

# MODULE-5

## CASE STUDIES

### Microsoft Azure:

Microsoft Azure (formerly Windows Azure) is the cloud computing service from Microsoft. Enabled primarily through Microsoft-managed data centers, this service proves to be a reliable solution, especially for Microsoft evangelists. Like the above solutions, it supports the development, test, deployment, and management of applications and services. For web development, it offers support for PHP, ASP.net, and Node.js.

The Windows Azure is used to deploy code on Microsoft's servers. This code holds access to local storage resources (blobs, queues, and tables). While the SQL Azure it is not a full SQL Server instance it can be integrated with SQL Server. The security features like authentication, security, etc. are supported using Azure AppFabric that allows applications within your LAN to communicate with Azure cloud. Overall it is a complete package that supports development, management as well security of applications.

### What is Microsoft Azure?

Azure is a cloud computing platform which was launched by Microsoft in February 2010. It is an open and flexible cloud platform which helps in development, data storage, service hosting, and service management. The Azure tool hosts web applications over the internet with the help of Microsoft data centres.

### Types of Azure Clouds

There are mainly three types of clouds in Microsoft Azure are:

1. PAAS
2. SAAS
3. IASS



## **Azure as IaaS**

IaaS (Infrastructure as a Service) is the foundational cloud platform layer. This Azure service is used by IT administrators for processing, storage, networks or any other fundamental computer operations. It allows users to run arbitrary software.

### **Advantages:**

- It offers efficient design time portability
- It is advisable for the application which needs complete control
- IaaS offers quick transition of services to clouds
- The apparent benefit of IaaS is that it frees you from the concerns of setting up many physical or virtual machines.
- Helps you to access, monitor and manage datacenters

### **Disadvantages of IaaS:**

- Plenty of security risks from unpatched servers
- Some companies have defined processes for testing and updating on-premise servers vulnerabilities. This cannot be done with Azure.

## **Azure as PaaS**

PaaS is a computing platform which includes an operating system, programming language execution environment, database or web services. This Azure service is used by developers and application providers.

As its name suggests, this platform is provided to the client to develop and deploy software. It allows the client to focus on application development instead of worrying about hardware and infrastructure. It also takes care of operating systems, networking and servers issues.

### **Advantages:**

- The total cost is low as the resources are allocated on demand and servers are automatically added or subtracted.
- Azure is less vulnerable because servers are automatically checked for all known security issues
- The entire process is not visible to the developer, so it does not have a risk of a data breach

### **Disadvantages:**

- Portability issues can occur when you use PaaS services
- There may be different environment at Azure, so the application needs to adapt accordingly.

## Azure As SaaS

SaaS (Software as a Service) is software which is centrally hosted and managed. It is a single version of the application is used for all customers. You can scale out to multiple instances. This helps you to ensure the best performance in all locations. The software is licensed through a monthly or annual subscription. MS Exchange, Office, Dynamics are offered as a SaaS

## Azure key Concepts

Concept Name	Description
Regions	Azure is a global cloud platform which is available across various regions around the world. When you request a service, application, or VM in Azure, you are first asked to specify a region. The selected region represents datacenter where your application runs.
Datacenter	In Azure, you can deploy your applications into a variety of data centers around the globe. So, it is advisable to select a region which is closer to most of your customers. It helps you to reduce latency in network requests.
Azure portal	The Azure portal is a web-based application which can be used to create, manage and remove Azure resource and services. It is located at <a href="https://portal.azure.com">https://portal.azure.com</a> .
Resources	Azure resource is an individual computer, networking data or app hosting services which charged individually. Some common resources are virtual machines( VM), storage account, or SQL databases.
Resource groups	An Azure resource group is a container which holds related resource for an Azure solution. It may include every resource or just resource which you wants to manage.
Resource Manager templates	It is a JSON which defines one or more resource to deploy to a resource group. It also establishes dependencies between deployed resources.
Automation:	Azure allows you to automate the process of creating, managing and deleting resource by using PowerShell or the Azure command-line

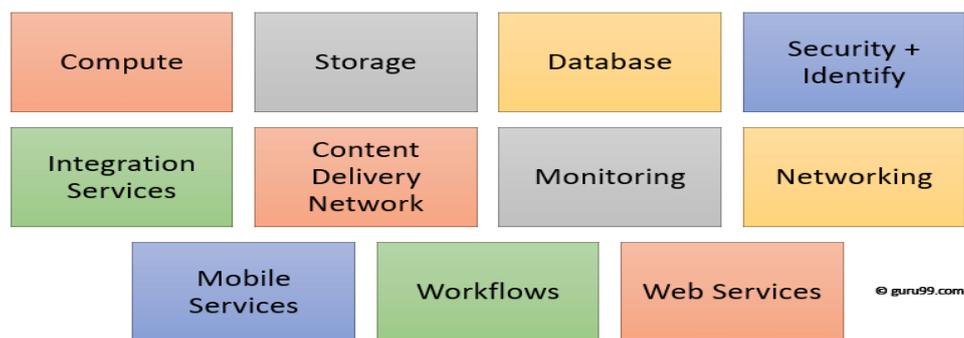
Interface (CLI).

**Azure PowerShell** PowerShell is a set of modules that offer cmdlets to manage Azure. In most cases, you are allowed to use, the cmdlets command for the same tasks which you are performing in the Azure portal.

**Azure command-line interface(CLI)** The Azure CLI is a tool that you can use to create, manage, and remove Azure resources from the command line.

**REST APIs** Azure is built on a set of REST APIs help you perform the same operation that you do in Azure portal UI. It allows your Azure resources and apps to be manipulated via any third party software application.

## Azure Domains (Components)



Key Azure Components

## Compute

It offers computing operations like app hosting, development, and deployment in Azure Platform. It has the following components:

- **Virtual Machine:** Allows you to deploy any language, workload in any operating system.
- **Virtual Machine Scale Sets:** Allows you to create thousands of similar virtual machines in minutes.
- **Azure Container Service:** Create a container hosting solution which is optimized for Azure. You scale and arrange applications using Kube, DC/OS, Swarm or Dockers.
- **Azure Container Registry:** This service store and manage container images across all types of Azure deployments.
- **Functions:** Let's you write code regardless of infrastructure and provisioning of servers. In the situation when your functions call rate scales up.
- **Batch:** Batch processing helps you scale to tens, hundreds or thousands of virtual machines and execute computer pipelines.

- Service Fabric: Simplify micro service-based application development and lifecycle management. It supports Java, PHP, Node.js, Python, and Ruby.

## Storage

Azure store is a cloud storage solution for modern applications. It is designed to meet the needs of their customer's demand for scalability. It allows you to store and process hundreds of terabytes of data. It has the following components:

- Blob Storage: Azure Blob storage is a service which stores unstructured data in the cloud as objects/blobs. You can store any type of text or binary data, such as a document, media file, or application installer.
- Queue Storage: It provides cloud messaging between application components. It delivers asynchronous messaging to establish communication between application components.
- File Storage: Using Azure File storage, you can migrate legacy applications. It relies on file shares to Azure quickly and without costly rewrites.
- Table Storage: Azure Table storage stores semi-structured NoSQL data in the cloud. It provides a key/attribute store with a schema-less design

## Database

This category includes Database as a Service (DBaaS) which offers SQL and NoSQL tools. It also includes databases like Azure Cosmos DB and Azure Database for PostgreSQL. It has the following components:

- SQL Database: It is a relational database service in the Microsoft cloud based on the market-leading Microsoft SQL Server engine.
- Document DB: It is a fully managed NoSQL database service which is It built for fast and predictable performance and ease of development.
- Reddish Cache: It is a secure and highly advanced key-value store. It stores data structures like strings, hashes, lists, etc.

## Content Delivery Network

Content Delivery Network (CDN) caches static web content at strategically placed locations. This helps you to offer speed for delivering content to users. It has the following components:

- VPN Gateway: VPN Gateway sends encrypted traffic across a public connection.
- Traffic Manager: It helps you to control and allows you to do the distribution of user traffic for services like WebApps, VM, Azure, and cloud services in different Datacenters.
- Express Route: Helps you to extend your on-premises networks into the Microsoft cloud over a dedicated private connection to Microsoft Azure, Office 365, and CRM Online.

## Security + Identify services

It provides capabilities to identify and respond to cloud security threats. It also helps you to manage encryption keys and other sensitive assets. It has the following components:

- **Key Vault:** Azure Key Vault allows you to safeguard cryptographic keys and helps you to create secrets used by cloud applications and services.
- **Azure Active Directory:** Azure Active Directory and identity management service. This includes multi-factor authentication, device registration, etc.
- **Azure AD B2C:** Azure AD B2C is a cloud identity management solution for your consumer-facing web and mobile applications. It allows you to scales hundreds of millions of consumer identities.

## Enterprise Integration Services:

- **Service Bus:** Service Bus is an information delivery service which works on the third-party communication system.
- **SQL Server Stretch Database:** This service helps you migrates any cold data securely and transparently to the Microsoft Azure cloud
- **Azure AD Domain Services:** It offers managed domain services like domain join, group policy, LDAP, etc. This authentication which is compatible with Windows Server Active Directory.
- **Multi-Factor Authentication:** Azure Multi-Factor Authentication (MFA) is two-step verification. It helps you to access data and applications to offers a simple sign-in process.

## Monitoring + Management Services

These services allow easy management of Azure deployment.

- **Azure Resource Manager:** It makes it easy for you to manage and visualize resource in your app. You can even control who is your organization can act on the resources.
- **Automation:** Microsoft Azure Automation is a way to automate the manual, long-running, error-free, and constantly repeated tasks. These tasks are commonly performed in a cloud and enterprise environment.

## Azure Networking

- **Virtual Network:** Perform Network isolation and segmentation. It offers filter and Route network traffic.
- **Load Balancer:** Offers high availability and network performance of any application. Load balance information Internet traffic to Virtual machines.
- **Application Gateway:** It is a dedicated virtual appliance that offers an Application Delivery Controller (ADC) as a service.
- **Azure DNS:** Azure DNS hosting service offers name resolution using Microsoft Azure infrastructure.

## Web and Mobile Services:

- Web Apps: Web Apps allows you to build and host websites in the programming language of your choice without the need to manage its infrastructure.
- Mobile Apps: Mobile Apps Service offers a highly scalable, globally available mobile app development platform for users.
- API Apps: API apps make it easier to develop, host and consume APIs in the cloud and on-premises.
- Logic Apps: Logic Apps helps you to simplify and implement scalable integrations

## Workflows in the cloud

It provides a visual designer to create and automate your process as a series of steps known as a workflow

- Notification Hubs: Azure Notification Hubs offers an easy-to-use, multi-platform, scaled-out push engine
- Event Hubs: Azure Event Hubs is data streaming platform which can manage millions of events per second. Data sent to an event hub can be transformed and stored using any real-time analytics offers batching/storage adapters.
- Azure Search: It is a cloud search-as-a-service solution which offers server and infrastructure management. It offers ready-to-use service that you can populate with your data. This can be used to add search to your web or mobile application.

## Migration

Migration tools help an organization estimate workload migration costs. It also helps to perform the migration of workloads from your local data centers to the Azure cloud.

### Traditional vs. Azure Cloud Model

Traditional	Azure Cloud Model
Dedicated infrastructure for each application	Loosely coupled apps and micro-services
Purpose-built hardware	Industry-standard hardware
Distinct infrastructure and operations teams	Service-focused DevOps teams
Customized processes & configurations	Standardized processes & configurations

## Applications of Azure

Microsoft Azure is used in a broad spectrum of applications like:

- Infrastructure Services
- Mobile Apps
- Web Applications

- Cloud Services
- Storage, Backup, and Recovery
- Data Management
- Media Services

## **Advantages of Azure**

Here, are advantages of using Azure:

- Azure infrastructure will cost-effectively enhance your business continuity strategy
- It allows you to access the application without buying a license for the individual machine
- Windows Azure offers the best solution for your data needs, from SQL database to blobs to tables
- Offers scalability, flexibility, and cost-effectiveness.
- Helps you to maintain consistency across clouds with familiar tools and resources
- Allows you to extend data center with a consistent management toolset and familiar development and identity solutions.
- You can deploy premium virtual machines in minutes which also include Linux and Windows servers
- Helps you to scale your IT resources up and down based on your needs
- You are not required to run the high-powered and high-priced computer to run cloud computing web-based applications.
- You will not require processing power or hard disk space if you are using Azure
- Cloud computing offers virtually limitless storage
- If your personal computer or laptop crashes, all your data is still out there in the cloud, and it is still accessible
- Sharing documents leads directly to better collaboration
- If you change your device your computers, applications and documents follow you through the cloud

## **DisAdvantages of Azure**

- Cloud computing is not possible if you can't connect to the Internet
- Azure is a web-based application which requires a lot of bandwidth to download, as do large documents
- Web-based applications can sometimes be slower compared to accessing a similar software program on your desktop PC

## What is Google App Engine, Its Advantages and how it can benefit Your Business



As we all know, Google is at the forefront of what you may call the Internet revolution. Besides being the number 1 search engine, the Google app engine is also leveraging Cloud Partner platform. It has come up with different products to help developers launch new scalable web and mobile apps.

Amongst its various cloud-based products, Google app engine has become quite popular. The app engine is a Cloud-based platform, is quite comprehensive and combines infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS). The app engine supports the delivery, testing and development of software on demand in a Cloud computing environment that supports millions of users and is highly scalable.

The company extends its platform and infrastructure to the Cloud through its app engine. It presents the platform to those who want to develop SaaS solutions at competitive costs.

### **Who Benefits the Most from the Google App Engine?**

As an entrepreneur have you ever looked for a software solution to satisfy your specific need? If yes, what do you do in these circumstances? All things considered, you either pay somebody to build a solution from scratch, or you build up a custom web application on your own. While you may think the latter sounds good but it's costly, time-consuming, and impractical. Therefore, Google App Engine (GAE) makes it easy and modernized.

Business owners can scale up their web-based applications without compromising on the performance. Companies like Best Buy and Khan Academy have chosen Google App Engine for their apps.

### **Google App Engine**

Google App Engine is a development as well as a hosting platform that powers everything from big businesses web apps to mobile games, using the same infrastructure that powers Google's worldwide-scale web applications.

It is a platform-as-a-service (PaaS) Cloud computing platform that is fully managed and uses inbuilt services to run your apps. You can start development almost instantly after downloading the software development kit (SDK). You can go on to the Google app developer's guide right away when you click on the language you wish to develop your app in.

As soon as you have signed up for a Cloud account, you can build your app:

- With the template/HTML package in Go
- With Jinja2 and webapp2 in Python
- With Cloud SQL in PHP
- With Maven in Java

The apps are 'sandboxed' and run on several servers by the app engine. To deal with additional demands, the app engine allows additional resources for the application.

