Cloud Computing

Overview and Introduction

Just Think…….

- Electricity
- Water supply
- Transportation

Why not computing as a **UTILITY**

Cloud & Computing

- A Cloud is …
  - Datacenter hardware and software
  - that the vendors use to offer the
- Computing
  - the use or operation of computers
- Wikipedia:
  - "the term derives from the fact that most technology diagrams depict the Internet or IP availability by using a drawing of a cloud.”

The interesting thing about Cloud Computing is that we've **redefined Cloud Computing** to include everything that **we already do**. . . . I don't understand what we would do differently in the light of Cloud Computing other than **change the wording** of some of our ads.

Larry Ellison, quoted in the Wall Street Journal, September 26, 2008

Cloud computing: state-of-the-art and research challenges

Slides adapted

Word history….

- Envisioned that computing facilities will be provided to the general public like a utility

  [John McCarthy, 1960]

- Business model of providing services across the Internet

  [Google's CEO Eric Schmidt,2006]

Definition

- No standard definition
  - A break in the clouds: towards a cloud definition
  - Discuss 20 different definitions from the different sources.
- There has been work on standardizing the definition of cloud computing

The National Institute of Standards and Technology (NIST) definition

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Related technologies

Grid Computing:

- Distributed computing paradigm that **coordinates networked resources** to achieve a common computational objective.
- Computation-intensive applications.
- Cloud computing is similar to Grid computing in that it also employs distributed resources to achieve application-level objectives.
- Cloud computing takes one step further by leveraging **virtualization technologies.**

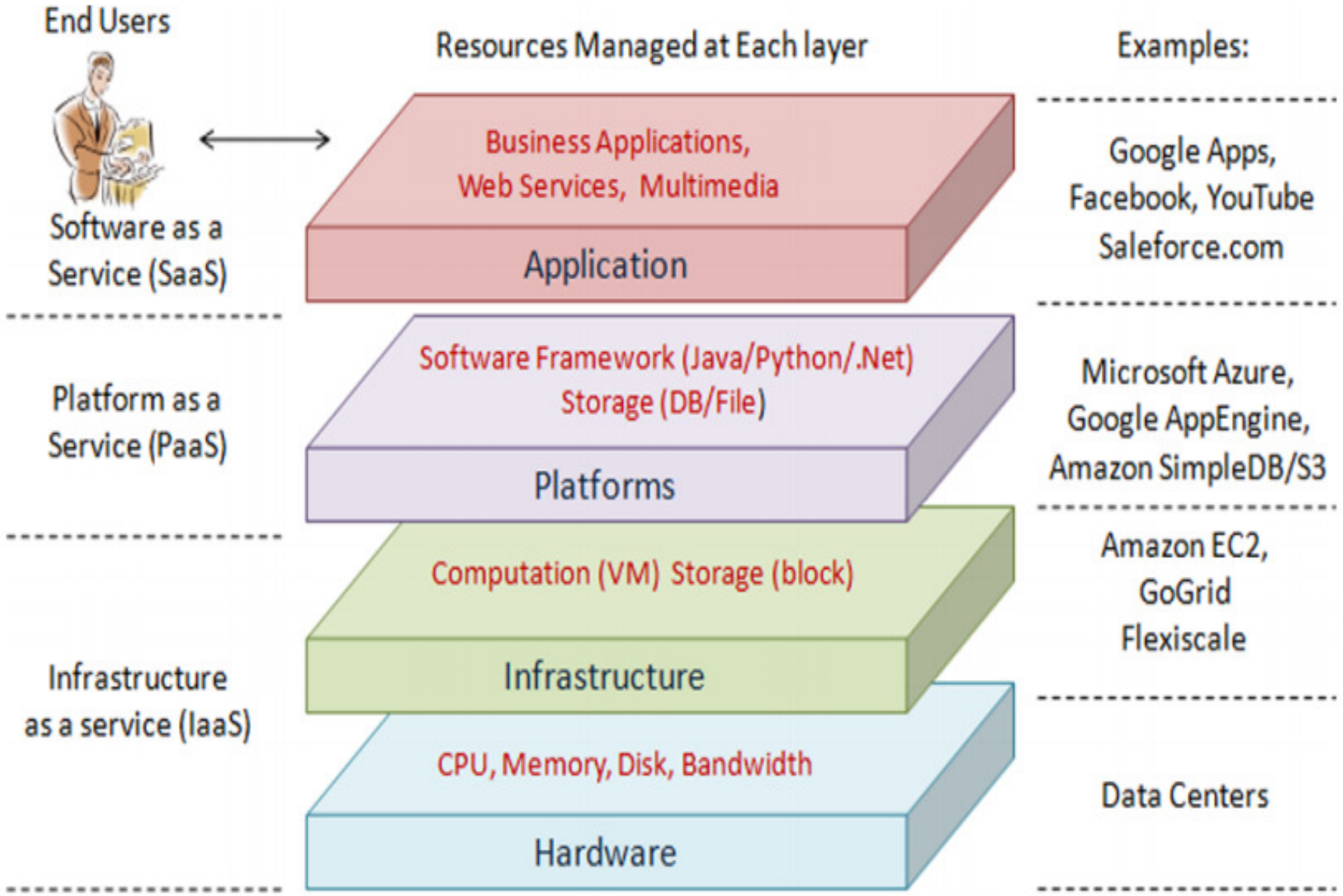
Virtualization:

