

[Learning Go on Codecademy](#)

Go Tools

[golang tools](#) holds the source for various packages and tools that support the Go programming language.

[Go in Visual Studio Code](#) is an extension that gives you language features like IntelliSense, code navigation, symbol search, bracket matching, snippets, and many more that will help you in Golang development.

[Traefik](#) is a modern HTTP reverse proxy and load balancer that makes deploying microservices easy. Traefik integrates with your existing infrastructure components (Docker, Swarm mode, Kubernetes, Marathon, Consul, Etcd, Rancher, Amazon ECS, etc.) and configures itself automatically and dynamically. Pointing Traefik at your orchestrator should be the only configuration step you need.

[Gitea](#) is Git with a cup of tea, painless self-hosted git service. Using Go, this can be done with an independent binary distribution across all platforms which Go supports, including Linux, macOS, and Windows on x86, amd64, ARM and PowerPC architectures.

[OpenFaaS](#) is Serverless Functions Made Simple. It makes it easy for developers to deploy event-driven functions and microservices to Kubernetes without repetitive, boiler-plate coding. Package your code or an existing binary in a Docker image to get a highly scalable endpoint with auto-scaling and metrics.

[micro](#) is a terminal-based text editor that aims to be easy to use and intuitive, while also taking advantage of the capabilities of modern terminals. As its name indicates, micro aims to be somewhat of a successor to the nano editor by being easy to install and use. It strives to be enjoyable as a full-time editor for people who prefer to work in a terminal, or those who regularly edit files over SSH.

[Gravitational Teleport](#) is a modern security gateway for remotely accessing into Clusters of Linux servers via SSH or SSH-over-HTTPS in a browser or Kubernetes clusters.

[NATS](#) is a simple, secure and performant communications system for digital systems, services and devices. NATS is part of the Cloud Native Computing Foundation (CNCF). NATS has over 30 client language implementations, and its server can run on-premise, in the cloud, at the edge, and even on a Raspberry Pi. NATS can secure and simplify design and operation of modern distributed systems.

[Act](#) is a GO program that allows you to run our GitHub Actions locally.

[Fiber](#) is an [Express](#) inspired web framework built on top of [Fasthttp](#), the fastest HTTP engine for Go. Designed to ease things up for fast development with zero memory allocation and performance in mind.

[Glide](#) is a vendor Package Management for Golang.

[BadgerDB](#) is an embeddable, persistent and fast key-value (KV) database written in pure Go. It is the underlying database for [Dgraph](#), a fast, distributed graph database. It's meant to be a performant alternative to non-Go-based key-value stores like RocksDB.

[Go kit](#) is a programming toolkit for building microservices (or elegant monoliths) in Go. We solve common problems in distributed systems and application architecture so you can focus on delivering business value.

[Codis](#) is a proxy based high performance Redis cluster solution written in Go.

[zap](#) is a blazing fast, structured, leveled logging in Go.

[HttpRouter](#) is a lightweight high performance HTTP request router (also called multiplexer or just mux for short) for Go.

[Gorilla WebSocket](#) is a Go implementation of the WebSocket protocol.

[Delve](#) is a debugger for the Go programming language.

[GORM](#) is a fantastic ORM library for Golang, aims to be developer friendly.

[Go Patterns](#) is a curated collection of idiomatic design & application patterns for Go language.

Python Development

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[Python Documentation](#)

Python Learning Resources

[Python](#) is an interpreted, high-level programming language. Python is used heavily in the fields of Data Science and Machine Learning.

[Python Developer's Guide](#) is a comprehensive resource for contributing to Python – for both new and experienced contributors. It is maintained by the same community that maintains Python.

[Azure Functions Python developer guide](#) is an introduction to developing Azure Functions using Python. The content below assumes that you've already read the [Azure Functions developers guide](#).

[CheckiO](#) is a programming learning platform and a gamified website that teaches Python through solving code challenges and competing for the most elegant and creative solutions.

[Python Institute](#)

[PCEP – Certified Entry-Level Python Programmer certification](#)

[PCAP – Certified Associate in Python Programming certification](#)

[PCPP – Certified Professional in Python Programming 1 certification](#)

[PCPP – Certified Professional in Python Programming 2](#)

[MTA: Introduction to Programming Using Python Certification](#)

[Getting Started with Python in Visual Studio Code](#)

[Google's Python Style Guide](#)

[Google's Python Education Class](#)

[Real Python](#)

[The Python Open Source Computer Science Degree by Forrest Knight](#)

[Intro to Python for Data Science](#)

[Intro to Python by W3schools](#)

[Codecademy's Python 3 course](#)

[Learn Python with Online Courses and Classes from edX](#)

[Python Courses Online from Coursera](#)

Python Frameworks and Tools

[Python Package Index \(PyPI\)](#) is a repository of software for the Python programming language. PyPI helps you find and install software developed and shared by the Python community.

[PyCharm](#) is the best IDE I've ever used. With PyCharm, you can access the command line, connect to a database, create a virtual environment, and manage your version control system all in one place, saving time by avoiding constantly switching between windows.

[Python Tools for Visual Studio\(PTVS\)](#) is a free, open source plugin that turns Visual Studio into a Python IDE. It supports editing, browsing, IntelliSense, mixed Python/C++ debugging, remote Linux/MacOS debugging, profiling, IPython, and web development with Django and other frameworks.