Apps like Khan Academy, Rovio, and Snapchat run on the app engine.

## Features of App Engine

### 1. Runtimes and Languages

You can use Go, Java, PHP or Python to write an app engine application. You can develop and test an app locally using the SDK containing tools for deploying apps. Every language has its own SDK and runtime. Your code is executed in a:

- Java 7 environment by Java runtime
- Python 2.7 environment by Python runtime
- PHP 5.4 environment by PHP runtime
- Go 1.2 environment by Go runtime

For more details, please refer

to [https://developers.google.com/appengine/features/#languages\\_and\\_runtimes](https://developers.google.com/appengine/features/#languages_and_runtimes).

### 2. Generally Available Features

These are covered by the depreciation policy and the service-level agreement of the app engine. Any changes made to such a feature are backward-compatible and implementation of such a feature is usually stable. These include data storage, retrieval, and search; communications; process management; computation; app configuration and management.

- Data storage, retrieval, and search include features such as HRD migration tool, Google Cloud SQL, logs, datastore, dedicated Memcache, blobstore, Memcache and search.
- Communications include features such as XMPP. channel, URL fetch, mail, and Google Cloud Endpoints.
- Process management includes features like scheduled tasks and task queue.
- Computation includes images.
- App management and configuration cover app identity, users, capabilities, traffic splitting, modules, SSL for custom domains, modules, remote access, and multitenancy.

For more details, please refer

to [https://developers.google.com/appengine/features/#generally available ga features](https://developers.google.com/appengine/features/#generally_available_ga_features).

### **3. Features in Preview**

These features are sure to ultimately become generally available features in some release of the app engine in the future. However, their implementation might change in backward-incompatible ways, as these are in the preview. These include Sockets, MapReduce and [Google Cloud Storage Client Library](#).

Preview features include Google Cloud storage client library, sockets, and MapReduce.

For more details, please refer

to [https://developers.google.com/appengine/features/#preview\\_features](https://developers.google.com/appengine/features/#preview_features).

### **4. Experimental Features**

These might or might not become generally available in app engine releases in the future. Their implementation might change in backward-incompatible ways. These are generally available publicly.

However, those mentioned as 'trusted tester' are available only to a select user group and they have to sign up to use the features. The experimental features include Appstats Analytics, Restore/Backup/Datastore Admin, Task Queue Tagging, MapReduce, Task Queue REST API, OAuth, Prospective Search, PageSpeed and OpenID.

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For more details, please refer

to [https://developers.google.com/appengine/features/#experimental\\_features](https://developers.google.com/appengine/features/#experimental_features).

### **5. Third-Party Services**

Your app can do things not built into the core product you know as app engine as Google offers documentation and helper libraries to enhance the capabilities of the app engine platform. Google partners with other organizations to achieve this.

The partners often present special offers for the customers of the app engine besides the helper libraries.

The services include Twilio (voice/SMS) and SendGrid (email).

For more details, please refer

to [https://developers.google.com/appengine/features/#third-party\\_services](https://developers.google.com/appengine/features/#third-party_services).

## **Advantages of Google App Engine**

There are many advantages to the Google App Engine that helps to take your app ideas to the next level. This includes:

### **Infrastructure for Security**

Around the world, the Internet infrastructure that Google has is probably the most secure. There is rarely any type of unauthorized access to date as the application data and code are stored in highly secure servers.

You can be sure that your app will be available to users worldwide at all times since Google has several hundred servers globally. Google's security and privacy policies are applicable to the apps developed using Google's infrastructure.

### **Faster Time to Market**

Quickly releasing a product or service to market is the most important thing for every business. Stimulating the development and maintenance of an app is critical when it comes to deploying the product fast. With the help of Google cloud app Engine, a business can quickly develop-

- Feature-rich apps with a quick development process
- The backend application in a PaaS style environment
- NoSQL style storage, flexible data storage, or Google Cloud SQL for relational database support.

This, further, results in superior quality code, faster time to market, thus offering better customer experience.

### **Quick to Start**

With no product or hardware to purchase and maintain, you can prototype and deploy the app to your users without taking much time.

### **Easy to Use**

Google App Engine (GAE) incorporates the tools that you need to develop, test, launch, and update the applications.

### **Rich set of APIs & Services**

Google App Engine has several built-in APIs and services that allow developers to build robust and feature-rich apps. These features include:

- Access to the application log
- Blobstore, serve large data objects
- Google Cloud Storage
- SSL Support
- Page Speed Services

- Google Cloud Endpoint, for mobile application
- URL Fetch API, User API, Me cache API, Channel API, XXMP API, File API

### **Scalability**

For any app's success, this is among the deciding factors. Google creates its own apps using GFS, Big Table and other such technologies, which are available to you when you utilize the Google app engine to create apps.

You only have to write the code for the app and Google looks after the testing on account of the automatic scaling feature that the app engine has. Regardless of the amount of data or number of users that your app stores, the app engine can meet your needs by scaling up or down as required.

The good thing about Google App Engine as a manageable platform is that it has made it feasible for our engineers to effortlessly scale up their applications with no-operations skill. It, additionally, sets us up with the best practices as far as logging, security and releasing management is concerned.

### **Performance and Reliability**

Google is among the leaders worldwide among global brands. So, when you discuss performance and reliability you have to keep that in mind. In the past 15 years, the company has created new benchmarks based on its services' and products' performance. The app engine provides the same reliability and performance as any other Google product.

### **Cost Savings**

You don't have to hire engineers to manage your servers or to do that yourself. You can invest the money saved into other parts of your business.

### **Platform Independence**

You can move all your data to another environment without any difficulty as there are not many dependencies on the app engine platform.

### **Conclusion:**

Google App Engine enables you to build web applications for your business leveraging Google's infrastructure.

App Engine applications are easy to develop, maintain, and can scale as your traffic and data storage needs grow. With App Engine, you don't end up paying for large server spaces and then spend on resources maintaining them. You just upload your application, and it's ready to serve to your users. Rest is taken care of by Google Cloud.

## OPEN SOURCE CLOUDS-CONTROLLING IT ALL WITH WEB-BASED DESKTOPS

- OPENSTACK
- CLOUDSTACK
- APACHE MESO
- EUCALYPTUS
- OPENNEBULA
- PSCALE

### 1. OpenStack

Beginning in 2010 as a joint project of Rackspace Hosting and NASA, OpenStack has grown so prolifically to be one of the choices used to build clouds. OpenStack is a set of open-source software tools for building and managing cloud computing platforms for public and private clouds.

This software platform is made up of interrelated components that control diverse, multi-vendor hardware pools of processing, storage, and networking resources throughout a data center. OpenStack can be managed through a web-based dashboard, through command-line tools, or through RESTful web services.

It has many components that work together. Some of the bare minimum required for it to work includes Glance, Nova, Neutron, Horizon, Cinder and Keystone.

Features of Openstack: [Source\(docs.openstack.org\)](http://docs.openstack.org)

- Leverages commodity hardware: No lock-in, lower price/GB: HDD/node failure agnostic: Self-healing, reliable, data redundancy protects from failures.
- Unlimited storage: Large and flat namespace, highly scalable read/write access, able to serve content directly from storage system.
- Multi-dimensional scalability: scale-out architecture: Scale vertically and horizontally-distributed storage. Backs up and archives large amounts of data with linear performance.
- Account/container/object structure: No nesting, not a traditional file system. Optimized for scale, it scales to multiple petabytes and billions of objects.
- Built-in replication 3X + data redundancy (compared with 2X on RAID): A configurable number of accounts, containers and object copies for high availability.

- Easily add capacity (unlike RAID resize): Elastic data scaling with ease: No central database: Higher performance, no bottlenecks.
- RAID not required: Handle many small, random reads and writes efficiently.
- Built-in management utilities: Account management: Create, add, verify, and delete users; Container management: Upload, download, and verify; Monitoring: Capacity, host, network, log trawling, and cluster health.
- Drive auditing: Detect drive failures preempting data corruption.
- Expiring objects: Users can set an expiration time or a TTL on an object to control access.
- Direct object access: Enable direct browser access to content, such as for a control panel.
- Realtime visibility into client requests: Know what users are requesting.
- Supports S3 API: Utilize tools that were designed for the popular S3 API.
- Restrict containers per account: Limit access to control usage by user.
- Multiple integrations with other systems. OPenstack integrates so well with the following systems: Ceph, Docker(plugins), Azure, Hyper-V and many more.

## 2. CloudStack

As a top-level project of the Apache Software Foundation (ASF), Apache CloudStack is open source software designed to deploy and manage large networks of virtual machines, as a highly available, highly scalable Infrastructure as a Service (IaaS) cloud computing platform.

It is a Java-based project that provides a management server and agents (if needed) for hypervisor hosts so that you can run an IaaS cloud. CloudStack currently supports the most popular hypervisors: VMware, KVM, Citrix XenServer, Xen Cloud Platform (XCP), Oracle VM server and Microsoft Hyper-V.

Features of CloudStack. Source: [cloudstack.apache.org](http://cloudstack.apache.org)

- Works with hosts running XenServer/XCP, KVM, Hyper-V, and/or VMware ESXi with vSphere
- Provides a friendly Web-based UI for managing the cloud
- Provides a native API. Users can manage their cloud with an easy to use Web interface, command line tools, and/or a full-featured RESTful API
- May provide an Amazon S3/EC2 compatible API (optional)

- Manages storage for instances running on the hypervisors (primary storage) as well as templates, snapshots, and ISO images (secondary storage)
- Orchestrates network services from the data link layer (L2) to some application layer (L7) services, such as DHCP, NAT, firewall, VPN, and so on
- Accounting of network, compute, and storage resources
- Multi-tenancy/account separation
- User management

### 3. Apache Mesos

Apache Mesos is the first open-source cluster manager that handles workloads efficiently in a distributed environment through dynamic resource sharing and isolation. It abstracts CPU, memory, storage, and other compute resources away from machines (physical or virtual), enabling fault-tolerant and elastic distributed systems to be easily built and run effectively. T

his cluster manager is built using the same principles as the Linux kernel, only at a different level of abstraction. The Mesos kernel runs on every machine and provides applications (e.g., Hadoop, Spark, Kafka, Elasticsearch) with API's for resource management and scheduling across entire datacenter and cloud environments (mesos.apache.org, 2019)

#### Features of Mesos

- Mesos is cross-platform: It runs on Linux, OSX and Windows. It is Cloud provider agnostic at the same time.
- Native support for launching containers with Docker and AppC images.
- Achieves great levels of High Availability: Fault-tolerant replicated master and agents using Zookeeper. Non-disruptive upgrades.
- It greatly scales linearly: Industry proven to easily scale to 10,000s of nodes.
- Support for APIs: HTTP APIs for developing new distributed applications, for operating the cluster, and for monitoring.
- A friendly web interface: Built-in Web UI for viewing cluster state and navigating container sandboxes.
- First class isolation support for CPU, memory, disk, ports, GPU, and modules for custom resource isolation.
- Support for running cloud native and legacy applications in the same cluster with pluggable scheduling policies.

## 4. Eucalyptus

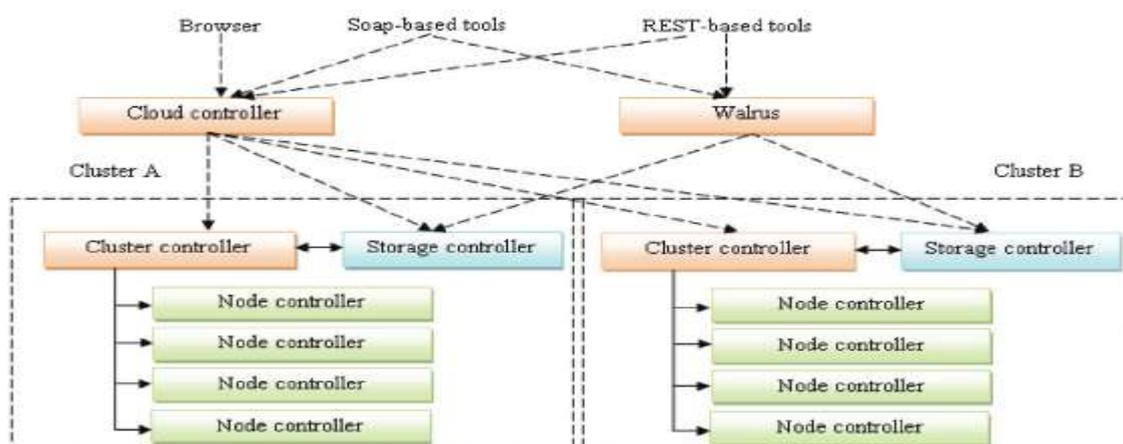
Eucalyptus is open source software for building AWS-compatible private and hybrid clouds. It is a Linux-based software architecture that implements scalable private and hybrid clouds within your existing IT infrastructure. As an on-premise (private) Infrastructure as a Service clouds solution, it allows you to use your own collections of resources (hardware, storage, and network) using a self-service interface on an as-needed basis. As an Infrastructure as a Service (IaaS) product, Eucalyptus allows your users to provision your compute and storage resources on-demand ([docs.eucalyptus.cloud](https://docs.eucalyptus.cloud)).

### Main Features of Eucalyptus

- Architecture: Eucalyptus is AWS Compatible and thus has five main components, Cloud controller, Walrus, Cluster controller, Storage controller, Node controller and Euca2ool.
- Users can run Amazon or Eucalyptus machine images as instances on both the clouds.
- Since it is AWS compatible, there is one hundred percent AWS API compatibility and support.
- Installation: When its installation is compared to other cloud platforms like Openstack, you will notice it is easier to install Eucalyptus.
- Administration: Administration of Eucalyptus is flexible giving you both a strong Command Line Interface compatible with EC2 API
- Popularity: Its popularity is medium
- IaaS offering: Eucalyptus offers both Public and private cloud implementations.