- Abstracts away the details of physical hardware and provides virtualized resources for high-level applications.
- A virtualized server is commonly called a virtual machine (VM).
- Forms the foundation of cloud computing.

Cloud computing architecture

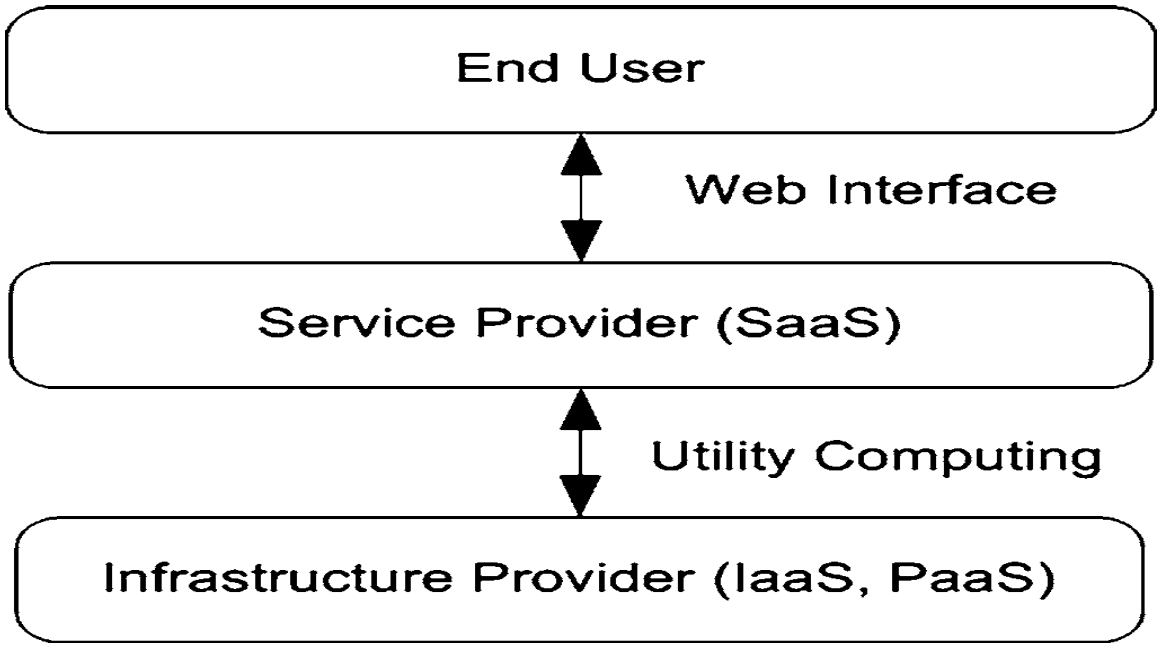
A 4-Layered Model

- Hardware/datacenter layer
  - Responsible for managing the physical resources e.g servers, routers, switches, power & cooling sys.
  - A data center usually contains thousands of servers , organized in racks & interconnected through switches, routers etc
- Infrastructure layer or virtualization layer,
  - Creates a pool of storage and computing resources by partitioning the physical resources using virtualization technologies such as Xen ,KVM & Vmware
  - Essential component of cloud computing
- Platform layer
  - Built on top of the infrastructure layer
  - Consists of operating systems & application frameworks.
  - The purpose: minimize the burden of deploying applications directly into VM containers.
  - E.g Google App Engine operates at the platform layer to provide API support for implementing storage, database and business logic of typical web applications.
- Application layer
  - highest level of the hierarchy
  - consists of the actual cloud applications.
  - Diff from traditional applications, cloud applications can leverage the


End Users
Resources Managed at Each layer
Examples:
Business Applications,
Web Services, Multimedia
Application
Google Apps,
Facebook, YouTube
Saleforce.com
Software as a
Service (SaaS)
Software Framework (Java/Python/.Net)
Storage (DB/File)
Platforms
Microsoft Azure,
Google AppEngine,
Amazon SimpleDB/S3
Platform as a
Service (PaaS)
Computation (VM) Storage (block)
Infrastructure
Amazon EC2,
GoGrid
Flexiscale
Infrastructure
as a service (IaaS)
CPU, Memory, Disk, Bandwidth
Hardware
Data Centers

Business model

- Resources are provided as services on an on-demand basis.
- Every layer is a customer of the layer below.
  - IaaS
  - PaaS
  - SaaS



Infrastructure as a Service

- Provisioning of infrastructural resources
- In terms of VMs
  - virtual machine functions as if it owned the entire computer