[Pylance](#) is an extension that works alongside Python in Visual Studio Code to provide performant language support. Under the hood, Pylance is powered by Pyright, Microsoft's static type checking tool.

[Pyright](#) is a fast type checker meant for large Python source bases. It can run in a "watch" mode and performs fast incremental updates when files are modified.

[Django](#) is a high-level Python Web framework that encourages rapid development and clean, pragmatic design.

[Flask](#) is a micro web framework written in Python. It is classified as a microframework because it does not require particular tools or libraries.

[Web2py](#) is an open-source web application framework written in Python allowing allows web developers to program dynamic web content. One web2py instance can run multiple web sites using different databases.

[AWS Chalice](#) is a framework for writing serverless apps in python. It allows you to quickly create and deploy applications that use AWS Lambda.

[Tornado](#) is a Python web framework and asynchronous networking library. Tornado uses a non-blocking network I/O, which can scale to tens of thousands of open connections.

[HTTPie](#) is a command line HTTP client that makes CLI interaction with web services as easy as possible. HTTPie is designed for testing, debugging, and generally interacting with APIs & HTTP servers.

[Scrapy](#) is a fast high-level web crawling and web scraping framework, used to crawl websites and extract structured data from their pages. It can be used for a wide range of purposes, from data mining to monitoring and automated testing.

[Sentry](#) is a service that helps you monitor and fix crashes in realtime. The server is in Python, but it contains a full API for sending events from any language, in any application.

[Pipenv](#) is a tool that aims to bring the best of all packaging worlds (bundler, composer, npm, cargo, yarn, etc.) to the Python world.

[Python Fire](#) is a library for automatically generating command line interfaces (CLIs) from absolutely any Python object.

[Bottle](#) is a fast, simple and lightweight [WSGI](#) micro web-framework for Python. It is distributed as a single file module and has no dependencies other than the [Python Standard Library](#).

[CherryPy](#) is a minimalist Python object-oriented HTTP web framework.

[Sanic](#) is a Python 3.6+ web server and web framework that's written to go fast.

[Pyramid](#) is a small and fast open source Python web framework. It makes real-world web application development and deployment more fun and more productive.

[TurboGears](#) is a hybrid web framework able to act both as a Full Stack framework or as a Microframework.

[Falcon](#) is a reliable, high-performance Python web framework for building large-scale app backends and microservices with support for MongoDB, Pluggable Applications and autogenerated Admin.

[Neural Network Intelligence\(NNI\)](#) is an open source AutoML toolkit for automate machine learning lifecycle, including [Feature Engineering](#), [Neural Architecture Search](#), [Model Compression](#) and [Hyperparameter Tuning](#).

[Dash](#) is a popular Python framework for building ML & data science web apps for Python, R, Julia, and Jupyter.

[Luigi](#) is a Python module that helps you build complex pipelines of batch jobs. It handles dependency resolution, workflow management, visualization etc. It also comes with Hadoop support built-in.

[Locust](#) is an easy to use, scriptable and scalable performance testing tool.

[spaCy](#) is a library for advanced Natural Language Processing in Python and Cython.

[NumPy](#) is the fundamental package needed for scientific computing with Python.

[Pillow](#) is a friendly PIL(Python Imaging Library) fork.

[IPython](#) is a command shell for interactive computing in multiple programming languages, originally developed for the Python programming language, that offers enhanced introspection, rich media, additional shell syntax, tab completion, and rich history.

[GraphLab Create](#) is a Python library, backed by a C++ engine, for quickly building large-scale, high-performance machine learning models.

[Pandas](#) is a fast, powerful, and easy to use open source data structures, data analysis and manipulation tool, built on top of the Python programming language.

[PuLP](#) is an Linear Programming modeler written in python. PuLP can generate LP files and call on use highly optimized solvers, GLPK, COIN CLP/CBC, CPLEX, and GUROBI, to solve these linear problems.

[Matplotlib](#) is a 2D plotting library for creating static, animated, and interactive visualizations in Python. Matplotlib produces publication-quality figures in a variety of hardcopy formats and interactive environments across platforms.

[Scikit-Learn](#) is a simple and efficient tool for data mining and data analysis. It is built on NumPy,SciPy, and matplotlib.

TypeScript Development

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[Start building with TypeScript on Google Cloud](#)

[Using TypeScript for Cloud Functions on Firebase](#)

TypeScript Learning Resources

[TypeScript](#) is a language for application-scale JavaScript. TypeScript adds optional types to JavaScript that support tools for large-scale JavaScript applications for any browser, for any host, on any OS. TypeScript compiles to readable, standards-based JavaScript.

[TypeScript support for Webpack](#)

[TypeScript Support for Nuxt.js](#)

[TypeScript Support for Vue.js](#)

[TypeScript Support for React Native](#)

[TypeScript Support for Angular](#)

[Ionic/TypeScript Starter Project](#)

[GitHub Actions for JavaScript and TypeScript](#)

Tools

[WebStorm](#) is a professional IDE for JavaScript(including support for both HTML and CSS) developed by JetBrains. WebStorm comes with intelligent code completion, on-the-fly error detection, powerful navigation and refactoring for JavaScript, TypeScript, stylesheet languages, and all the most popular frameworks([Angular](#), [React](#), [Vue.js](#), [Ionic](#), [Apache Cordova](#), [React Native](#), [Node.js](#), [Meteor](#), and [Electron](#)).