### Eucalyptus and its components:

Eucalyptus has six components:



- The Cloud Controller (CLC) is a Java program that offers EC2-compatible interfaces, as well as a web interface to the outside world. In addition to handling incoming requests, the CLC acts as the administrative interface for cloud management and performs high-level resource scheduling and system accounting. The CLC accepts user API requests from command-line interfaces like euca2ools or GUI-based tools like the Eucalyptus User Console and manages the underlying compute, storage, and network resources. Only one CLC can exist per cloud and it handles authentication, accounting, reporting, and quota management.
- Walrus, also written in Java, is the Eucalyptus equivalent to AWS Simple Storage Service (S3). Walrus offers persistent storage to all of the virtual machines in the Eucalyptus cloud and can be used as a simple HTTP put/get storage as a service solution. There are no data type restrictions for Walrus, and it can contain images (i.e., the building blocks used to launch virtual machines), volume snapshots (i.e., point-in-time copies), and application data. Only one Walrus can exist per cloud.
- The Cluster Controller (CC) is written in C and acts as the front end for a cluster within a Eucalyptus cloud and communicates with the Storage Controller and Node Controller. It manages instance (i.e., virtual machines) execution and Service Level Agreements (SLAs) per cluster.
- The Storage Controller (SC) is written in Java and is the Eucalyptus equivalent to AWS EBS. It communicates with the Cluster Controller and Node Controller and manages Eucalyptus block volumes and snapshots to the instances within its specific cluster. If an instance requires writing persistent data to memory outside of the cluster, it would need to write to Walrus, which is available to any instance in any cluster.
- The VMware Broker is an optional component that provides an AWS-compatible interface for VMware environments and physically runs on the Cluster Controller. The VMware Broker overlays existing ESX/ESXi hosts and transforms Eucalyptus Machine Images (EMIs) to VMware virtual disks. The VMware Broker mediates interactions between the Cluster Controller and VMware and can connect directly to either ESX/ESXi hosts or to vCenter Server.
- The Node Controller (NC) is written in C and hosts the virtual machine instances and manages the virtual network endpoints. It downloads and caches images from Walrus as well as creates and caches instances. While there is no theoretical limit to the number of Node Controllers per cluster, performance limits do exist.

## Eucalyptus Cloud Computing Architecture

**Eucalyptus is an open source software platform for implementing Infrastructure as a Service (IaaS) in a private or hybrid cloud computing environment.**

Eucalyptus **cloud computing architecture** is highly scalable because of its distributed nature. The Cloud level of the computing architecture is comprised of only two components and while used by many users, the transactions at each component are typically small. The Node level may have many components, but each component only

supports a few users, even though the transactions are larger. This **distributed cloud architecture** is flexible enough to support businesses of any size.

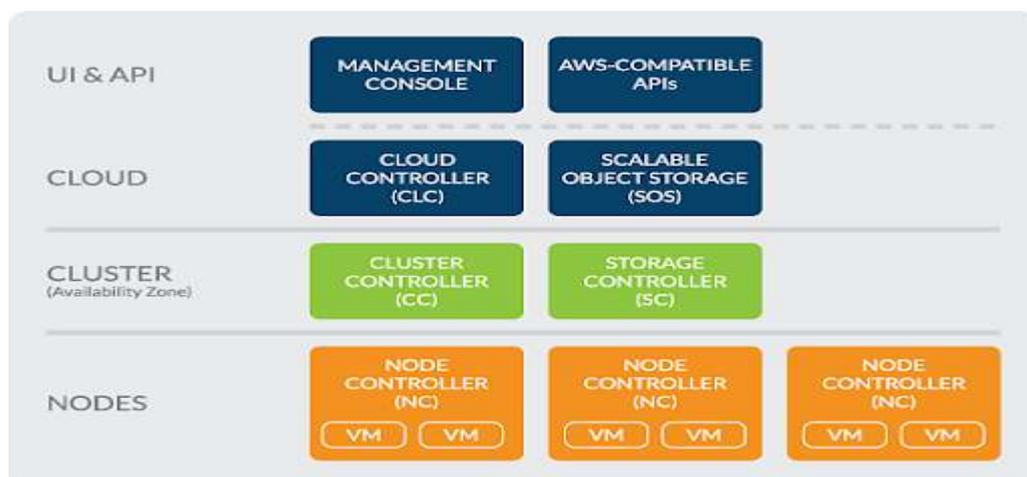
The Eucalyptus cloud platform pools together existing virtualized infrastructure to create cloud resources for infrastructure as a service, network as a service and storage as a service. The name Eucalyptus is an acronym for Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems.

Eucalyptus was founded out of a research project in the Computer Science Department at the University of California, Santa Barbara, and became a for-profit business called Eucalyptus Systems in 2009. Eucalyptus Systems announced a formal agreement with Amazon Web Services (AWS) in March 2012, allowing administrators to move instances between a Eucalyptus private cloud and the Amazon Elastic Compute Cloud (EC2) to create a hybrid cloud. The partnership also allows Eucalyptus to work with Amazon's product teams to develop unique AWS-compatible features.

Eucalyptus features include:

- Supports both Linux and Windows virtual machines (VMs).
- Application program interface- (API) compatible with Amazon EC2
- Compatible with Amazon Web Services (AWS) and Simple Storage Service (S3).
- Works with multiple hypervisors including VMware, Xen and KVM.
- Can be installed and deployed from source code or DEB and RPM
- Internal processes communications are secured through SOAP and WS-Security.
- Multiple clusters can be virtualized as a single cloud.
- Administrative features such as user and group management and reports.

### Eucalyptus Architecture Diagram



### Eucalyptus Cloud Components

Eucalyptus is made up of five distinct components that can be distributed in various cloud computing architectures. The five components are grouped into three separate levels. Jump to a specific page to learn more:

- Cloud Level
  - Cloud Controller (CLC)
  - Scalable Object Storage (SOS)

## **Eucalyptus Architecture: Cloud Level**

### Cloud Level

#### Cloud Controller (CLC)

The Cloud Controller (CLC) is a Java program that offers EC2-compatible SOAP and Query interfaces, as well as a Web interface to the outside world, for distribution within the cloud architecture. In addition to handling incoming requests, the CLC acts as the administrative interface for cloud management and performs high-level resource scheduling and system accounting. The CLC accepts user API requests from command-line interfaces like euca2ools or GUI-based tools like the Eucalyptus Management Console and manages the underlying computer storage and network resources. Only one CLC can exist per cloud.

The CLC handles high-level:

- Authentication
- Accounting
- Reporting
- Quota management

#### Scalable Object Storage

Scalable Object Storage (SOS) is the Eucalyptus service equivalent to AWS Simple Storage Service (S3). The SOS is pluggable service that allows infrastructure administrators the flexibility to implement scale-out storage on top of commodity resources using open source and commercial solutions that implement the S3 interface. Eucalyptus provides a basic storage implementation, known as Walrus, which may suit evaluation and smaller cloud deployments. For large-scale and increased performance, users are encouraged to connect the SOS to dedicated storage solutions such as RiakCS.

- Cluster Level (i.e., Availability Zone)
  - Cluster Controller (CC)
  - Storage Controller (SC)

## **Eucalyptus Architecture: Cluster Level**

### Cluster Level

#### Cluster Controller (CC)

A cluster is equivalent to an AWS availability zone, and a single Eucalyptus cloud can have multiple clusters. The Cluster Controller (CC) is written in C and acts as the front end for a cluster within a Eucalyptus cloud and communicates with the Storage Controller (SC) and Node Controller (NC). The CC manages instance (i.e., virtual machines) execution and Service Level Agreements (SLAs) per cluster.

#### Storage Controller (SC)

The Storage Controller (SC) is written in Java and is the Eucalyptus equivalent to AWS Elastic Block Store (EBS). The SC communicates with the Cluster Controller (CC) and Node Controller (NC) within the distributed cloud architecture and manages Eucalyptus block volumes and snapshots to the instances within its specific cluster. If an instance requires writing persistent data to memory outside of the cluster, it would need to write to the backend storage, which is available to any instance in any cluster. The SC interfaces with storage systems, including local, NFS, iSCSI, and SAN.

- Node Level

- Node Controller (NC)

## **Eucalyptus Architecture: Node Level**

Node Level

Node Controller (NC)

The Node Controller (NC) is part of the Node level of the cloud computing architecture. It is written in C and hosts the virtual machine instances and manages the virtual network endpoints. The NC downloads and caches images from Scalable Object Storage as well as creates and caches instances.

### **5. OpenNebula**

OpenNebula is a simple yet powerful and flexible turnkey open-source solution to build Private Clouds and manage Data Center virtualization. It implements IaaS. The first open-source version of OpenNebula was released in March 2008.

#### **Key Features of OpenNebula. Source: [openebula.org](http://openebula.org)**

- Capacity and performance Management and Interfaces for Administrators and advanced users
- High Availability
- Integration with external providers
- Platforms it runs on
- Crafted with security in mind
- Friendly Management

According to Nebula, here are the top ten reasons why you should use it to manage your private Cloud.

- **Powerful and Innovative:** Enterprise-class functionality for the management of virtualized data centers to build private and hybrid clouds
- **Infrastructure Agnostic:** Fully platform-independent; allows for leveraging of existing IT infrastructure, and avoiding vendor lock-in
- **Adaptable, Extensible and Integratable:** Allows you to build your customized cloud service and make cloud operations conform to existing policies

- Interoperable: Cloud interoperability and portability providing cloud consumers with choice across standards and most popular cloud interfaces
- Fully Open Source: OpenNebula is truly open-source code – not open core – distributed under Apache license
- Simple: Despite its technical sophistication and advanced functionality, OpenNebula is easy to download, install and update
- Stable and Proven: Rigorously tested through an internal QA process and by a large community with many massive scalable production deployments
- Mature: Development driven by user needs and matured through many release cycles
- Enterprise-class Product: OpenNebula comprises all key functionalities for enterprise cloud computing, storage and networking in a single install
- One-stop Support: Wide variety of community and commercial support from the developers of OpenNebula

## 6. AppScale

AppScale is an open-source cloud computing platform that automatically deploys and scales unmodified Google App Engine applications over public and private cloud systems and on-premise clusters. It is a distributed software system that implements a cloud platform as a service (PaaS). As such, AppScale is an easy-to-manage serverless platform for building and running scalable web and mobile applications on any infrastructure. The platform enables developers to focus solely on business logic in order to rapidly build scalable apps, cleanly separating it from deployment and scaling logic. It allows operations to provide a consistent, tunable environment that can simplify running and maintaining apps on multiple infrastructures ([github.com/AppScale/appscale](https://github.com/AppScale/appscale), 2019). It is supported and maintained by AppScale Systems, in conjunction with Google.

### Main goal of AppScale

The goal of AppScale is to provide developers with a rapid, API-driven development platform that can run applications on any cloud infrastructure. AppScale decouples application logic from its service ecosystem to give developers and cloud administrators control over application deployment, data storage, resource use, backup, and migration ([www.appscale.com](http://www.appscale.com)).

## Features AppScale

- Scalable: as the name suggests, AppScale deploys and automatically Google App Engine applications with ease.
- Quick prototyping
- AppScale is easy to use hence making companies favor it.

## OPENNEBULA: A FREE SOLUTION FOR BUILDING CLOUDS



OpenNebula is a free and open source software solution for building clouds and for data centre virtualisation. It is based on open technologies and is distributed under the Apache License 2. OpenNebula has features for scalability, integration, security and accounting. It offers cloud users and administrators a choice of interfaces.

OpenNebula is an open source platform for constructing virtualised private, public and hybrid clouds. It is a simple yet feature-rich, flexible solution to build and manage data centre virtualisation and enterprise clouds. So, with OpenNebula, virtual systems can be administered and monitored centrally on different Hyper-V and storage systems. When a component fails, OpenNebula takes care of the virtual instances on a different host system. The integration and automation of an existing heterogeneous landscape is highly flexible without further hardware investments.

### **Benefits of OpenNebula**

The plurality of support to Hyper-V and platform-independent architecture makes

OpenNebula the ideal solution for heterogeneous computing centre environments.  
The main advantages of OpenNebula are:

- It is 100 per cent open source and offers all the features in one edition.
- It provides control via the command line or Web interface, which is ideal for a variety of user groups and needs.
- OpenNebula is available for all major Linux distributions, thus simplifying installation.
- The long-term use of OpenNebula in large scale production environments has proven its stability and flexibility.
- OpenNebula is interoperable and supports OCCI (Open Cloud Computing Interface) and AWS (Amazon Web Services).

### Key features of OpenNebula

OpenNebula has features for scalability, integration, security and accounting. The developers also claim that it supports standardisation, interoperability and portability. It allows cloud users and administrators to choose from several cloud interfaces. Figure 1 shows the important features of OpenNebula.

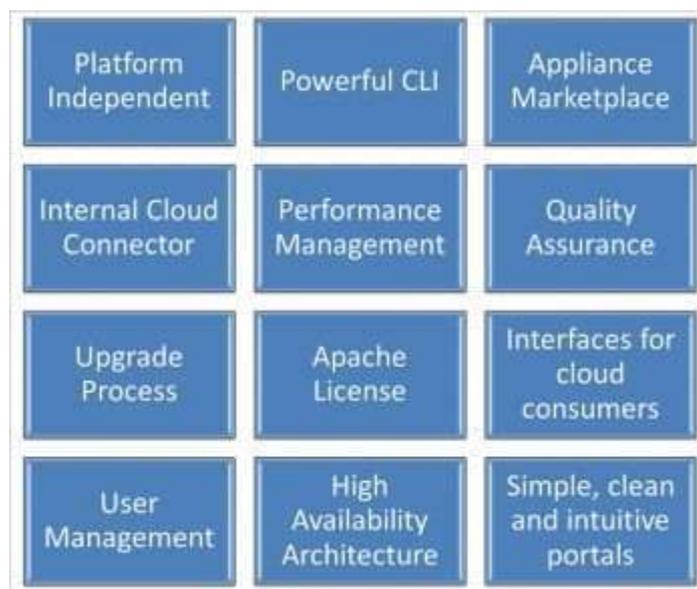


Figure 1: Key features of OpenNebula

### Why OpenNebula?

- **Web interface or CLI – the choice is yours**  
By using the OpenNebula CLI or Web interface, you can keep track of activities at any time. There is a central directory service through which you can add new users, and those users can be individually entitled. Managing systems, configuring new virtual systems or even targeting the right users and groups is easy in OpenNebula.

- **Availability at all times**  
OpenNebula not only takes care of the initial provisioning, but the high availability of its cloud environment is much better compared to other cloud solutions. Of course, the central OpenNebula services can be configured for high availability, but this is not absolutely necessary. All systems continue to operate in their original condition and are automatically included in the restored availability of the control processes.
- **Easy remote access**  
In virtual environments, one lacks the ability to directly access the system when there are operational problems or issues with the device. Here, OpenNebula offers an easy solution — using the browser, one can access the system console of the host system with a VNC integrated server.
- **Full control and monitoring**  
All host and guest systems are constantly monitored in OpenNebula, which keeps the host and VM dashboards up to date at all times. Depending on the configuration, a virtual machine is to be restarted in case of the host system failing or if migrating to a different system. If a data store is used with parallel access, the systems can of course be moved, while in operation, on to other hardware. The maintenance window can be minimised and can often be completely avoided.
- **Open standards**  
OpenNebula is 100 per cent open source under the Apache License. By supporting open standards such as OCCI and a host of other open architecture, OpenNebula provides the security, scalability and freedom of a reliable cloud solution without vendor lock-in, which involves considerable support and follow-up costs.

