

# Software Systems Architecture in a World of Cloud Computing

Christine Miyachi  
SDM Entering Class 2000

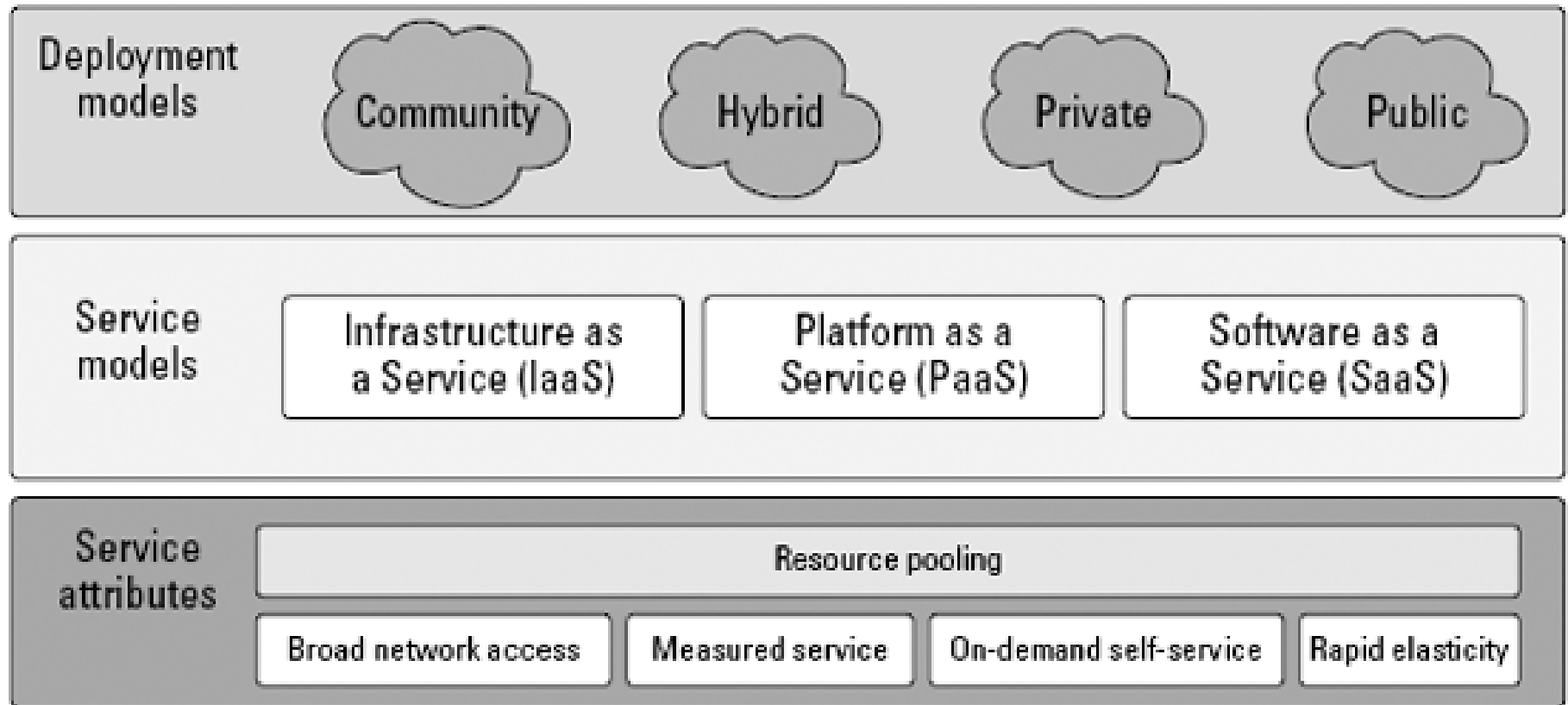
# Outline

- Overview of cloud computing
- The business of cloud
- The process of cloud
- Software Architecture in the cloud

# Definition of Cloud Computing

- The current NIST definition for Cloud Computing states:
- *“Cloud computing is a model for enabling ubiquitous, 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. This cloud model is composed of five essential characteristics, three service models, and four deployment models.”*
- [http://www.nist.gov/customcf/get\\_pdf.cfm?pub\\_id=909616](http://www.nist.gov/customcf/get_pdf.cfm?pub_id=909616)