[ReSharper](#) is a Visual Studio Extension for .NET Developers. It comes with code quality analysis, which is available in C#, VB.NET, XAML, ASP.NET, ASP.NET MVC, JavaScript, TypeScript, CSS, HTML, and XML. You'll know right away if your code needs to be improved. ReSharper is one of many powerful tools developed by [JetBrains](#).

[ts-migrate](#) is a tool for helping migrate code to TypeScript. It takes a JavaScript, or a partial TypeScript, project in and gives a compiling TypeScript project out. ts-migrate is intended to accelerate the TypeScript migration process. The resulting code will pass the build, but a followup is required to improve type safety.

[Deno](#) is a simple, modern and secure runtime for JavaScript and TypeScript that uses V8 and is built in Rust.

[gulp-typescript](#) is an TypeScript compiler for gulp with incremental compilation support.

[React](#) is a declarative, efficient, and flexible JavaScript library for building user interfaces.

[React Native](#) is a framework for building native apps for iOS and Android with React.

[Vue.js](#) is a progressive, incrementally-adoptable JavaScript framework for building UI on the web.

[Angular](#) is a development platform for building mobile and desktop web applications using Typescript/JavaScript and other languages.

[Ionic Framework](#) is a powerful cross-platform UI toolkit for building native-quality iOS, Android, and Progressive Web Apps with HTML, CSS, and JavaScript.

[Stencil](#) is a simple compiler for generating Web Components and static site generated progressive web apps (PWA). Stencil was built by the Ionic team for its next generation of performant mobile and desktop Web Components.

[Storybook](#) is a development environment for UI components. It allows you to browse a component library, view the different states of each component, and interactively develop and test components. It works with React, Vue, Angular, Ember, and other web frameworks.

[Prettier](#) is an opinionated code formatter. It enforces a consistent style by parsing your code and re-printing it with its own rules that take the maximum line length into account, wrapping code when necessary.

[Nest](#) is a framework for building efficient, scalable [Node.js](#) server-side applications. It is built with TypeScript and combines elements of Object Oriented Programming(OOP), Functional Programming, and Functional Reactive Programming(FRP).

[Definitely Typed](#) is a repository for high quality TypeScript type definitions.

[TypeORM](#) is an ORM that can run in NodeJS, Browser, Cordova, PhoneGap, Ionic, React Native, NativeScript, Expo, and Electron platforms and can be used with TypeScript and JavaScript (ES5, ES6, ES7, ES8).

[NativeScript](#) empowers you to access native APIs from JavaScript directly. The framework currently provides iOS and Android runtimes for rich mobile development and can be utilized in a number of diverse use cases.

[AssemblyScript](#) compiles a strict variant of TypeScript to [WebAssembly](#) using [Binaryen](#).

[React Hook Form](#) is a performant, flexible and extensible forms with easy to use validation(Web + React Native).

[Apollo Client](#) is a fully-featured caching GraphQL client with integrations for React, Angular, and more. It allows you to easily build UI components that fetch data via GraphQL.

[TensorFlow.js](#) is an open-source WebGL hardware-accelerated JavaScript library for training and deploying machine learning models.

[Rome](#) is a linter, compiler, bundler, and [more](#) for JavaScript, TypeScript, JSON, HTML, Markdown, and CSS.

[Eclipse Theia](#) is an extensible platform to develop full-fledged multi-language Cloud & Desktop IDE-like products with state-of-the-art web technologies.

[InversifyJS](#) is a powerful and lightweight inversion of control(IoC) container for JavaScript & Node.js apps powered by TypeScript. An IoC container uses a class constructor to identify and inject its dependencies.

[Gatsby](#) is a free and open source framework based on React that helps developers build blazing fast websites and apps.

[Meteor](#) is an ultra-simple environment for building modern web applications with JavaScript.

[TypeScript ESLint](#) is a monorepo for all the tooling which enables ESLint to support TypeScript.

[TS node](#) is a TypeScript execution and REPL for node.js.

.NET Development

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[Start building with .NET on Google Cloud](#)

[.NET Documentation](#)

.NET Learning Resources

[.NET](#) is a developer platform with tools and libraries for building any type of app, including web, mobile, desktop, games, IoT, cloud, and microservices.

[.NET documentation](#)

[Getting started with .NET](#)

[.NET Application Architecture Guide](#)

[Intro .NET Guide by JetBrains](#)

[C# documentation](#) write any application using the C# programming language on the .NET platform.

Tools

[.NET Core](#) is a cross-platform .NET implementation for websites, servers, and console apps on Windows, Linux, and macOS. The .NET Framework supports websites, services, desktop apps, and more on Windows. Xamarin/Mono is a .NET implementation for running apps on all the major mobile operating systems.

[.NET runtime](#) is a collection of libraries and shared host (dotnet) installers for all supported platforms, as well as the sources to .NET runtime and libraries.

[ASP.NET Core](#) is a cross-platform .NET framework for building modern cloud-based web applications on Windows, Mac, or Linux.