## Key Features of OpenNebula

### Interfaces for Administrators and advanced users

- Powerful CLI that resembles typical UNIX-command applications
- SunStone Portal for administrators and advanced users

### Capacity and performance Management

- Fine-grained ACLs for resource allocation
- Resource Quota Management to track and limit computing, storage and networking resource utilization
- Dynamic creation of Clusters as pools of hosts that share datastores and virtual networks for load balancing, high availability, and high performance computing

- Dynamic creation of Virtual Data Centers as fully-isolated virtual infrastructure environments where a group of users, under the control of the VDC administrator, can create and manage compute, storage and networking capacity
- Federation of multiple OpenNebula Zones for scalability, isolation or multiple-site support
- Powerful and flexible Scheduler for the definition of workload and resource-aware allocation policies such as packing, striping, load-aware, affinity-aware.

## High Availability

- High availability architecture
- Persistent database backend with support for high availability configurations
- Configurable behaviour in the event of host or VM failure to provide easy to use and cost-effective failover solutions

## Integration with external providers

- Native support for hybrid cloud computing with connectors for AWS and Azure
- Modular and extensible architecture
- Customizable plug-ins for integration with any third-party data center service
- API for integration with higher level tools such as billing, self-service portals...

## Platforms it runs on

- Fully platform-independent
- Broad support for commodity and enterprise-grade hypervisor, monitoring, storage, networking and user management services
- Build a cloud on LXD, KVM and VMware vCenter
- Packages for major Linux distributions

## Crafted with security in mind

- Fine-grained ACLs and user quotas
- Powerful user, group and role management
- Integration with user management services like LDAP, Active Directory...
- Login token functionality
- Fine-grained auditing
- Support for isolation at different levels

## *Friendly Management*

- Virtual infrastructure management adjusted to enterprise data centers
- Complete life-cycle management of virtual resources
- Powerful hooking system
- Full control, monitoring and accounting of virtual infrastructure resources
- Fine-grained multi-tenancy

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- **Simple:** Despite its technical sophistication and advanced functionality, OpenNebula is easy to download, install and update
- **Stable and Proven:** Rigorously tested through an internal QA process and by a large community with many massive scalable production deployments
- **Mature:** Development driven by user needs and matured through many release cycles
- **Enterprise-class Product:** OpenNebula comprises all key functionalities for enterprise cloud computing, storage and networking in a single install
- **One-stop Support:** Wide variety of community and commercial support from the developers of OpenNebula

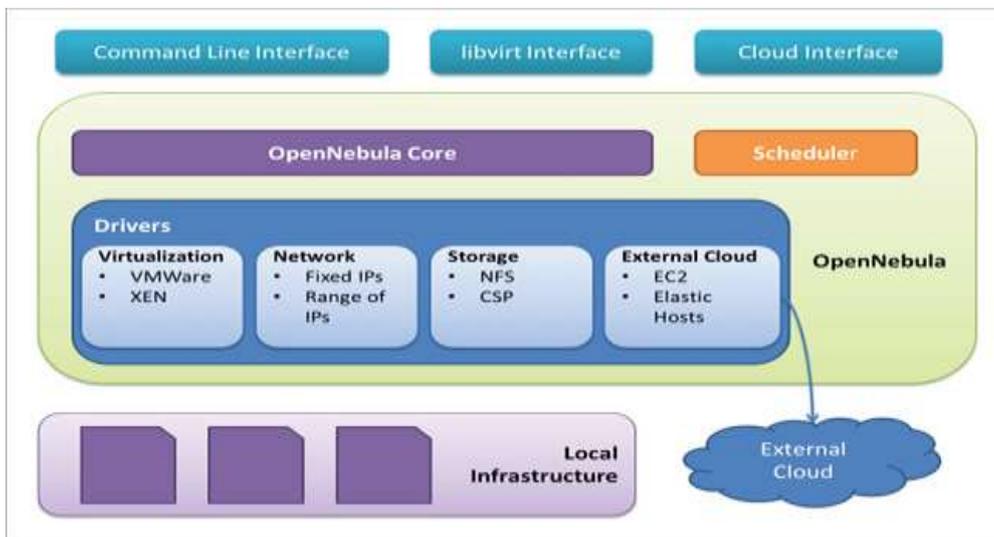


Figure 2: OpenNebula architecture

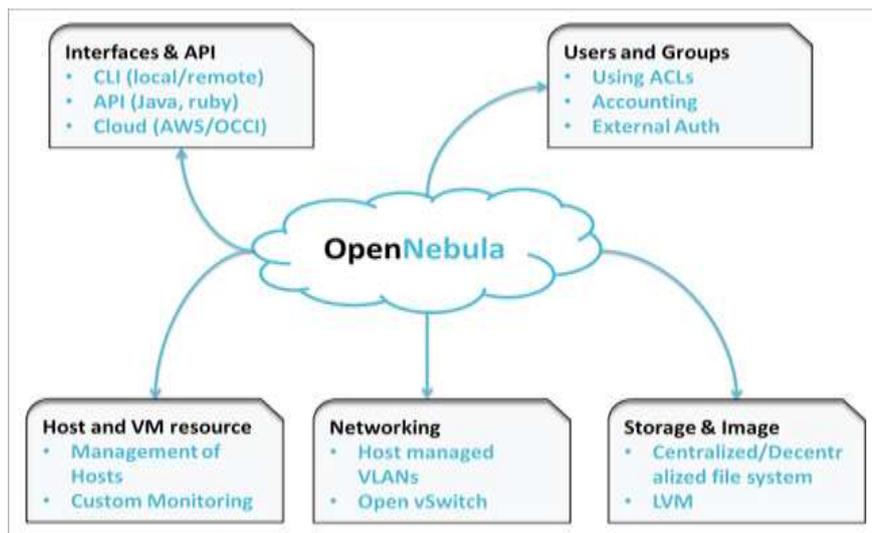


Figure 3: OpenNebula components

### OpenNebula architecture

To control a VM's life cycle, the OpenNebula core coordinates with the following three areas of management:

- 1) Image and storage technologies — to prepare disk images
- 2) The network fabric — to provide the virtual network environment
- 3) Hypervisors — to create and control VMs

Through pluggable drivers, the OpenNebula core can perform the above operations. It also supports the deployment of services.

VM placement decisions are taken by a separate scheduler component. It follows the rank scheduling policy, which makes place for VMs on a physical host according to the rank given by the scheduler. These ranks are decided by the scheduler, using a ranking algorithm.

OpenNebula uses cloud drivers to interact with external clouds, and also integrates the core with other management tools by using management interfaces.

## Components of OpenNebula

Based on the existing infrastructure, OpenNebula provides various services and resources. You can view the components in Figure 3.

- **APIs and interfaces:** These are used to manage and monitor OpenNebula components. |To manage physical and virtual resources, they work as an interface.
- **Users and groups:** These support authentication, and authorise individual users and groups with the individual permissions.
- **Hosts and VM resources:** These are a key aspect of a heterogeneous cloud that is managed and monitored, e.g., Xen, VMware.
- **Storage components:** These are the basis for centralised or decentralised template repositories.
- **Network components:** These can be managed flexibly. Naturally, there is support for VLANs and Open vSwitch.

## The front-end

- The machine that has OpenNebula installed on it is known as the front-end machine, which is also responsible for executing OpenNebula services.
- The front-end needs to have access to the image repository and network connectivity to each node.
- It requires Ruby 1.8.7 or above.
- OpenNebula's services are listed below:
  1. Management daemon (Oned) and scheduler (mm\_sched)
  2. Monitoring and accounting daemon (Onecctd)
  3. Web interface server (Sunstone)
  4. Cloud API servers (EC2- query or OCCl)

## Virtualisation hosts

- To run the VMs, we require some physical machines, which are called hosts.
- The virtualisation sub-system is responsible for communicating with the hypervisor and taking the required action for any node in the VM life cycle.
- During the installation, the admin account should be enabled to execute commands with root privileges.

## Storage

Data stores are used to handle the VM images, and each data store must be accessible by the front-end, using any type of storage technology.

OpenNebula has three types of data stores:

- File data store – used to store the plain files (not disk images)
- Image data store – repository for images only  
System data store – used to hold the running VM images  
The image data store type depends on the storage technology used. There are three types of image data stores available:
- File system – stores VM images in file formats
- LVM – reduces the overhead of having the file system in place; the LVM is used to store virtual images instead of plain files
- Ceph – stores images using Ceph blocks  
OpenNebula can handle multiple storage scenarios, either centralised or decentralised.

## Networking

There must be at least two physical networks configured in OpenNebula:

- Service network – to access the hosts to monitor and manage hypervisors, and to move VM images.
- Instance network – to offer network connectivity between the VMs across the different hosts.

Whenever any VM gets launched, OpenNebula will connect its network interfaces to the bridge described in the virtual network definition.

OpenNebula supports four types of networking modes:

- Bridged—where the VM is directly attached to the physical bridge in the hypervisor.
- VLAN—where the VMs are connected by using 802.1Q VLAN tagging.
- Open vSwitch—which is the same as VLAN but uses an open vSwitch instead of a Linux bridge.
- VXLAN—which implements VLAN using the VXLAN protocol.

## Collaborating via Web-Based Communication Tools: Evaluating Web Mail Services

Traditional email is anything but cloud based. The type of email program you probably have installed on your PC uses a protocol called the Post Office Protocol (POP). POP email requires the use of a dedicated email client program, such as Microsoft Outlook or Outlook Express, and—at the ISP level—email servers to send and receive messages.

The problem with traditional POP email is that you're tied to the client program installed on your PC. The messages you receive are stored on that PC, and you usually can't access

them when you're traveling or away from that PC. There are none of the "anytime, anywhere" advantages you're used to with cloud-based services.

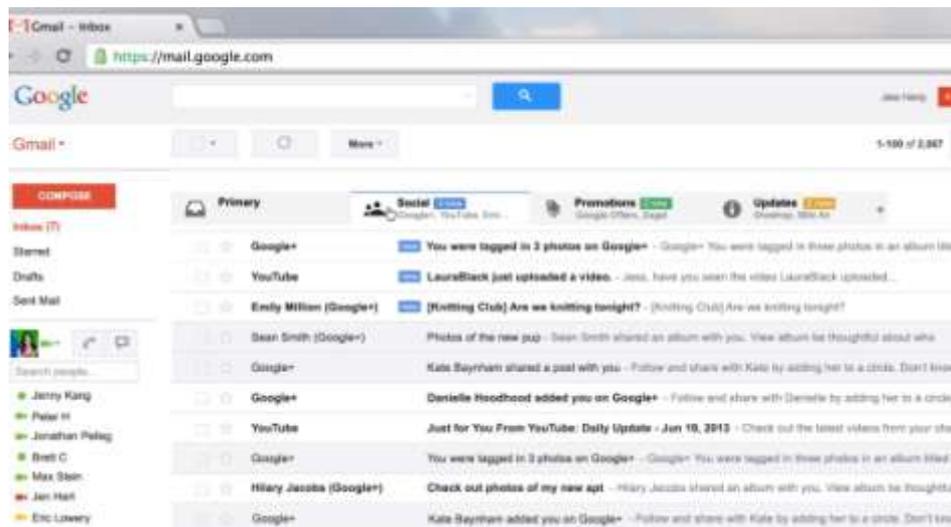
Fortunately, there is a better way to manage your email—in the form of web-based email services, also known as web mail or HTTP email. Unlike traditional POP email, web mail can be accessed from any PC using any web browser, and all your messages are stored on the web, not locally. It's just like a cloud service; no special software required. This lets you retrieve and manage your email when you're out of the office or on the road.

Not only is web mail more versatile than traditional POP email, it's also easier to set up. All you need to know is your user ID and password, and then you access a page that lets you view the contents of your inbox, read and reply to messages, create new messages, and (in many cases) store messages in folders. You can even, on some services, use your web mail account to access your ISP's POP email.

## Gmail

Google's web mail service is called Gmail ([mail.google.com](http://mail.google.com)). Gmail is free, it lets you send and receive email from any web browser, and the interface even looks similar to its competitors, as you can see in Figure 1.

Figure 1. The Gmail inbox.



But Gmail offers a few unique features that set it apart from the web-based email crowd. First, Gmail doesn't use folders. That's right, with Gmail you can't organize your mail into folders, as you can with the other services. Instead, Gmail pushes the search paradigm as the way to find the messages you want—not a surprise, given Google's search-centric business model.

Gmail does, however, let you "tag" each message with one or more labels. This has the effect of creating virtual folders, as you can search and sort your messages by any of their labels.

In addition, Gmail groups together related email messages in what Google calls conversations. A conversation might be an initial message and all the replies (and replies to replies) to that message; a conversation might also be all the daily emails from a single source that have a common subject, such as messages from subscribed-to mailing lists.

Like most of the other services we discuss here, Gmail is a free service; all you have to do is sign up for an account. Of course, if you already have an account for any other Google service, that account can serve as your Gmail account. When you sign up for your Gmail account, you get assigned your email address (in the form of name@gmail.com) and you get access to the Gmail inbox page. As of June 2008, Gmail offered 6GB of storage for users.

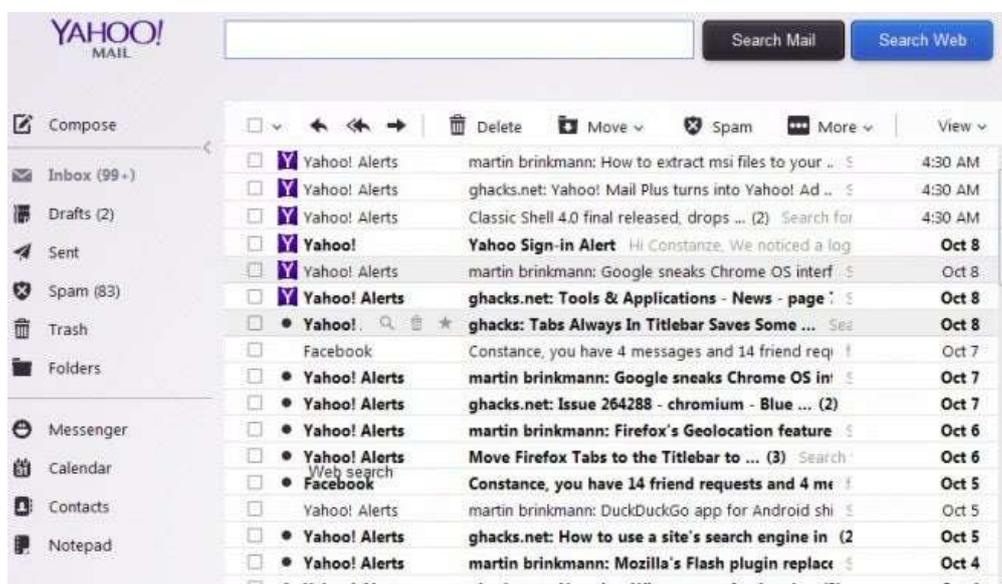
## Yahoo! Mail

Yahoo! Mail ([mail.yahoo.com](http://mail.yahoo.com)) is another web mail service, provided by the popular Yahoo! search site. The basic Yahoo! Mail is free and can be accessed from any PC, using any web browser. Yahoo! also offers a paid service called Yahoo! Mail Plus that lets you send larger messages and offers offline access to your messages via POP email clients.