# Figure 1.1. The NIST cloud computing definitions



From *Cloud Computing Bible*, Chapter 1.2

# THE FIVE CLOUD CHARACTERISTICS

- *On-demand self-service*
- *Broad network access*
- *Resource pooling*
- *Rapid elasticity*
- *Measured service*

# CLOUD DEPLOYMENT MODELS

- *Private cloud*
- *Community cloud*
- *Public cloud*
- *Hybrid cloud*

# XaaS or <Something> as a Service

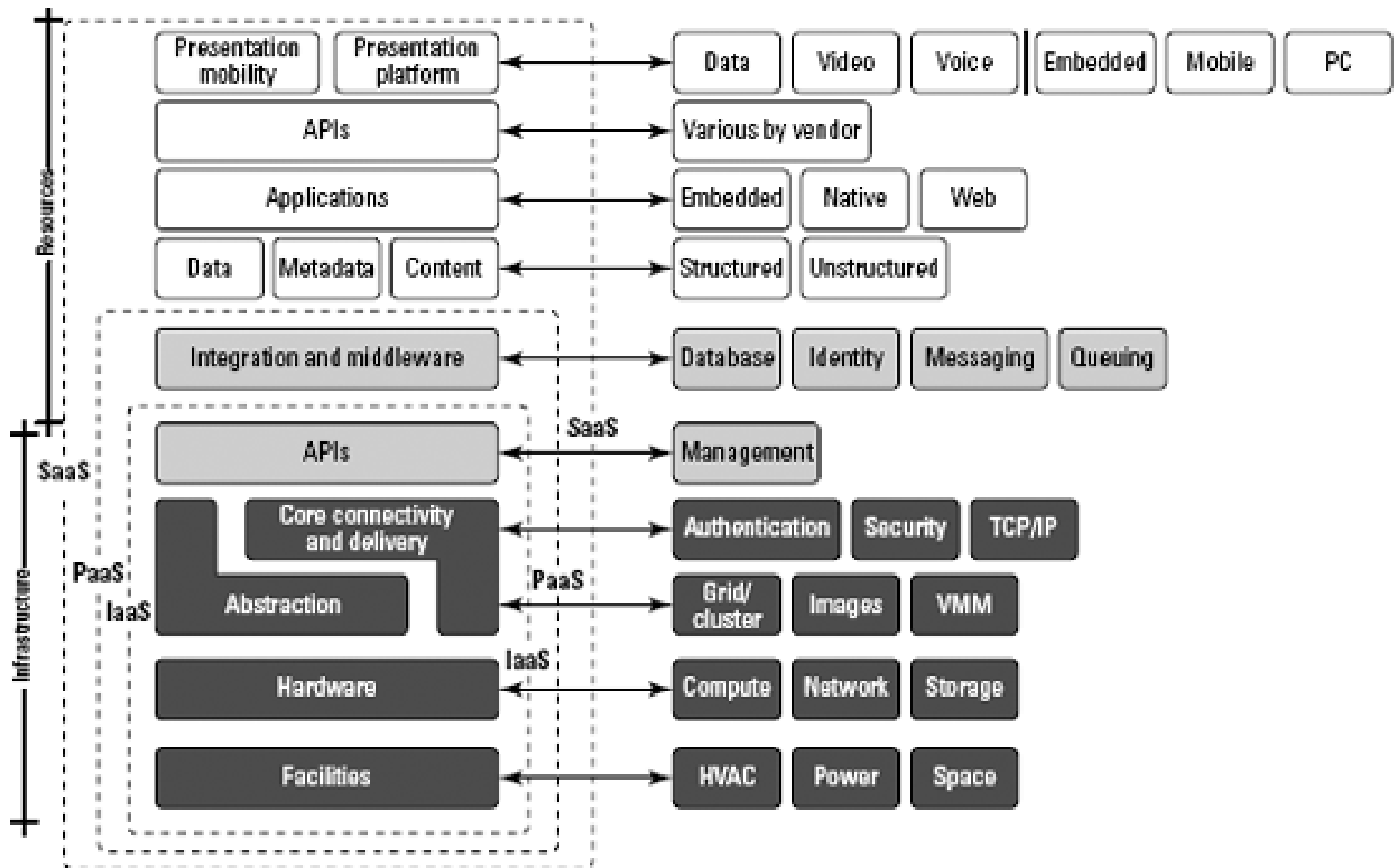
- **Infrastructure as a Service:** virtual machines, virtual storage, virtual infrastructure, and other hardware assets as resources that clients can provision.
- **Platform as a Service:** virtual machines, operating systems, applications, services, development frameworks, transactions, and control structures.
- **Software as a Service:** a complete operating environment with applications, management, and the user interface.