[Mono](#) is a software platform designed to allow developers to easily create cross platform applications. It is an open source implementation of Microsoft's .NET Framework based on the ECMA standards for C# and the Common Language Runtime.

[Visual Studio](#) is an integrated development environment (IDE) from Microsoft; which is a feature-rich application that can be used for many aspects of software development. Visual Studio makes it easy to edit, debug, build, and publish your app. By using Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, and Windows Store.

[Rider](#) is a fast and powerful, cross-platform .NET IDE developed by JetBrains to develop .NET, ASP.NET, .NET Core, Xamarin, or Unity applications for Windows, Mac, Linux.

[Resharper](#) is a [Visual Studio](#) Extension for .NET Developers that has On-the-fly code quality analysis for C#, VB.NET, XAML, ASP.NET, ASP.NET MVC, JavaScript, TypeScript, CSS, HTML, and XML. Letting you know right away if your code needs to be improved.

[dotTrace](#) is an .NET performance Profiler developed by Jet Brains. It helps users locate performance bottlenecks in a variety of .NET applications: desktop applications, .NET Core, ASP.NET, ASP.NET Core applications hosted on IIS or IIS Express web servers, Silverlight, WCF services, Windows services, Universal Windows Platform applications, and unit tests.

[dotMemory](#) is an .NET memory Profiler developed by Jet Brains. It allows the user to analyze memory usage in a variety of .NET and .NET Core applications: desktop applications, Windows services, ASP.NET web applications, IIS, IIS Express, arbitrary .NET processes, and more.

[dotCover](#) is an .NET unit test runner and code coverage tool developed by Jet Brains. It helps the user figure out on-the-fly which unit tests are affected by your latest code changes, and automatically re-runs the affected tests for you. The continuous testing mode can be switched on for any unit test session.

[Avalonia](#) is a cross-platform XAML-based UI framework providing a flexible styling system and supporting a wide range of Operating Systems such as Windows via .NET Framework and .NET Core, Linux via Xorg, macOS.

[Polly](#) is a .NET resilience and transient-fault-handling library that allows developers to express policies such as Retry, Circuit Breaker, Timeout, Bulkhead Isolation, and Fallback in a fluent and thread-safe manner.

[IdentityServer](#) is a free, open source [OpenID Connect](#) and [OAuth 2.0](#) framework for ASP.NET Core. IdentityServer4 incorporates all the protocol implementations and extensibility points needed to integrate token-based authentication, single-sign-on and API access control in your applications.

[ILSpy](#) is the open-source .NET assembly browser and decompiler.

[Hangfire](#) is an easy way to perform background job processing in your .NET and .NET Core applications with no Windows Service or Task Scheduler required.

[React Native Windows](#) is a framework for building native Windows apps with React. [React Native](#) is a framework developed by Facebook that enables you to build world-class application experiences on native platforms using a consistent developer experience based on JavaScript and React.

[ReactiveUI](#) is a composable, cross-platform model-view-viewmodel framework for all .NET platforms that is inspired by functional reactive programming, which is a paradigm that allows you to abstract mutable state away from your user interfaces and express the idea around a feature in one readable place and improve the testability of your application.

[Refit](#) is the automatic type-safe REST library for .NET Core, Xamarin and .NET. It's heavily inspired by Square's Retrofit library, Refit turns your REST API into a live interface.

[MAUI](#) is the .NET Multi-platform App UI, a framework for building native device applications spanning mobile, tablet, and desktop.

[Quasar](#) is a fast and light-weight remote administration tool coded in C#. The usage ranges from user support through day-to-day administrative work to employee monitoring. Providing high stability and an easy-to-use user interface, Quasar is the perfect remote administration solution for you.

Ruby Development

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[Start building with Ruby on Google Cloud](#)

[Ruby Documentation](#)

Ruby Learning Resources

[Ruby](#) is a dynamic, open source programming language with a focus on simplicity and productivity. It has an elegant syntax that is natural to read and easy to write.

[Ruby Documentation](#)

[Ruby Community](#)

[Ruby Gems](#)

[Ruby courses by Coursera](#)

[Learn Ruby course by Codecademy](#)

[Ruby Glossary](#)

[Ruby in Twenty Minutes Quickstart](#)

[Getting started with a Ruby on Rails application on CircleCI.](#)

[The Ruby Style Guide](#)

[Airbnb's Ruby Style Guide](#)

Tools

[RubyMine](#) is a professional IDE developed by Jet Brains that provides support for Ruby, Ruby on Rails and web development.

[Rails](#) is a web-application framework that includes everything needed to create database-backed web applications according to the [Model-View-Controller \(MVC\)](#) pattern. Understanding the MVC pattern is key to understanding Rails. MVC divides your application into three layers: Model, View, and Controller, each with a specific responsibility.

[rbenv](#) allows to pick a Ruby version for your application and guarantee that your development environment matches production. Put rbenv to work with Bundler for painless Ruby upgrades and bulletproof deployments.

[Prettier for Ruby](#) is a plugin for the Ruby programming language and its ecosystem. prettier is an opinionated code formatter that supports multiple languages and integrates with most editors. The idea is to eliminate discussions of style in code review and allow developers to get back to thinking about code design instead.

[Active Admin](#) is a Ruby on Rails framework for creating elegant backends for website administration.