Whether you use the free or the paid version, Yahoo! Mail gives you unlimited storage—which means you can effectively use Yahoo! Mail as an online backup or file-storage system. All you have to do is email yourself those files you want to store, and then place those messages (with attachments) in your designated storage folder.

As you can see in Figure 2, the Yahoo! Mail interface is more functional than that offered by Gmail. It also offers traditional folder-based organization. You get a message pane and a reading pane, just as you do with Microsoft Outlook. Yahoo! also offers users the SpamGuard spam filter and Norton Antivirus virus scanner.

Figure 2. Previewing messages with Yahoo! Mail.



## Windows Live Hotmail

Hotmail was one of the first web-based email services, and it's still one of the largest. But it's not called "Hotmail" anymore; Microsoft has moved it into its Windows Live suite of online services and now calls it Windows Live Hotmail.

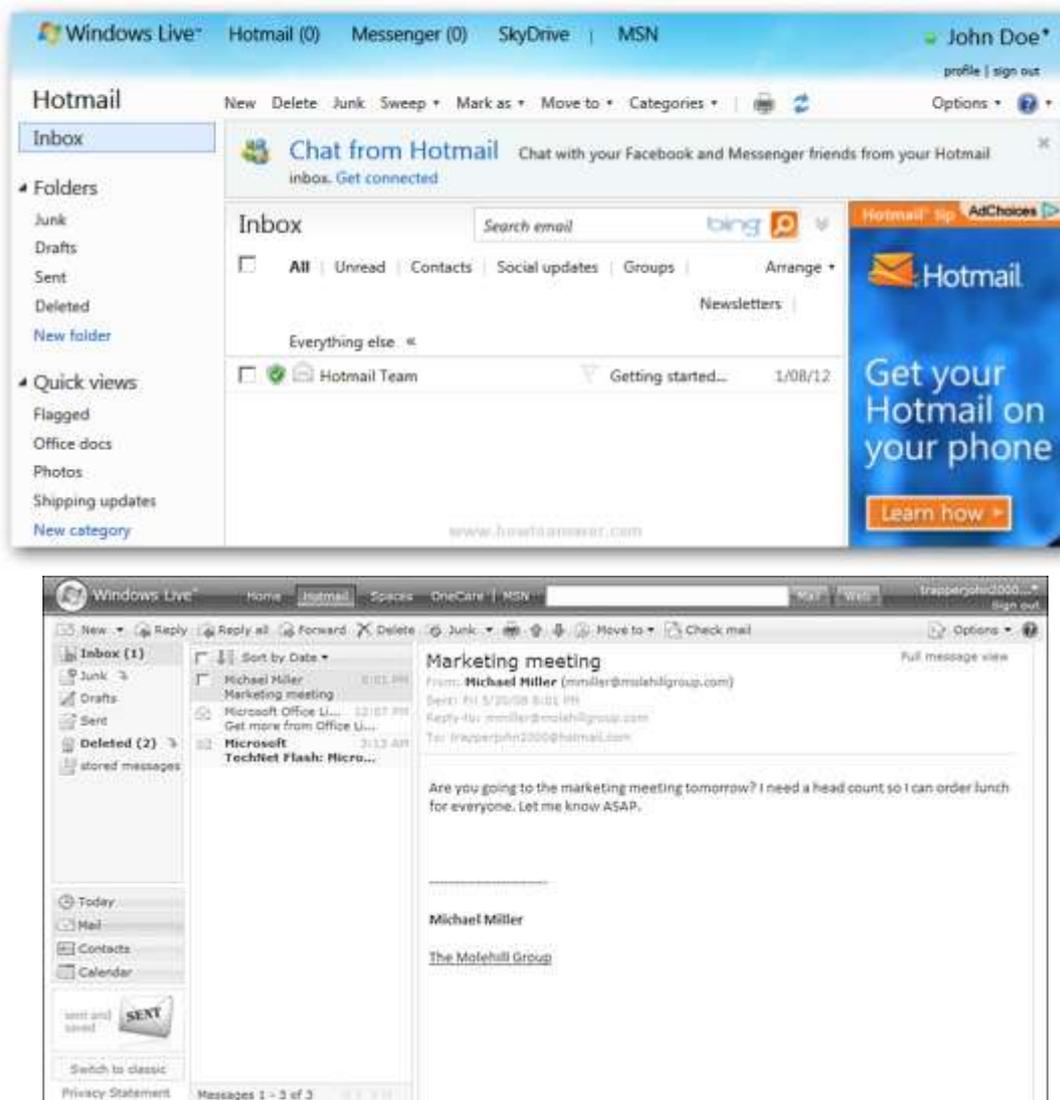
### Note

Hotmail started life (in 1996) as an independent company, but was acquired by software behemoth Microsoft in 1997.

Like most web mail services, Hotmail (we're going to call it by its old, shorter name) can be accessed from any web browser on any PC anywhere in the world, for free. Microsoft gives you 5GB of storage, not quite as much as you get with Gmail (6GB) or Yahoo! Mail (unlimited).

As you can see in Figure 3, the new Windows Live Hotmail interface is as snazzy as they come. You have your folder pane on the left, message page in the middle, and reading pane on the right. The new Hotmail also integrates with your Windows Live contacts and calendar, as well as other Windows Live services.

Figure 3. The new Windows Live Hotmail interface.



## Apple MobileMe Mail

As part of its MobileMe suite of applications, Apple offers MobileMe Mail ([www.me.com](http://www.me.com)). What makes MobileMe Mail unique is that it's not limited to just computer users; you can also send and receive emails from your Apple iPhone or iPod touch, via Wi-Fi Internet or cellular network.

MobileMe Mail is a web-based service that can also be accessed with your existing Mac or Windows-based email program, including Outlook, Outlook Express, and Windows Mail. It has its own native interface on the iPhone and iPod touch, as shown in Figure 4.

Figure 4. MobileMe Mail on an Apple iPhone.



Unlike the other webmail services discussed here, MobileMe Mail isn't free. It's part of the MobileMe suite of applications, which costs \$99 per year. (But you do get a really cool .me email address!)

## OtherWeb Mail Services

Gmail, Yahoo! Mail, and Windows Live Hotmail are the three largest web mail services (and MobileMe Mail promises to be a competitor), but there are literally hundreds more. Besides these big providers, there are dozens of independent web mail services, plus a plethora of topic-specific websites that offer (among other content and services) their own branded HTTP email. In addition, just about every cloud service provider, such as Zoho, offers web mail as part of its suite; web mail is also part of most web-based desktops.

So if you're looking for a web mail service and don't want to go with one of the big three, here's a short list of some of the other major providers to check out:

- AOL Mail ([mail.aol.com](mailto:mail.aol.com))
- BigString ([www.bigstring.com](http://www.bigstring.com))
- Excite Mail ([mail.excite.com](mailto:mail.excite.com))
- FlashMail ([www.flashmail.com](http://www.flashmail.com))
- GMX Mail ([www.gmx.com](http://www.gmx.com))
- [Inbox.com](http://www.inbox.com) ([www.inbox.com](http://www.inbox.com))
- Lycos Mail ([mail.lycos.com](mailto:mail.lycos.com))
- [Mail.com](http://www.mail.com) ([www.mail.com](http://www.mail.com))
- Zoho Mail ([zoho.mail.com](mailto:zoho.mail.com))

## Collaborating via Blogs and Wikis

### Collaborating via Blogs and Wikis : Evaluating Blogs for Collaboration

Group projects are all about collaboration and communication, so it pays to seek out every possible way to communicate with other group members. We've already looked at web mail and instant messaging, social network groups and groupware, but there are even more ways to handle your group communications.

#### Evaluating Blogs for Collaboration

If you've been on the Internet for any length of time, you've probably heard something about blogs. A blog (short for "web log") is a kind of online journal that its author updates frequently with new musings and information.

In terms of organization, a blog is a collection of individual posts or messages. The posts are arranged in reverse chronological order, with the newest posts at the top—which makes it easy to keep track of the latest developments. Older posts are relegated to the blog archives, which are generally accessible via a link in the sidebar column. And, at the end of each post, you'll find a link to comments; this is where blog readers can register their own personal comments about any given post.

But here's what makes blogs really powerful. A blog doesn't have to be the work of a single author; it can include posts from multiple contributors, as well as comments on each of those posts. This makes a blog ideal for keeping track of progress on a group project.

Here's how it goes. You create your blog, hosted on your company's servers or on a popular blogging tool such as Blogger or WordPad. You make it a private blog and assign authorship status to all the members of your team. This means that everyone on your team can initiate new posts, as well as comment on the posts of others.

When you have something important to say to the group, you make a blog post. Same with the other members; when they have updated info, they post it. In addition, other members can comment on your posts—for example, you can create a post to schedule a meeting, and have the other members comment on your post with their replies.

#### Note

Your blog posts don't have to be text only (although they can be). Most blogs let you include digital photos, blueprints, and other graphics, as well as audio and video files, in your posts.

Members of your group can access the blog by navigating to its web page to see what's new, or subscribe to an RSS feed that will notify them whenever there's a new post to the blog, so they're never in the dark.

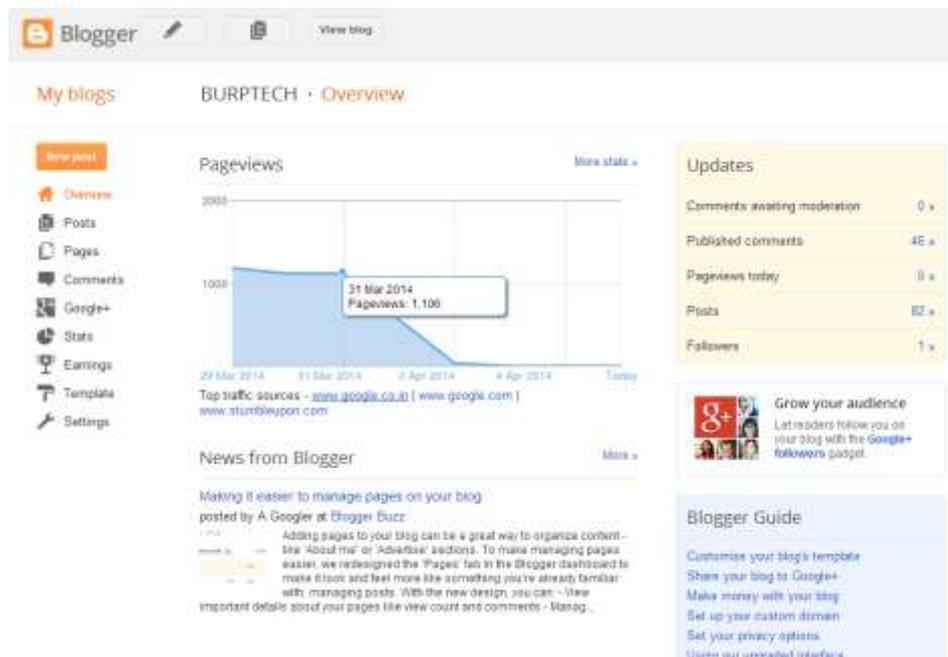
Where can your blog be hosted? If you work for a large company, ask your IT department about hosting your blog on the company's servers. Otherwise, you can check out any of the following blog-hosting communities, all of which will let you create private group blogs.

#### **Blogger**

Blogger ([www.blogger.com](http://www.blogger.com)) is Google's blog-hosting community, and with more than 8 million individual blogs, the largest blog host on the Internet. All Blogger blogs are free, which contributes to their popularity.

The Blogger Dashboard, shown in Figure 1, is where you manage all your blog activity. From here you can create new blog posts, edit comments to your posts, manage your Blogger account and profile, and access Blogger's help system. It's also where you create a new blog.

Figure 1. Managing your blog via the Blogger Dashboard.



Creating a new Blogger blog is as easy as filling in a few forms. After you click the Create a Blog link in the Blogger Dashboard, you're asked to enter a title for your blog and a corresponding blog address (the part of the URL that goes before Blogger's blogspot.com domain). Next, you get to choose a template for your blog—a predesigned combination of page layout, colors, and fonts. Blogger now creates your blog—and you're ready to start posting.

#### Note

By default, Blogger serves as host for your blog, and assigns you a URL in the blogspot.com domain. If you'd rather host your blog on your own website, that option is also available.

Figure 2 shows a typical Blogger blog—if there is such a beast as a “typical” blog. You can customize your blog with any number of different templates and color schemes; you can also add a variety of gadgets and other nonpost page elements.

Of course, one of the things you'll want to customize is the list of people who have access to you blog. By default, a Blogger blog is completely public, and anyone on the Internet can read it. However, there's a way to make your blog private so that only invited guests can view it; just go to the Blogger Dashboard, click the Manage: Settings link, and then click the Permissions link. When the next page appears, go to the Blog Readers section and select who can view your blog: Anybody (keeps the blog public), Only People I Choose, or Only Blog Authors.

For a group blog, the option you want is Only Blog Authors. Of course, you now have to invite the other members of your group to be blog authors; do this by clicking the Add Authors button.

## Note

In Blogger parlance, a blog author is someone who, like you, can create new blog postings. Although anyone can add comments to existing postings, only blog authors can create new postings.

## TypePad

TypePad ([www.typepad.com](http://www.typepad.com)) is quite similar to Blogger. You can customize your blog with a number of different designs and widgets, and you can select multiple coauthors for your blog. However, TypePad isn't free; you pay anywhere from \$4.95 to \$89.95 per month, depending on the features you want. (You need at least the Pro plan, starting at \$14.95/month, to support multiple co-authors.)

## WordPress

WordPress ([www.wordpress.com](http://www.wordpress.com)) is another popular blog-hosting community. It's a lot like both Blogger and TypePad, but perhaps a bit more customizable. You get lots of themes to choose from, sidebar widgets, and a private members-only option. You also can create multiple blogs and assign multiple authors. And, like Blogger, a WordPress blog is completely free.

## Note

Facebook, MySpace, and other social networks also include blogs as part of their profile pages—as do many online groupware and web-based desktop applications.