# IaaS

- Amazon Elastic Compute Cloud (EC2)



# Figure 1.5. The Cloud Reference Model



Cloud Computing Bible, Chapter 1.2

(c) Copyright Christine Miyachi 2013

# PaaS

- Force.com
- Google AppEngine
- Windows Azure Platform

# SaaS

- GoogleApps
- SalesForce.com
- Office 365

# SaaS is different

- Software is binary code installed onto a computer
- SaaS delivers code and data over a browser

# Why we love SaaS

- No installation or hardware worries
- Backups occur automatically
- People not co-located can work together with same data
- Large data sets easier to work with at one location
- No compatibility issues
- Upgrades are handled in the cloud

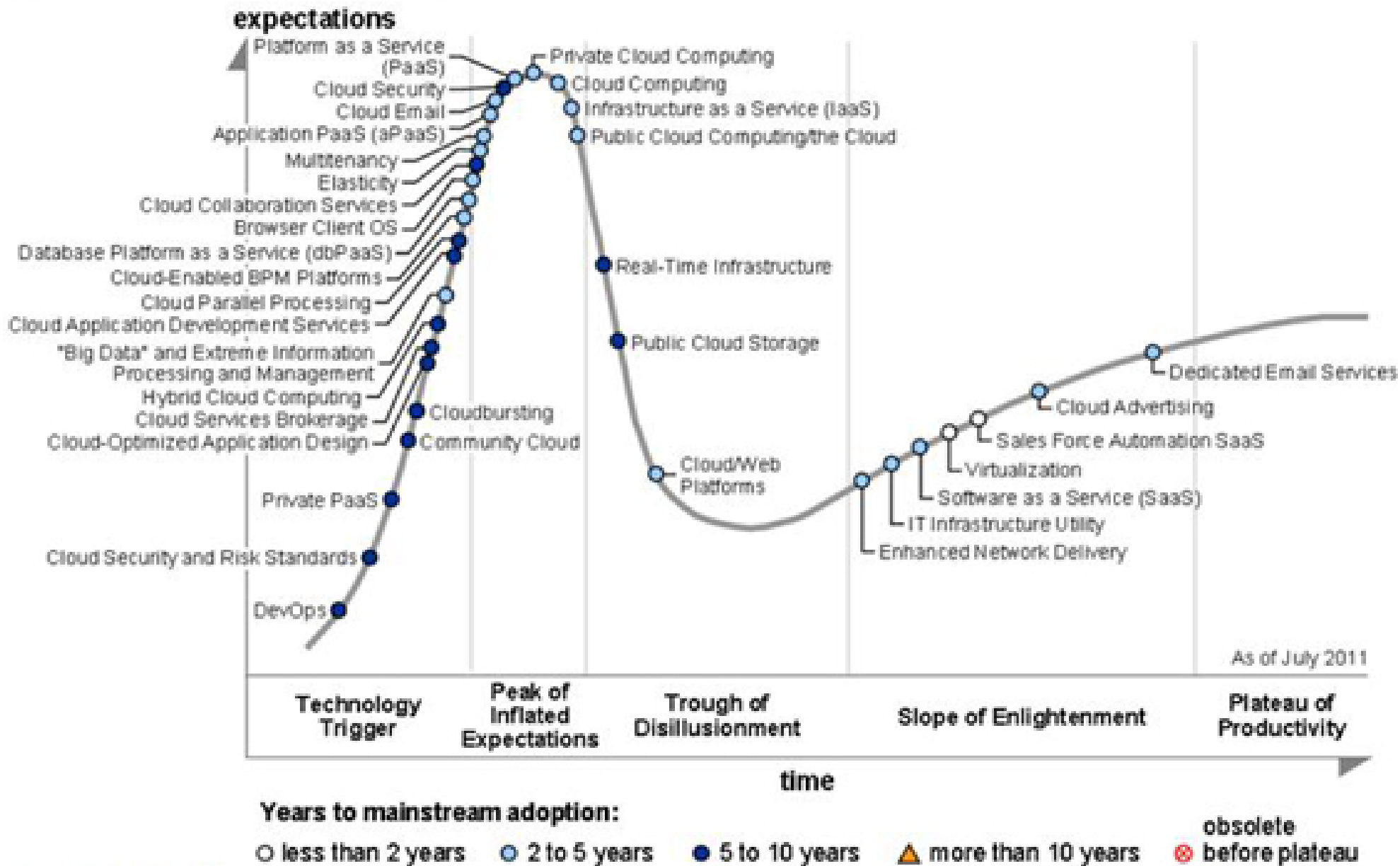
# **THE BUSINESS OF CLOUD**

# Why Cloud Now?

- For those old timers, do you remember thin clients in the 1980s?
- What happened?
  - Hard disks and memory became cheap
  - Fueled the rise of the personal computer.
- Privacy advocates still warn against being locked into proprietary systems.\*

\*<http://www.guardian.co.uk/technology/2008/sep/29/cloud.computing.richard.stallman>

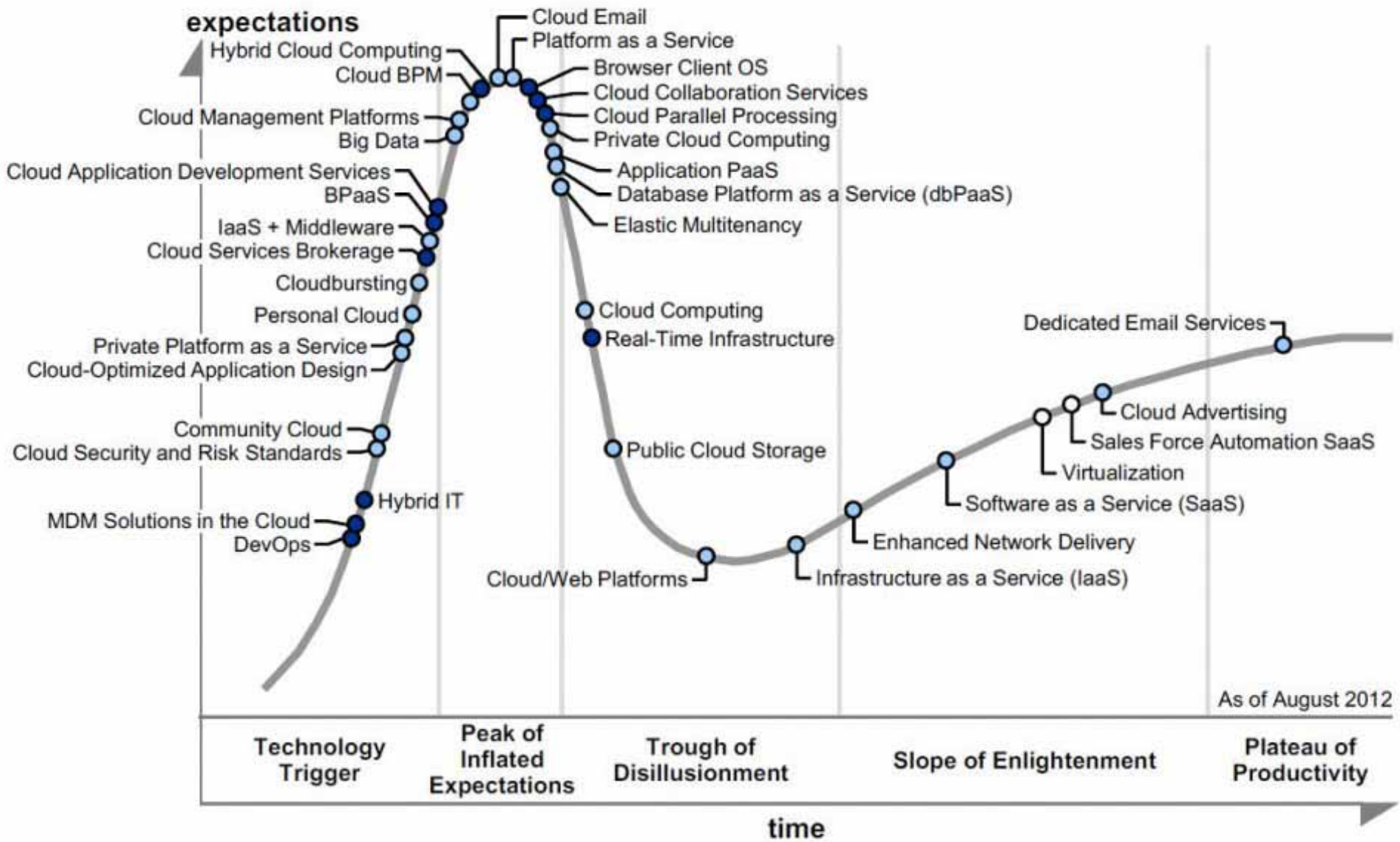
Figure 1. Hype Cycle for Cloud Computing, 2011