[Capistrano](#) is a framework for building automated deployment scripts. Although Capistrano itself is written in Ruby, it can easily be used to deploy projects of any language or framework, be it Rails, Java, or PHP.

[Spree](#) is an open source E-commerce platform for Rails 6 with a modern UX, optional PWA frontend, REST API, GraphQL, several official extensions and 3rd party integrations.

[Sidekiq](#) is a simple, efficient background processing for Ruby. It uses hreads to handle many jobs at the same time in the same process. It does not require Rails but will integrate tightly with Rails to make background processing dead simple.

[Kaminari](#) is a Scope and Engine based, clean, powerful, and customizable paginator for modern web app frameworks and ORMs.

[React-Rails](#) is a flexible tool to use [React](#) with Rails. By integrating React.js with Rails views and controllers, the asset pipeline, or webpacker.

[Pry](#) is a runtime developer console and IRB alternative with powerful introspection capabilities.

[Brakeman](#) is a static analysis tool which checks Ruby on Rails applications for security vulnerabilities.

[dotenv](#) is a Ruby gem to load environment variables from `.env`.

[Scientist](#) is a Ruby library for carefully refactoring critical paths.

[fastlane](#) is a tool written in Ruby for iOS and Android developers to automate tedious tasks like generating screenshots, dealing with provisioning profiles, and releasing your application.

[Fluentd](#) collects events from various data sources and writes them to files, RDBMS, NoSQL, IaaS, SaaS, Hadoop and so on all written in Ruby.

PHP Development

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[Start building with PHP on Google Cloud](#)

[PHP Documentation](#)

PHP Learning Resources

[PHP](#) is a popular general-purpose scripting language that is especially suited to web development. Fast, flexible and pragmatic, PHP powers everything from your blog to the most popular websites in the world.

[PHP 8](#)

[What's New in PHP 8 - Auth0](#)

[PHP Manual](#)

[MIT's PHP Code Style Guide](#)

[PHP Style Guide](#)

[PHP tutorial by W3Schools](#)

[PHP MySQL & CodeIgniter Course on Udemy](#)

Tools

[PhpStorm](#) is a professional PHP IDE developed by Jet Brains for working with Symfony, Laravel, Drupal, WordPress, Laminas, Magento, Joomla!, CakePHP, Yii, and other frameworks.

[Laravel](#) is a web application framework with expressive, elegant syntax. We believe development must be an enjoyable and creative experience to be truly fulfilling.

[PHP Tools for Visual Studio/VS Code](#) is an extension that turns Visual Studio into a powerful PHP development environment.

[Symfony](#) is a PHP framework for web and console applications and a set of reusable PHP components. Symfony is used by thousands of web applications (including BlaBlaCar.com and Spotify.com) and most of the [popular PHP projects](#) (including Drupal and Magento).

[CakePHP](#) is a rapid development framework for PHP which uses commonly known design patterns like Associative Data Mapping, Front Controller, and MVC. CakePHP's main goal is to provide a structured framework that enables PHP users at all levels to rapidly develop robust web applications, without any loss to flexibility.

[Composer](#) is a tool that helps you declare, manage, and install dependencies of PHP projects.

[Guzzle](#) is a PHP HTTP client that makes it easy to send HTTP requests and trivial to integrate with web services.

[DesignPatternsPHP](#) is a collection of known design patterns and some sample code how to implement them in PHP 7.4. Every pattern has a small list of examples.

[CodeIgniter](#) is an Application Development Framework for people who build web sites using PHP. Its goal is to enable you to develop projects much faster than you could if you were writing code from scratch, by providing a rich set of libraries for commonly needed tasks, as well as a simple interface and logical structure to access these libraries. CodeIgniter lets you creatively focus on your project by minimizing the amount of code needed for a given task.

[HHVM](#) is an open-source virtual machine designed for executing programs written in [Hack](#). HHVM uses a just-in-time (JIT) compilation approach to achieve superior performance while maintaining amazing development flexibility. HHVM should be used together with a webserver like the built in, easy to deploy [Proxygen](#), or a [FastCGI-based](#) webserver on top of nginx or Apache.

[PHPUnit](#) is a programmer-oriented testing framework for PHP. It is an instance of the xUnit architecture for unit testing frameworks.

[Phalcon](#) is an open source web framework delivered as a C extension for the PHP language providing high performance and lower resource consumption.

[Swoole](#) is an event-driven asynchronous & coroutine-based concurrency networking communication engine with high performance written in C and C++ for PHP.

[Matomo](#) is a full-featured PHP MySQL software program that you download and install on your own webserver. At the end of the five-minute installation process, you will be given a JavaScript code. Simply copy and paste this tag on websites you wish to track and access your analytics reports in real-time.

[Grav](#) is a Fast, Simple, and Flexible, file-based Web-platform. There is Zero installation required. Just extract the ZIP archive, and you are already up and running. It follows similar principles to other flat-file CMS platforms, but has a different design philosophy than most. Grav comes with a powerful Package Management System to allow for simple installation and upgrading of plugins and themes, as well as simple updating of Grav itself.

[Whoops](#) is an error handler framework for PHP. Out-of-the-box, it provides a pretty error interface that helps you debug your web projects, but at heart it's a simple yet powerful stacked error handling system.

[Slim](#) is a PHP micro framework that helps you quickly write simple yet powerful web applications and APIs.