## **Collaborating via Blogs and Wikis : Evaluating Wikis for Collaboration**

Our final method of group collaboration is the wiki. You're probably familiar with the concept of wikis, thanks to the web's most popular wiki—Wikipedia.

If you've never used Wikipedia ([www.wikipedia.org](http://www.wikipedia.org)), you're in for an eye opener. Wikipedia is, in essence, a giant online encyclopedia—but with a twist. Wikipedia's content is created solely by the site's users, resulting in the world's largest online collaboration. Wikipedia articles are written, edited, and elaborated on by people of all types, from students, to subject-matter experts and professional researchers, to interested amateurs. It's a true group collaboration.

Which is, in fact, what a wiki is—a collection of web pages where any users can contribute or modify content. The first wiki was WikiWikiWeb, a website founded in 1995 to facilitate the exchange of ideas between computer programmers. Wikis enable all users not only to write new articles, but also to comment on and edit existing articles.

## Note

The word wiki comes from the Hawaiian word for “fast”—and is not an acronym for “what I know is,” as some suggest.

Today, many organizations use wikis as collaborative applications. A group wiki can be public (open to all users), as Wikipedia is, or private—which is ideal for project groups, businesses, and other organizations.

A private wiki invites all group members to create new pages on the wiki site or to edit any existing page. All writing and editing is done within the web browser, no extra software or tools necessary. In most instances, there is no review of the articles or edits before they’re accepted.

The result is a collection of articles or documents, written collaboratively. The wiki software organizes the articles behind the scenes and manages the versioning for each article.

Do you think a wiki is a good tool for your particular organization or project? If so, check out the following wiki hosting services; they make it easy to get your wiki up and running and to manage it on an ongoing basis.

### **PBwiki**

PBwiki ([www.pbwiki.com](http://www.pbwiki.com)) offers various levels of wiki hosting. Small wikis (one to three users) are free; larger ones are priced as low as \$4 per user per month. Wiki creation is easy, thanks to a variety of premade templates. You also get online file storage to help you organize your other documents as part of your wiki.

### **Versionate**

Versionate ([www.versionate.com](http://www.versionate.com)) offers hosted wikis designed for group collaboration. A Versionate wiki is business friendly, thanks to SSL-level security and full control over editing privileges; you can also import Word, Excel, PowerPoint, and PDF documents into your wiki. The company offers several different plans: Free (500MB storage), Personal (2GB storage for \$2/month), Business (unlimited storage for \$25/month), and Enterprise (unlimited storage for \$2/user/month).

### **wikihost.org**

The [wikihost.org](http://wikihost.org) site ([www.wikihost.org](http://www.wikihost.org)) provides free wiki hosting. Wiki creation is via the GeboBebo engine, which offers a local database structure, user and rights management, RSS feeds and email notification for new and updated articles, and image and file uploading.

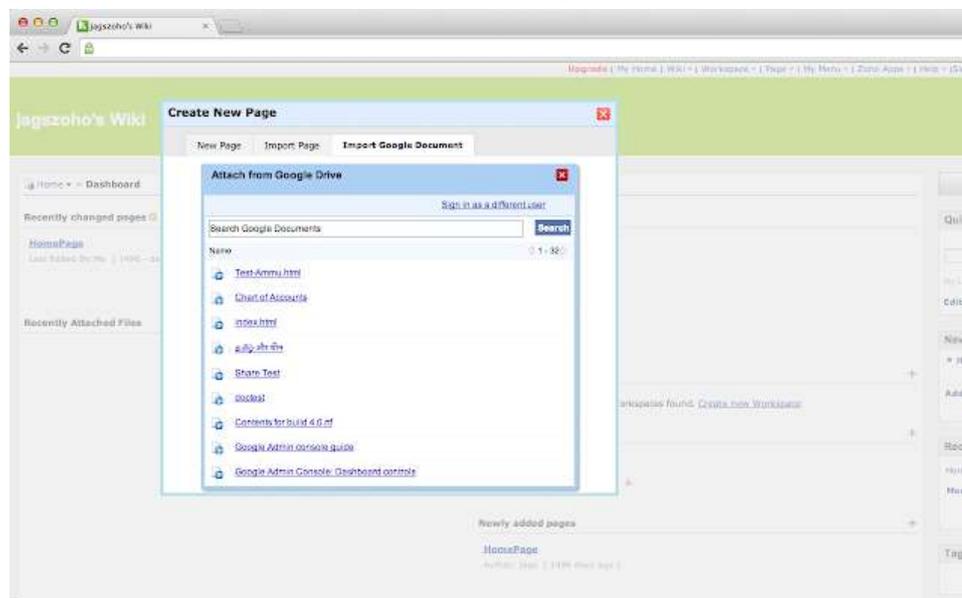
## Wikispaces

Wikispaces ([www.wikispaces.com](http://www.wikispaces.com)) claims to host more than 450,000 individual wikis. Standard features include image and file uploading, widget and media embedding, RSS feeds and email notifications, discussion areas, and detailed user statistics. A variety of hosting plans are available, from Basic (free) to Private Label Premium (\$800/month).

## Zoho Wiki

Finally, from our friends at Zoho, comes their wiki application, Zoho Wiki ([wiki.zoho.com](http://wiki.zoho.com)). They offer free wiki hosting complete with WYSIWYG editing, versioning of wiki pages, and the ability to make your wiki public or private—all for free. Your wiki is managed from a Dashboard page, like the one shown in Figure 1; just click the New Page icon to add a new page to the wiki.

Figure 1. Using the Zoho Wiki Dashboard to manage a wiki.



## Is Cloud Computing Necessary for Group Collaboration?

That is, many of these tools either exist solely on a dedicated server (such as a company's internal server) or work via peer-to-peer technology. Knowing this, just how necessary is cloud computing for effective group collaboration?

The answer, of course, is not totally necessary. After all, you can easily use noncloud tools, such as instant messaging, to communicate with other members of your group. And, if your group is 100 percent internal to your company, there's no reason to venture into the cloud at all—assuming you always have access to your company's network, of course.

But if you want to include people from outside your organization in your group, or if your group is spread out between multiple locations, or if members of your group travel or work from home, then incorporating some cloud-based tools makes a lot of sense. When you're out of the main office, it's a lot easier to log on to a cloud website than it is to try to

remotely tunnel into your company's network.

That's not to say that pure cloud technology is always necessary. Your application and documents could just as easily be hosted on the hosting provider's servers; they don't have to be "in the cloud," per se. That said, as applications become bigger and more powerful, and as the need for huge amounts of storage continues to increase, the advantages of sharing cloud resources become more explicit.

So even if your groupware and collaboration applications aren't yet hosted in the cloud, they probably will be sometime in the future. It's simply a lot more efficient to share space on hundreds or thousands of cloud computers than it is to keep buying more servers for your data center. That's the real reason why cloud computing will likely become ubiquitous; it provides more power and storage for less money than any other current computing solution.

## **Collaborating via Social Networks and Groupware : Creating Groups on Social Networks**

When it comes to collaborating with a group of people who may or may not share the same physical location, one naturally turns to the web. When all team members have access to the Internet, why not use the Internet to connect the members of the group—to enable communication, file sharing, and the like?

### **Creating Groups on Social Networks**

You're probably already familiar with social networks such as Facebook and MySpace. The typical social network is a hosted site that aims to create a community of users, each of whom posts his or her own personal profile on the site. Each user includes enough personal information in her profile to enable other users with similar interests to connect as "friends"; one's collection of friends helps to build a succession of personal communities.

Most profile pages include some form of blog, discussion forum, or chat space so that friends can communicate with the person profiled. In many instances, individual users also post a running list of their current activities so that their friends always know what they're up to.

Given that social networks are personal in nature, what value do they hold for businesses, community groups, and families? Lots, if you use them properly.

You see, most social networking sites let you create your own topic-specific groups. In this instance, a group is a collection of users who share the same interest; group members can communicate via discussion boards, share photos and videos, and even upload and download documents and other files.

In other words, a social network group is like a virtual meeting or community room. Instead of posting notices on a physical bulletin board, you post notices on a virtual message board. Instead of exchanging brochures and papers by hand, you upload photos, documents, and other files for all to share. And, because most social networks are free for all to use (in exchange for the occasional on-page advertisement), it's a cheap way to keep the members of your group up-to-date and organized.

In this regard, I find social network groups especially useful for community groups, far-flung friends, and families. You get just enough functionality to keep everyone in touch with each other, at no cost to anyone involved. No IT support is necessary, nor do you have to lease web hosting space; the social network site maintains all the servers and technology. And, of course, all of these sites are easy to join and easy to use, which is nice if your groups include non-tech-savvy members.

These social network groups are less useful for larger businesses. In a nutshell, these groups lack the advanced collaboration features that help to keep group projects on track. In addition, the profusion of web page advertising is anathema to many businesspeople. Finally, many businesses aren't comfortable posting their business on a nonsecure third-party site (nor should they be), especially when more secure options are available.

With all this in mind, let's take a quick look at the two most popular social networking sites (at least in the United States) and what they offer in terms of group collaboration features.

## Facebook

Of all the social network sites, I recommend Facebook ([www.facebook.com](http://www.facebook.com)) first and foremost for those serious about group collaboration. Compared to MySpace, Facebook is more of a site for grown-ups; MySpace is more suited for teenagers and preteens.

When you create a group on Facebook, you end up with a group page like the one in Figure 1. A Facebook group includes the following collaborative features:

- Recent news
- Discussion board
- Uploaded photos and videos
- Posted web pages
- The Wall—a kind of chat board

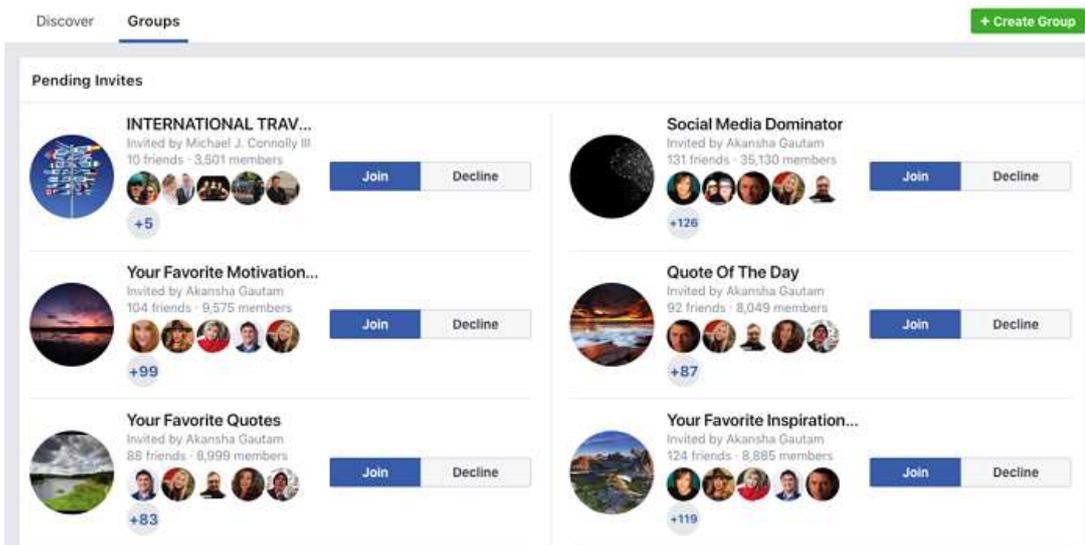
Figure 1.

## How to Create a Facebook Group

### 1. Find "Add Group"

From your "[home page](#)" on Facebook go to the Explore - Groups section on the left side menu and click on, "Groups."

Once you get there, it will look like this:

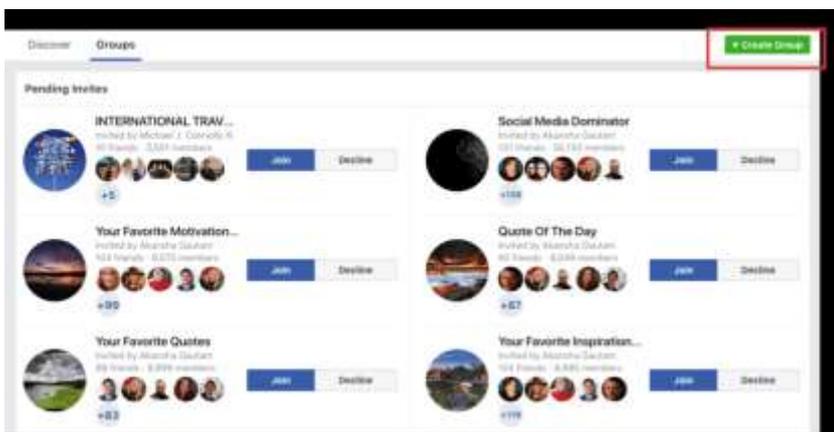


## 2. Click "Create Group"

You'll be taken to a page that displays the option to [create a group](#) as well as showing you some:

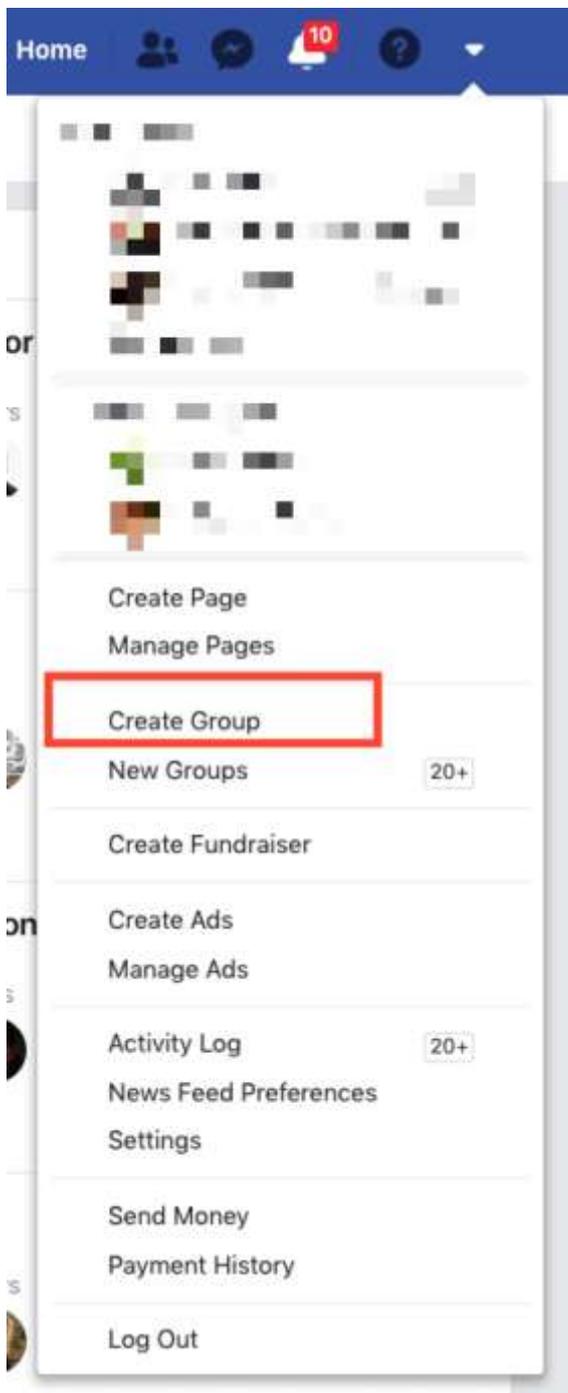
- Pending Invites
- Favorites
- Your Groups
- Groups You Manage

To begin the process of creating a group, click "Create Group" in the upper right hand corner.