Source: Gartner (July 2011)



Figure 1. Hype Cycle for Cloud Computing, 2012



As of August 2012

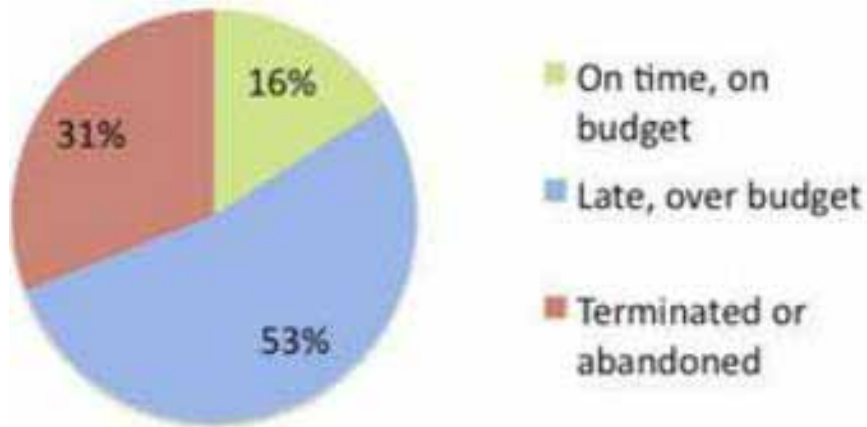
**Plateau will be reached in:**

- less than 2 years
- 2 to 5 years
- 5 to 10 years
- ▲ more than 10 years
- ⊗ obsolete before plateau

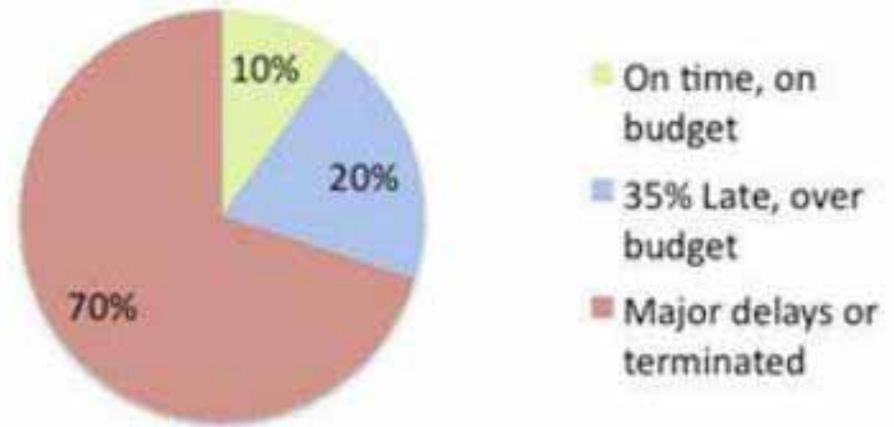
Source: Gartner (August 2012)