Bash/PowerShell Development

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[Start building with PowerShell on Google Cloud](#)

[PowerShell Documentation](#)

Bash/PowerShell Learning Resources

[Introduction to Bash Shell Scripting by Coursera](#)

[Bash: Shell Script Basics by Pluralsight](#)

[Bash/Shell by Codecademy](#)

[Windows Remote Management in Ansible using PowerShell](#)

[Getting Started with PowerShell](#)

[PowerShell in Azure Cloud Shell](#)

[Azure Functions using PowerShell](#)

[Azure Automation runbooks](#)

[Using Visual Studio Code for PowerShell Development](#)

[Integrated Terminal in Visual Studio Code](#)

[AWS Tools for Windows PowerShell](#)

[PowerShell Best Practices and Style Guide](#)

[AWS Command Line Interface and aws-shell Sample for AWS Cloud9](#)

[Configuring Cloud Shell on Google Cloud](#)

[Google's Shell Style Guide](#)

Bash/ PowerShell Tools

[Bash](#) is the GNU Project's shell(Bourne Again SHell), which is an sh-compatible shell that integrates together useful features from the Korn shell (ksh) and the C shell (csh).

[PowerShell Core](#) is a cross-platform (Windows, Linux, and macOS) automation and configuration tool/framework that works well with your existing tools and is optimized for dealing with structured data (JSON, CSV, XML, etc.), REST APIs, and object models. It also includes a command-line shell, an associated scripting language and a framework for processing cmdlets.

[Azure PowerShell](#) is a set of cmdlets for managing Microsoft Azure resources directly from the PowerShell command line.

[Windows Subsystem for Linux \(WSL\)](#) is a compatibility layer developed by Microsoft for running Linux binary executables in a Executable/Linkable Format natively on Windows 10 and Windows Server.

[AWS Shell](#) is a command-line shell program that provides convenience and productivity features to help both new and advanced users of the AWS Command Line Interface.

[Google Cloud Shell](#) is a free admin machine with browser-based command-line access for managing your infrastructure and applications on Google Cloud Platform.

[VS Code Bash Debug](#) is a bash debugger GUI frontend based on awesome bashdb scripts (bashdb now included in package).

[VS Code Bash IDE](#) is a Visual Studio Code extension utilizing the [bash language server](#), that is based on [Tree Sitter](#) and its [grammar for Bash](#) and supports [explainshe](#)ll integration.

C/C++ Development

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[C++ Client Libraries for Google Cloud Services](#)

C/C++ Learning Resources

[C++](#) is a cross-platform language that can be used to build high-performance applications developed by Bjarne Stroustrup, as an extension to the C language.

[C](#) is a general-purpose, high-level language that was originally developed by Dennis M. Ritchie to develop the UNIX operating system at Bell Labs. It supports structured programming, lexical variable scope, and recursion, with a static type system. C also provides constructs that map efficiently to typical machine instructions, which makes it one of the most widely used programming languages today.

[Embedded C](#) is a set of language extensions for the C programming language by the [C Standards Committee](#) to address issues that exist between C extensions for different [embedded systems](#). The extensions help enhance microprocessor features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations. This makes Embedded C the most popular embedded software language in the world.

[C & C++ Developer Tools from JetBrains](#)

[Open source C++ libraries on cppreference.com](#)

[C++ Graphics libraries](#)

[C++ Libraries in MATLAB](#)

[C++ Tools and Libraries Articles](#)

[Google C++ Style Guide](#)

[Introduction C++ Education course on Google Developers](#)

[C++ style guide for Fuchsia](#)

[C and C++ Coding Style Guide by OpenTitan](#)

[Chromium C++ Style Guide](#)

[C++ Core Guidelines](#)

[C++ Style Guide for ROS](#)

[Learn C++](#)

[Learn C : An Interactive C Tutorial](#)

[C++ Institute](#)

[C++ Online Training Courses on LinkedIn Learning](#)

[C++ Tutorials on W3Schools](#)

[Learn C Programming Online Courses on edX](#)

[Learn C++ with Online Courses on edX](#)

[Learn C++ on Codecademy](#)

[Coding for Everyone: C and C++ course on Coursera](#)

[C++ For C Programmers on Coursera](#)

[Top C Courses on Coursera](#)

[C++ Online Courses on Udemy](#)

[Top C Courses on Udemy](#)

[C++ For Programmers Course on Udacity](#)

[C++ Fundamentals Course on Pluralsight](#)

[Introduction to C++ on MIT Free Online Course Materials](#)

[Introduction to C++ for Programmers | Harvard](#)

[Online C Courses | Harvard University](#)

C/C++ Tools

[Visual Studio](#) is an integrated development environment (IDE) from Microsoft; which is a feature-rich application that can be used for many aspects of software development. Visual Studio makes it easy to edit, debug, build, and publish your app. By using Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, and Windows Store.

[Visual Studio Code](#) is a code editor redefined and optimized for building and debugging modern web and cloud applications.

[Vcpkg](#) is a C++ Library Manager for Windows, Linux, and MacOS.

[ReSharper C++](#) is a Visual Studio Extension for C++ developers developed by JetBrains.