>> **Facebook also offers an alternate way to create a new group**

Right of your name and the notifications bell in the right hand corner, click on the drop down and choose, "Create Group."



Once you choose that option, a lightbox will open where you can begin to add your [Facebook group](#) details.

Create New Group

Groups are great for getting things done and staying in touch with just the people you want. Share photos and videos, have conversations, make plans and more.

Name your group

Add some people

Enter names or email addresses...

Select privacy [Learn more about groups privacy](#)

Closed Group  
Anyone can find the group and see who's in it. Only members can see posts.

Pin to Shortcuts

Create

### 3. Name Your Group

The first thing you need to do is give your group a name -- I'm naming my group "Scott Secret Group".

This name can be whatever you want and you can change it later. But try to **make the group name memorable** and searchable -- so people can find it.

Create New Group

Groups are great for getting things done and staying in touch with just the people you want. Share photos and videos, have conversations, make plans and more.

Name your group

Scott Secret Group

Add some people

Enter names or email addresses...

Select privacy [Learn more about groups privacy](#)

Closed Group  
Anyone can find the group and see who's in it. Only members can see posts.

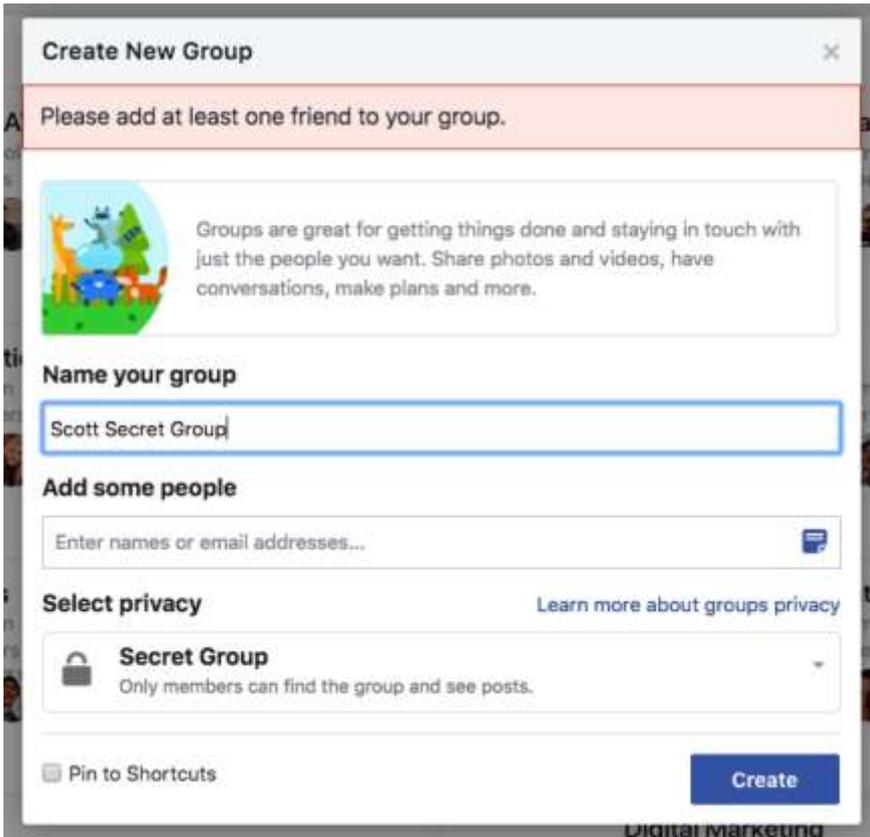
Pin to Shortcuts

Create

### 4. Add Members

Facebook does something odd here -- and out of order, in my opinion.

You're actually required to add at least 1 friend to the group before you can create it. If you don't you get the error message below:



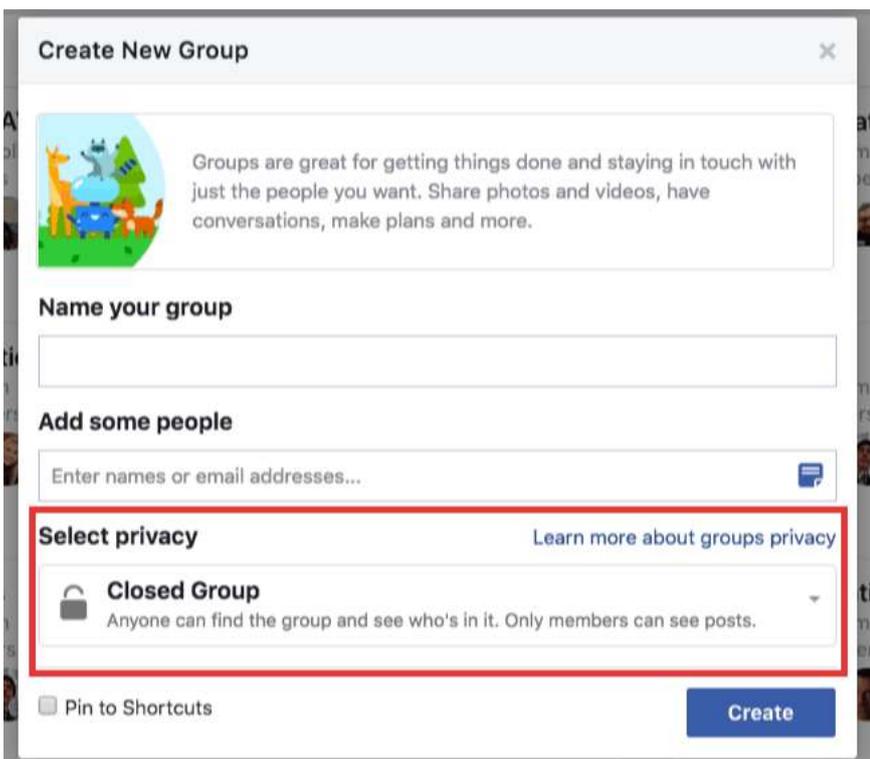
The screenshot shows the 'Create New Group' dialog box with a red error banner at the top that reads: 'Please add at least one friend to your group.' Below the banner is a section with a colorful illustration of animals and the text: 'Groups are great for getting things done and staying in touch with just the people you want. Share photos and videos, have conversations, make plans and more.' Underneath is the 'Name your group' section with a text input field containing 'Scott Secret Group'. The 'Add some people' section has a text input field with the placeholder 'Enter names or email addresses...'. The 'Select privacy' section shows a dropdown menu set to 'Secret Group' with the description 'Only members can find the group and see posts.' At the bottom, there is a 'Pin to Shortcuts' checkbox and a blue 'Create' button.

So in order to **create your group**, you'll need to add at least 1 friend to the group.

## 5. Choose Privacy Setting

You'll now need to decide **what privacy setting** you want your group to have.

This is probably the most important choice you'll make while creating your group -- as there are some limits to changing down the road.



This screenshot shows the same 'Create New Group' dialog box, but the 'Closed Group' option is selected in the 'Select privacy' dropdown menu. The 'Closed Group' option is highlighted with a red rectangular box and includes the description: 'Anyone can find the group and see who's in it. Only members can see posts.' The 'Name your group' field is now empty. The 'Add some people' field and the 'Create' button remain the same as in the previous screenshot.

If you have fewer than 5000 members you'll be able to change the settings as you see fit.

But as soon as your groups grows to over 5000 members, you can only change an Open group to Closed or Secret -- and a Closed group to Secret.

You won't be able to change the privacy again after this.

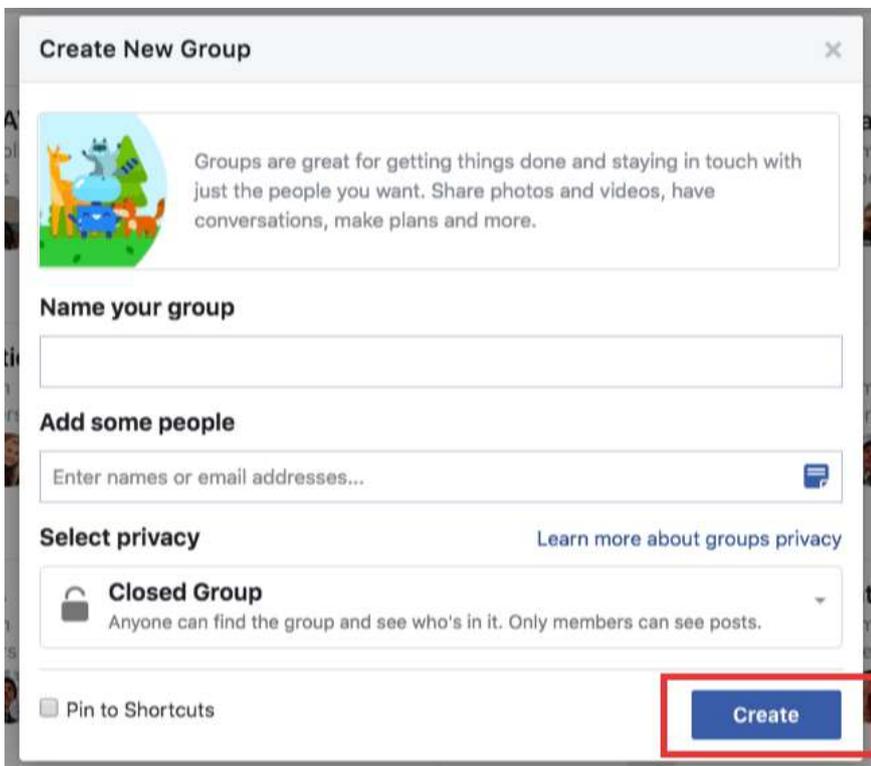
There can be confusion about [what privacy setting a group should have](#) -- Open, Closed or Secret.

It's fairly self explanatory as seen above -- but here's another great graphic from Facebook to break it down:

	Open	Closed	Secret
Who can join?	Anyone can join or be added by a member	Anyone can ask to join or be added	Anyone, but they have to be added
Who can see the group name and who's in it?	Anyone	Anyone	Only members
Who can see posts in the group?	Anyone	Only members	Only members
Who can find the group in search?	Anyone	Anyone	Only members
Who can see stories about the group on Facebook (like in News Feed and search)?	Anyone	Anyone	Only members

## 6. Click Create

After you choose your privacy setting, click the "Create" button as you've seen in previous images:



## 7. Add Your Cover Image

Facebook will now give you the option to add your creative graphic for your header or cover image.

This is completely up to you and should be aligned with your current brand or the theme of your group.

But if you've created many groups or have multiple groups in your favorites, you'll want to choose an image that differentiates each of them.



Keep in mind: the dimensions for this cover photo are different from those on your personal Timeline or business Page.

You want to use **1640 x 856 pixels** for your group cover image.

## 8. Complete "About" Section

Your about section is important for 2 reasons:

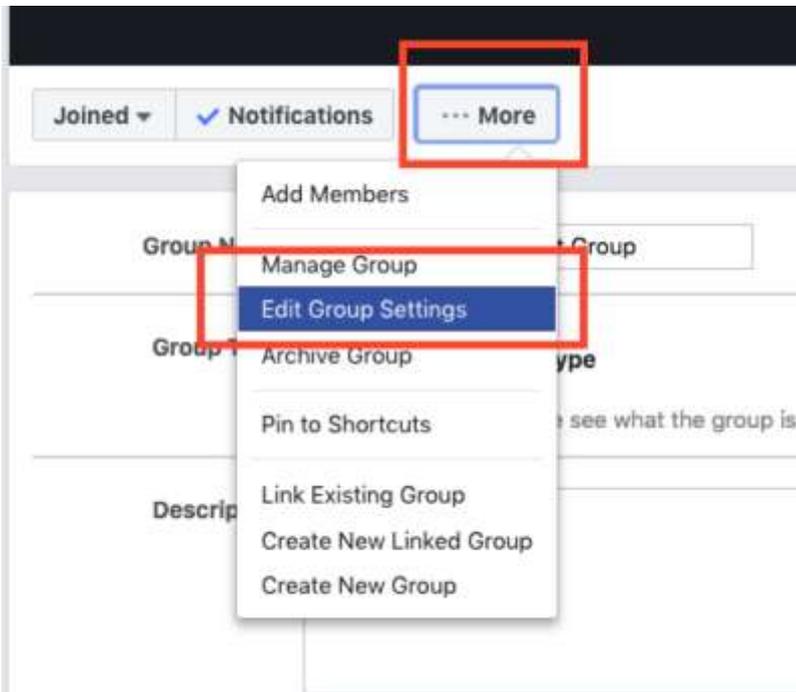
- Gives prospective members an idea what your group is about
- Can display any "rules" you may have about the group

So fill it out as you see fit -- seeing as this is YOUR group.

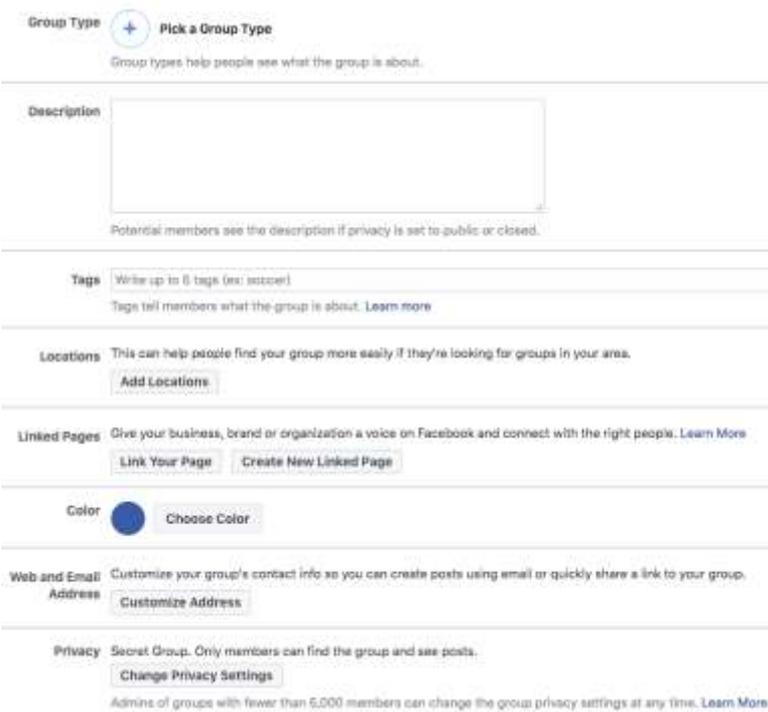
## 10. Edit Group Settings

Next you'll want to edit the group settings.