# **THE PROCESS OF CLOUD**

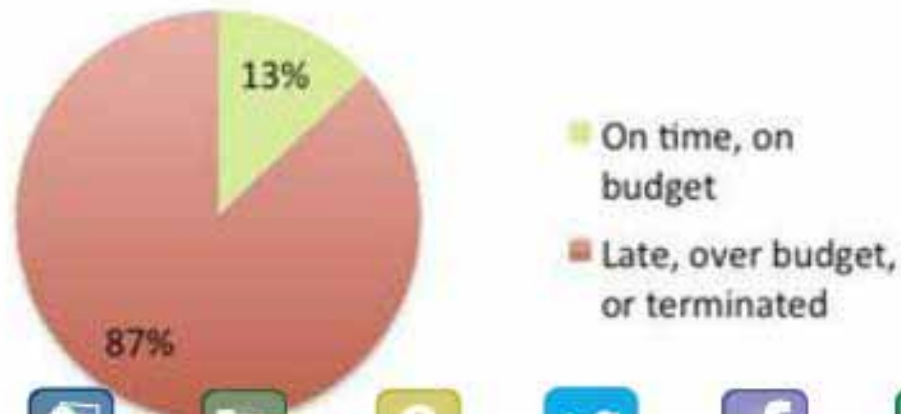
**Software Projects (Johnson 1995)**



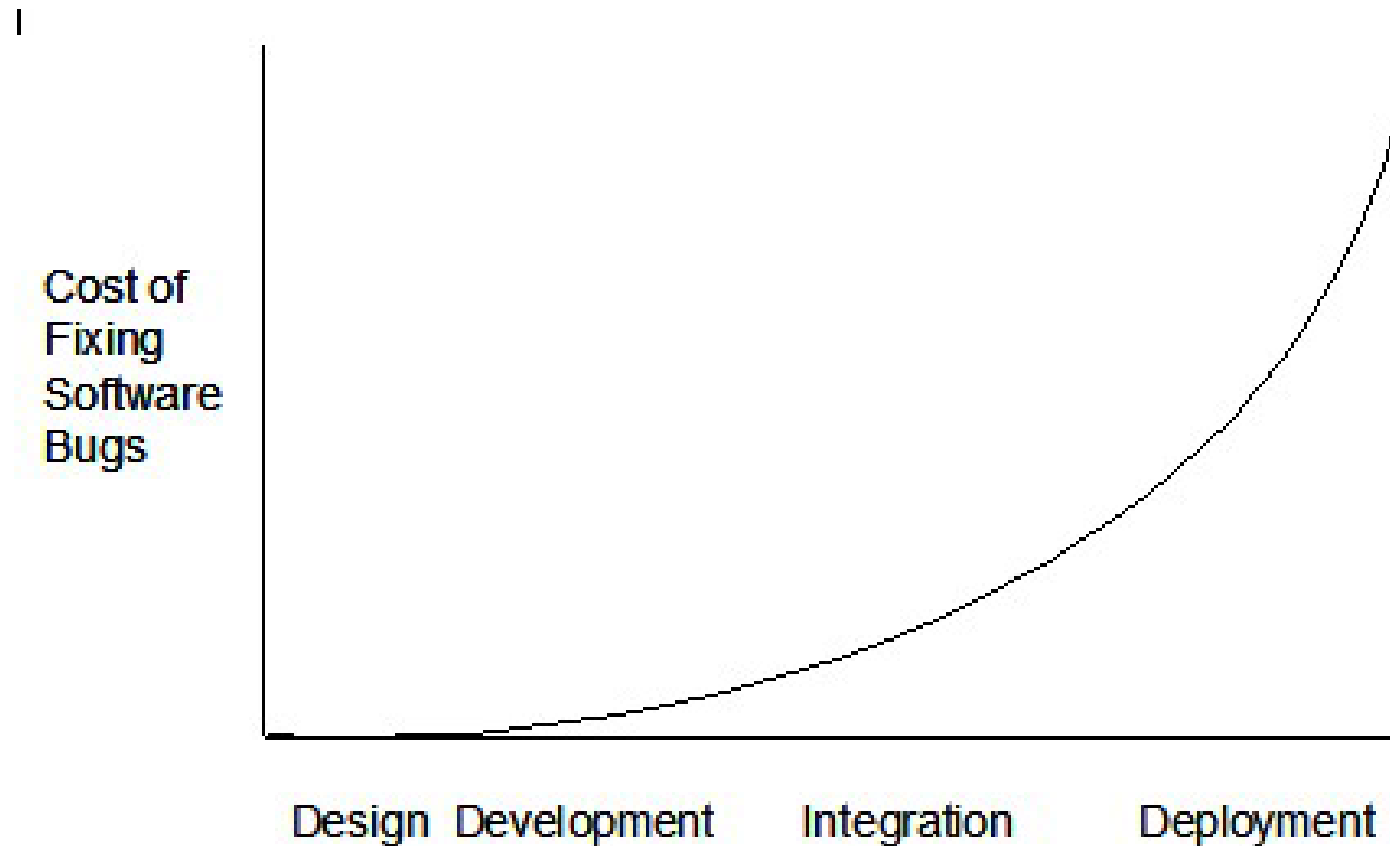
**Software Projects (Jones 2004)**



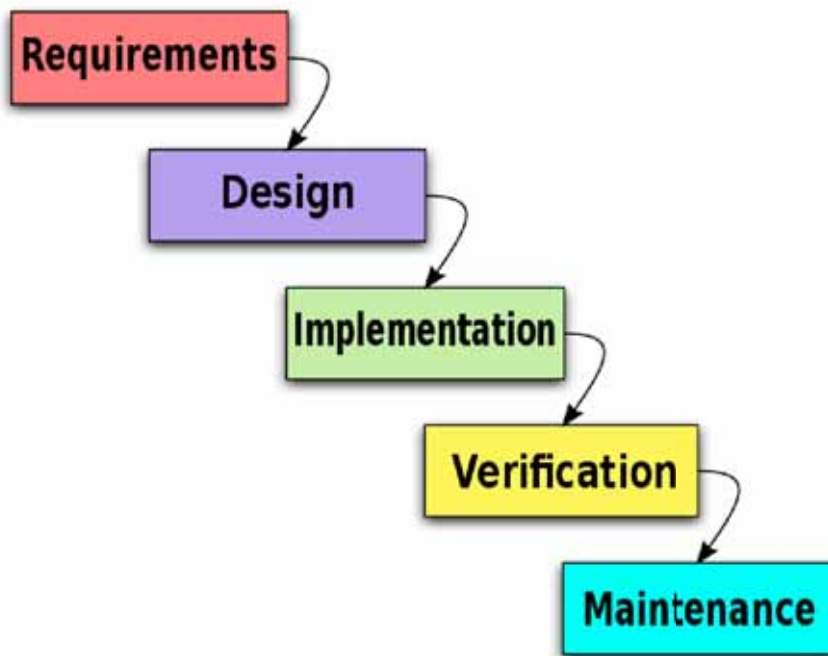