[AppCode](#) is constantly monitoring the quality of your code. It warns you of errors and smells and suggests quick-fixes to resolve them automatically. AppCode provides lots of code inspections for Objective-C, Swift, C/C++, and a number of code inspections for other supported languages. All code inspections are run on the fly.

[CLion](#) is a cross-platform IDE for C and C++ developers developed by JetBrains.

[Code::Blocks](#) is a free C/C++ and Fortran IDE built to meet the most demanding needs of its users. It is designed to be very extensible and fully configurable. Built around a plugin framework, Code::Blocks can be extended with plugins.

[CppSharp](#) is a tool and set of libraries which facilitates the usage of native C/C++ code with the .NET ecosystem. It consumes C/C++ header and library files and generates the necessary glue code to surface the native API as a managed API. Such an API can be used to consume an existing native library in your managed code or add managed scripting support to a native codebase.

[Conan](#) is an Open Source Package Manager for C++ development and dependency management into the 21st century and on par with the other development ecosystems.

[High Performance Computing \(HPC\) SDK](#) is a comprehensive toolbox for GPU accelerating HPC modeling and simulation applications. It includes the C, C++, and Fortran compilers, libraries, and analysis tools necessary for developing HPC applications on the NVIDIA platform.

[Thrust](#) is a C++ parallel programming library which resembles the C++ Standard Library. Thrust's high-level interface greatly enhances programmer productivity while enabling performance portability between GPUs and multicore CPUs. Interoperability with established technologies such as CUDA, TBB, and OpenMP integrates with existing software.

[Boost](#) is an educational opportunity focused on cutting-edge C++. Boost has been a participant in the annual Google Summer of Code since 2007, in which students develop their skills by working on Boost Library development.

[Automake](#) is a tool for automatically generating Makefile.in files compliant with the GNU Coding Standards. Automake requires the use of GNU Autoconf.

[Cmake](#) is an open-source, cross-platform family of tools designed to build, test and package software. CMake is used to control the software compilation process using simple platform and compiler independent configuration files, and generate native makefiles and workspaces that can be used in the compiler environment of your choice.

[GDB](#) is a debugger, that allows you to see what is going on 'inside' another program while it executes or what another program was doing at the moment it crashed.

[GCC](#) is a compiler Collection that includes front ends for C, C++, Objective-C, Fortran, Ada, Go, and D, as well as libraries for these languages.

[GSL](#) is a numerical library for C and C++ programmers. It is free software under the GNU General Public License. The library provides a wide range of mathematical routines such as random number generators, special functions and least-squares fitting. There are over 1000 functions in total with an extensive test suite.

[OpenGL Extension Wrangler Library \(GLEW\)](#) is a cross-platform open-source C/C++ extension loading library. GLEW provides efficient run-time mechanisms for determining which OpenGL extensions are supported on the target platform.

[Libtool](#) is a generic library support script that hides the complexity of using shared libraries behind a consistent, portable interface. To use Libtool, add the new generic library building commands to your Makefile, Makefile.in, or Makefile.am.

[Maven](#) is a software project management and comprehension tool. Based on the concept of a project object model (POM), Maven can manage a project's build, reporting and documentation from a central piece of information.

[TAU \(Tuning And Analysis Utilities\)](#) is capable of gathering performance information through instrumentation of functions, methods, basic blocks, and statements as well as event-based sampling. All C++ language features are supported including templates and namespaces.

[Clang](#) is a production quality C, Objective-C, C++ and Objective-C++ compiler when targeting X86-32, X86-64, and ARM (other targets may have caveats, but are usually easy to fix). Clang is used in production to build performance-critical software like Google Chrome or Firefox.

[OpenCV](#) is a highly optimized library with focus on real-time applications. Cross-Platform C++, Python and Java interfaces support Linux, MacOS, Windows, iOS, and Android.

[Libc++](#) is the NVIDIA C++ Standard Library for your entire system. It provides a heterogeneous implementation of the C++ Standard Library that can be used in and between CPU and GPU code.

[ANTLR \(ANOther Tool for Language Recognition\)](#) is a powerful parser generator for reading, processing, executing, or translating structured text or binary files. It's widely used to build languages, tools, and frameworks. From a grammar, ANTLR generates a parser that can build parse trees and also generates a listener interface that makes it easy to respond to the recognition of phrases of interest.

[Qt++](#) is a light and powerful C++ web framework for highly scalable and resource-efficient web application. It's zero-dependency and easy-portable.

[JavaCPP](#) is a program that provides efficient access to native C++ inside Java, not unlike the way some C/C++ compilers interact with assembly language.

[Cython](#) is a language that makes writing C extensions for Python as easy as Python itself. Cython is based on Pyrex, but supports more cutting edge functionality and optimizations such as calling C functions and declaring C types on variables and class attributes.

[Spdlog](#) is a very fast, header-only/compiled, C++ logging library.

[Infer](#) is a static analysis tool for Java, C++, Objective-C, and C. Infer is written in [OCaml](#).

Rust Development

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[unofficial Google Cloud Storage API for Rust](#)

[unofficial gCloud client for Rust](#)

Rust Learning Resources

[Rust](#) is a multi-paradigm programming language focused on performance and safety. Rust has a comparable amount of runtime to C and C++, and has set up its standard library to be amenable towards OS development. Specifically, the standard library is split into two parts: core and std. Core is the lowest-level aspects only, and doesn't include things like allocation, threading, and other higher-level features.