You do this by clicking on the "More" tab and then clicking "Edit Group Settings":



Once on the edit page, you'll have many options to change:



Items you can change:

- **Group Name**
- **Group Type**

- **Description**
- **Tags**
- **Locations**
- **Linked Pages**
- **Privacy Settings**
- **Membership Approval** -- Do you want to let anyone add members or should only you be able to?
- **Set a Group Address** -- Here you'll have a chance to give the group a custom url as well as an email address where people could email the group directly.
- **Change your Description**
- **Change Posting Permissions** -- Here you can decide if only admins can post or if members can as well
- **Post Approval** -- You can require that all posts be approved by an admin before going live

Once you're done and happy with the settings, click "Save".

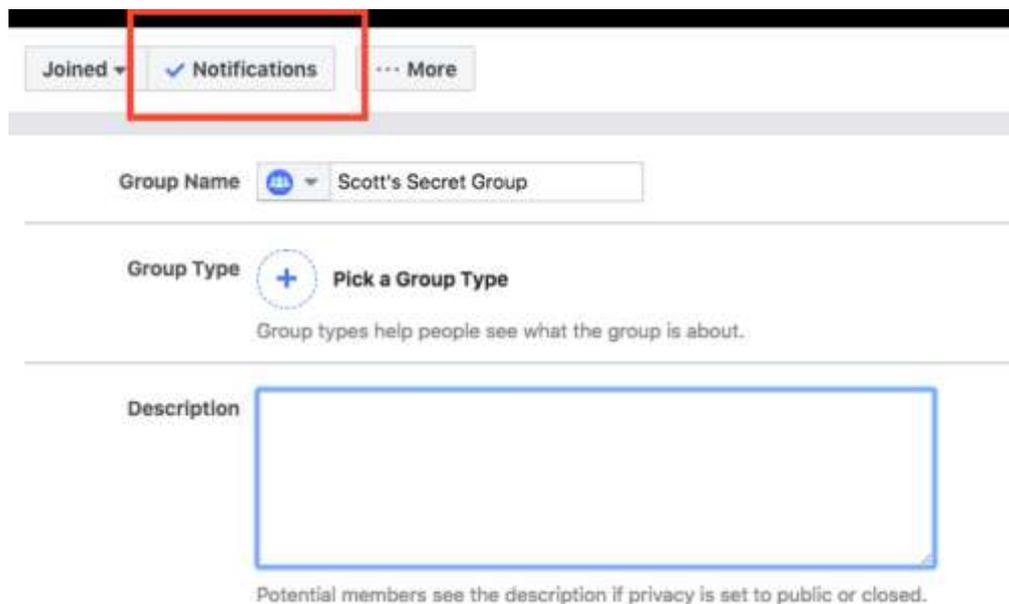
### Your Group is Ready to Go!

You've now successfully created a Facebook Group! Congrats!

Now you can post updates inside the groups -- and so can members (if you've allowed it).

### A Few Group Features to Point Out

**Notifications**- As an admin you should probably turn the notifications on to receive all updates when anyone posts -- just in case someone spams the group & you want to respond quickly:



**Messages/Chat**- One of the great things about groups is you can initiate a group chat/message with either all members of a group or select members.

This is especially useful when you have an announcement to make or need to quickly collaborate on an item/issue.

**Events**- A feature probably not used often enough in Groups is Events. Inside the group you can create events that only members can see & RSVP for.

Just click on the "Events" tab to the left and then "Create Event" & the lightbox below will load to create your event.

**Files-** Inside groups you can share files of any kind as well as create Documents which group members can add to & collaborate on.

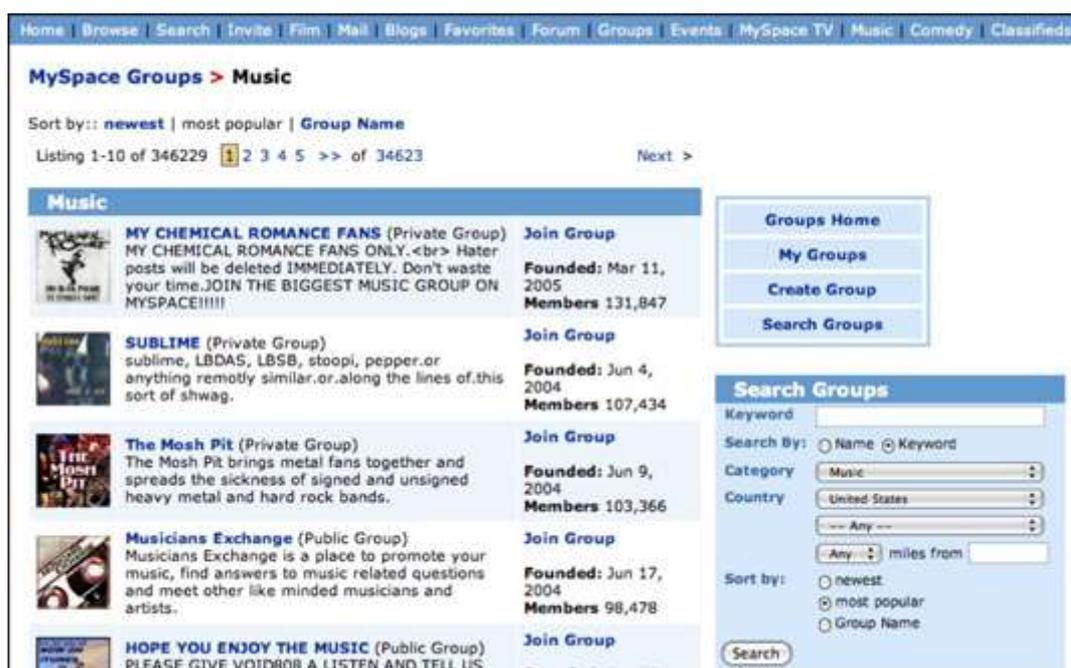
Think of this as your own little workspace within Facebook -- or perhaps a replacement for apps like Basecamp or Dropbox.

Your group can be Open (public), Closed (description if public, but members have to be approved), or Secret (membership by invitation only). Unfortunately, Facebook groups do not offer file uploading or sharing.

## MySpace

A group on MySpace ([www.myspace.com](http://www.myspace.com)) is even more limited in functionality than what you can find on Facebook; this isn't surprising, given MySpace's typically younger audience. There's no file uploading, although members can upload group photos. There's a facility for posting group bulletins, and the obligatory discussion board, but that's it. Oh, and you have to put up with advertisements smack in the middle of your group page, as you can see in Figure 2. If you can live with all this, by all means consider MySpace for your (limited) group needs.

Figure 2. A MySpace group page.



## Other Web Groups

The groups on social networking sites aren't the only groups you can create on the web. In fact, they may be some of the less-functional groups out there; other sites do groups better.

Case in point: Google Groups ([groups.google.com](http://groups.google.com)). When you create a Google Group, you get the obligatory message forum, but you also get to upload and share files, as well as create topic-specific pages within the group; group members can be notified of new posts via email. A Google Group can be Public (anyone can join, but only members can read

messages), Announcement-Only (anyone can join, but only moderators can post messages), or Restricted (only the people you invite can join).

Similar to Google Groups is Yahoo! Groups ([groups.yahoo.com](http://groups.yahoo.com)). Here you also get a message forum (with email notification of new posts) and file uploading, and also a photo library, group calendar, and polls. You can select whether your group appears in the Yahoo! Groups directory, whether anyone can join or if you have to approve all members, and who can post messages to the group.

Because of the file-uploading and -sharing options, either of these two groups might be more useful to you than a Facebook or MySpace group—even though they might not have the cachet of the social networking groups

## **Collaborating via Social Networks and Groupware : Evaluating Online Groupware**

For larger businesses, a social network group probably won't suffice. What you need instead is a collection of web-based collaborative tools that help your team members not only communicate with each other but also manage their group projects.

This type of solution is commonly known as groupware, and when it's based in the cloud it's called online groupware. In a nutshell, groupware is collaboration software for workgroups. Online groupware does away with the physical constraints of traditional groupware, letting members from throughout an organization, in any location, access group assets.

What does this mean? In practicality, online groupware typically includes some or all of the following tools:

- File and document uploading and sharing
- Web calendar
- Task/project manager
- Message boards
- Text-based chat rooms / instant messaging
- Wiki-like collaborative pages
- Blogs

Why use online groupware? First of all, it puts all your group communications (and, in some cases, files) all in one place—and that one place is accessible to group members in any location, as long as they have an Internet connection. Second, groupware makes it easier to communicate, which should reduce the number of meetings and conferences calls, as well as your email traffic. Finally, all this should increase your group's collective and members' individual productivity. It's as simple as that.

For example, suppose you're managing a community not-for-profit group. You can use online groupware to connect other managers and volunteers across the community. You can share plans, proposals, and other documents with all members, and use the groupware to solicit and receive proposals and invoices from suppliers. And, best of all, you can do this from your own computer, which means fewer phone calls, car trips, and unnecessary meetings—all of which translates into less time involved and fewer expenses, both of which are important for charities.

So read on to learn about some of the most popular online groupware applications.

## AirSet

AirSet ([www.airset.com](http://www.airset.com)) provides a cloud-based website for your group. Your AirSet site can include group announcements, a web calendar, contact list, task list, instant messaging, wiki for collaborative publishing, blog, file sharing and online storage, photo albums, and music playlists. And with all these tools, when one person in the group makes a change, everyone else sees the updated information.

## ContactOffice

ContactOffice ([www.contactoffice.com](http://www.contactoffice.com)) is a web-based data management system that lets you share emails, contacts, tasks, appointments, and documents with other group members. You can create internal or intercompany groups; the latter helps you communicate with customers, suppliers, and other people outside your immediate office. You also get a web-based calendar, address book, message forum, and real-time chat. (Figure 1 shows the ContactOffice's "virtual office" dashboard page.)

Figure 1. ContactOffice's "virtual office."

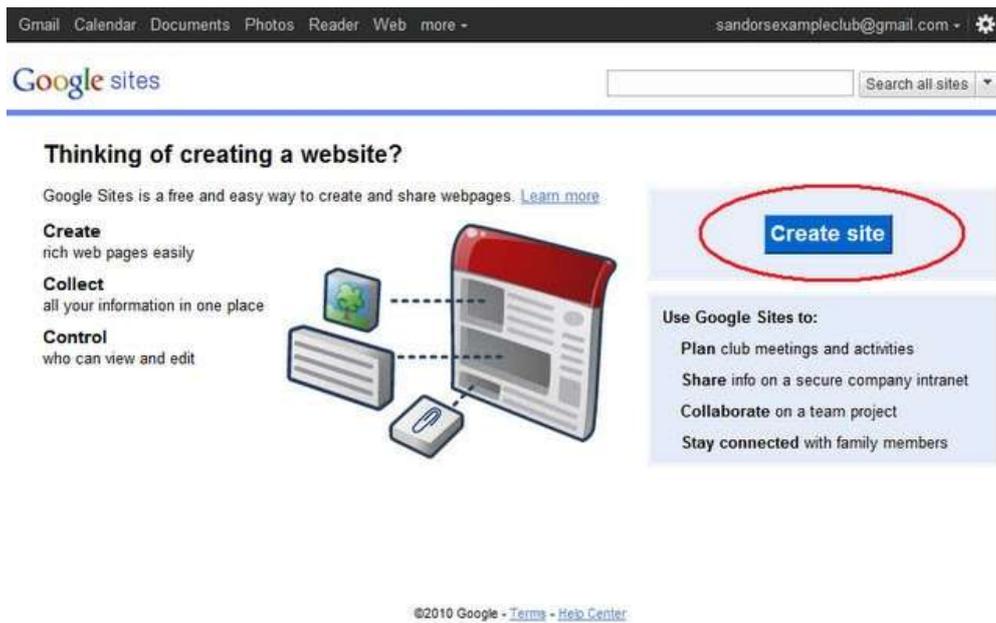


## Google Sites

Google Sites ([sites.google.com](http://sites.google.com)), formerly known as Jotspot, lets you create a group web page (hosted by Google), like the one shown in Figure 2. This page is completely customizable with your choice of file uploads, group announcements, task/project management, mailing lists, group calendar, and the like. Google Sites also integrates with

Google's other online apps, including Gmail, Google Calendar, Google Docs, and Google Talk. And, as with most things Google, it's completely free.

Figure 2. A typical Google Sites group page.



## Huddle

Huddle ([www.huddle.net](http://www.huddle.net)) is a hosted environment that combines online collaboration, project management, and document sharing, using social networking principles. You create a network of collaborative team workspaces, managed from a central dashboard. You can then take advantage of Huddle's online file storage, project calendar, RSS and email notifications, whiteboard, wiki, and other collaborative tools.

## Nexo

Nexo ([www.nexo.com](http://www.nexo.com)) lets you create a free personalized group website. The site can include photos, videos, forums, message boards, interactive calendars, polls, and to-do lists. Nexo targets its service to family, friend, and community groups, although it may also function for some less-demanding business groups.

## Note

Nexo was recently acquired by Shutterfly.

## OpenTeams

OpenTeams ([www.openteams.com](http://www.openteams.com)) is better suited for larger businesses. It offers team folders, blogging, and wiki-like collaborative pages, all monitored via a customizable Navigator page, shown in Figure 4. From here you can keep track of key team members, organize resources with tags, participate in threaded discussions, and monitor new content posted by team members. Pricing is on a per-user, per-use basis, starting at \$0.99 per user log-on day.

Figure 4. The OpenTeams Navigator



## ProjectSpaces

ProjectSpaces ([www.projectsaces.com](http://www.projectsaces.com)) provides an online workspace designed especially for group collaboration. You get an online document library, email discussion lists, task management, group announcements via email and RSS, a shared group calendar, and shared group documents.

## teamspace

Our final online groupware application is called teamspace ([www.teamspace.com](http://www.teamspace.com)), with a lowercase t. This application offers task and project management, contact management, an online calendar, message forum, notice board, file sharing, text-based chat, and synchronization with Microsoft Outlook. Pricing is on a per-member basis, with additional fees for storage space used.