- IaaS provider
  - Amazon EC2
  - GoGrid
  - Flexiscale

Platform as a Service

- Resources including operating system support and software development frameworks.
- Examples of PaaS
  - Google App Engine
  - Microsoft
  - Windows Azure

Software as a Service

- Applications over the Internet.
- Examples of SaaS
  - Salesforce.com
  - Rackspace
  - SAP Business

Types of clouds

- lowering operation cost, while others may prefer high reliability and security
  - Public
  - Private
  - Hybrid
  - Virual

- **Public clouds**
  - Service providers offer their resources as services to the general public.
  - key benefits
    - No initial capital investment on infrastructure
  - Lack fine-grained control over data, network and security settings
- **Private clouds**
  - Internal clouds;Exclusive use by a single organization.
  - Managed by the organization or by external providers. A private cloud offers the
  - key benefits
    - Control over performance
    - Reliability and security.
  - Criticized: Similar to traditional proprietary server farms and do not provide benefits such as no up-front capital costs.

- **Hybrid clouds**
  - combination of public and private
  - part of the service infrastructure runs in private clouds while the remaining part runs in public clouds
  - Offer more flexibility
  - Tighter control and security
  - A hybrid cloud requires carefully determining the best split between public and private cloud components.

- **Virtual Private Cloud**
  - A VPC is essentially a platform running on top of public clouds.
  - Difference: leverages virtual private network (VPN) technology
    - Allows service providers to design their own topology and security settings such as firewall rules.
  - More holistic design since it not only virtualizes servers and applications, but also the underlying communication network as well.

Cloud computing characteristics

- Multi-tenancy
- Shared resource pooling
- Geo-distribution and ubiquitous networ access
- Service oriented
  - Service Level Agreement (SLA)
- Dynamic resource provisioning
- Self-organizing
  - flash crowd effect
- Utility-based pricing
  - pay per-use pricing model