[The Rust Language Reference](#)

[The Rust Programming Language Book](#)

[Learning Rust](#)

[Why AWS loves Rust](#)

[Rust Programming courses on Udemy](#)

[Safety in Systems Programming with Rust at Standford by Ryan Eberhardt](#)

[WebAssembly meets Kubernetes with Krustlet using Rust](#)

[Microsoft's Project Verona](#)

Rust Tools

[Cargo](#) is a package manager that downloads your Rust project's dependencies and compiles your project.

[Crater](#) is a tool to run experiments across parts of the Rust ecosystem. Its primary purpose is to detect regressions in the Rust compiler, and it does this by building a large number of crates, running their test suites and comparing the results between two versions of the Rust compiler. It can operate locally (with Docker as the only dependency) or distributed on the cloud. It can operate locally (with Docker as the only dependency) or distributed on the cloud.

[VSCode-Rust](#) is plugin that adds language support for Rust to Visual Studio Code. Rust support is powered by a separate language server - either by the official Rust Language Server (RLS) or rust-analyzer, depending on the user's preference. If you don't have it installed, the extension will install it for you (with permission). This extension is built and maintained by the Rust IDEs and editors team with the focus on providing a stable, high quality extension that makes the best use of the respective language server.

[Apache Arrow](#) is a development platform for in-memory analytics. It contains a set of technologies that enable big data systems to process and move data fast. Arrow's libraries are available for C, C++, C#, Go, Java, JavaScript, MATLAB, Python, R, Ruby, and Rust.

[Wasmer](#) enables super lightweight containers based on [WebAssembly](#) that can run anywhere such as the Desktop to the Cloud and IoT devices, and also embedded in [any programming language](#).

[Firecracker](#) is an open source virtualization technology that is purpose-built for creating and managing secure, multi-tenant container and function-based services that provide serverless operational models. Firecracker runs workloads in lightweight virtual machines, called microVMs, which combine the security and isolation properties provided by hardware virtualization technology with the speed and flexibility of containers. Firecracker has also been integrated in container runtimes, for example [Kata Containers](#) and [Weaveworks Ignite](#).

[Tokio](#) is an event-driven, non-blocking I/O platform for writing asynchronous applications with the Rust programming language.

[TiKV](#) is an open-source distributed transactional key-value database that also provides classical key-value APIs, but also transactional APIs with ACID compliance.

[Sonic](#) is a fast, lightweight and schema-less search backend similar to Elasticsearch in some use-cases.

[Hyper](#) is a fast and correct HTTP library for Rust.

[Rocket](#) is an async web framework for Rust with a focus on usability, security, extensibility, and speed.

[Clippy](#) is a collection of lints to catch common mistakes and improve your Rust code.

[Servo](#) is a prototype web browser engine written in the Rust language.

[Vector](#) is a high-performance, end-to-end (agent & aggregator) observability data platform that puts the user in control of their observability data.

[RustPython](#) is a Python Interpreter written in Rust.

[Miri](#) is an interpreter for Rust's mid-level intermediate representation. It can run binaries and test suites of cargo projects and detect certain classes of undefined behavior. Miri will also tell you about memory leaks: when there is memory still allocated at the end of the execution, and that memory is not reachable from a global static, Miri will raise an error.

[Chalk](#) is an implementation and definition of the Rust trait system using a PROLOG-like logic solver.

[stdarch](#) is Rust's standard library vendor-specific APIs and run-time feature detection.

[Simpleinfra](#) is a repo that contains the tools and automation written by the Rust infrastructure team to manage our services. Using some of the tools in this repo require privileges only infra team members have.

[Rustlings](#) is a small set of exercises to get you used to reading and writing Rust code.

[Krustlet](#) acts as a Kubernetes Kubelet(written in Rust) by listening on the event stream for new pods that the scheduler assigns to it based on specific Kubernetes [tolerations](#). The project is currently experimental.

Operating System

[Redox](#) is a Unix-like Operating System written in Rust, aiming to bring the innovations of Rust to a modern microkernel and full set of applications. Actively being developed by [Jeremy Soeller](#).

[Bottlerocket OS](#) is an open-source Linux-based operating system meant for hosting containers. Bottlerocket focuses on security and maintainability, providing a reliable, consistent, and safe platform for container-based workloads.

[Tock](#) is an embedded operating system designed for running multiple concurrent, mutually distrustful applications on Cortex-M and RISC-V based embedded platforms. Tock's design centers around protection, both from potentially malicious applications and from device drivers. Tock uses two mechanisms to protect different components of the operating system. First, the kernel and device drivers are written in Rust, a systems programming language that provides compile-time memory safety, type safety and strict aliasing. Tock uses Rust to protect the kernel (the scheduler and hardware abstraction layer) from platform specific device drivers as well as isolate device drivers from each other. Second, Tock uses memory protection units to isolate applications from each other and the kernel.

[Rust on Chrome OS](#) is a document that provides information on creating Rust projects for installation within Chrome OS and Chrome OS SDK.

[Writing an OS in Rust](#) is a blog series creates a small operating system in the Rust programming language by [Philipp Oppermann](#).

Contribute

- If would you like to contribute to this guide simply make a [Pull Request](#).

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