**Software Projects (Taylor 2000)**



# Cost of Fixing Software Bugs

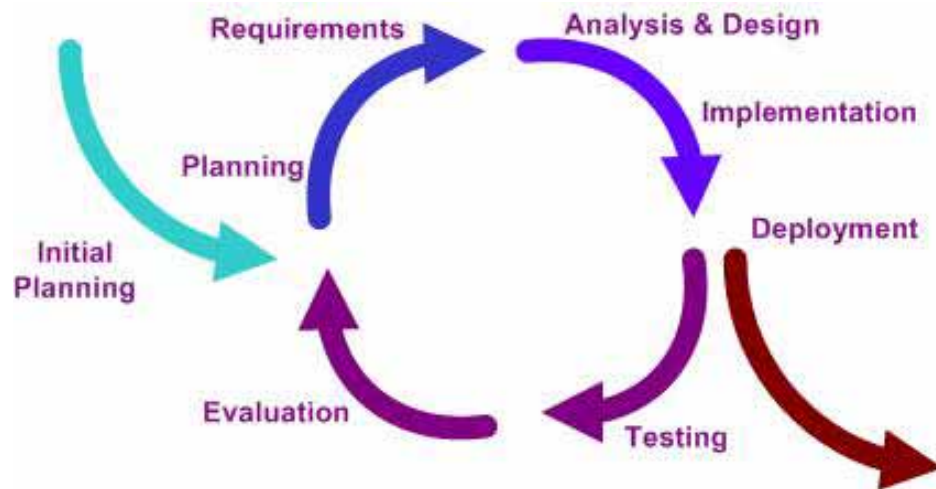


# Waterfall Lifecycle



In this methodology, all requirement analysis, design, and architecture are done up front. This is often called BDUF (Big Documentation Up Front)

# Iterative/ Agile

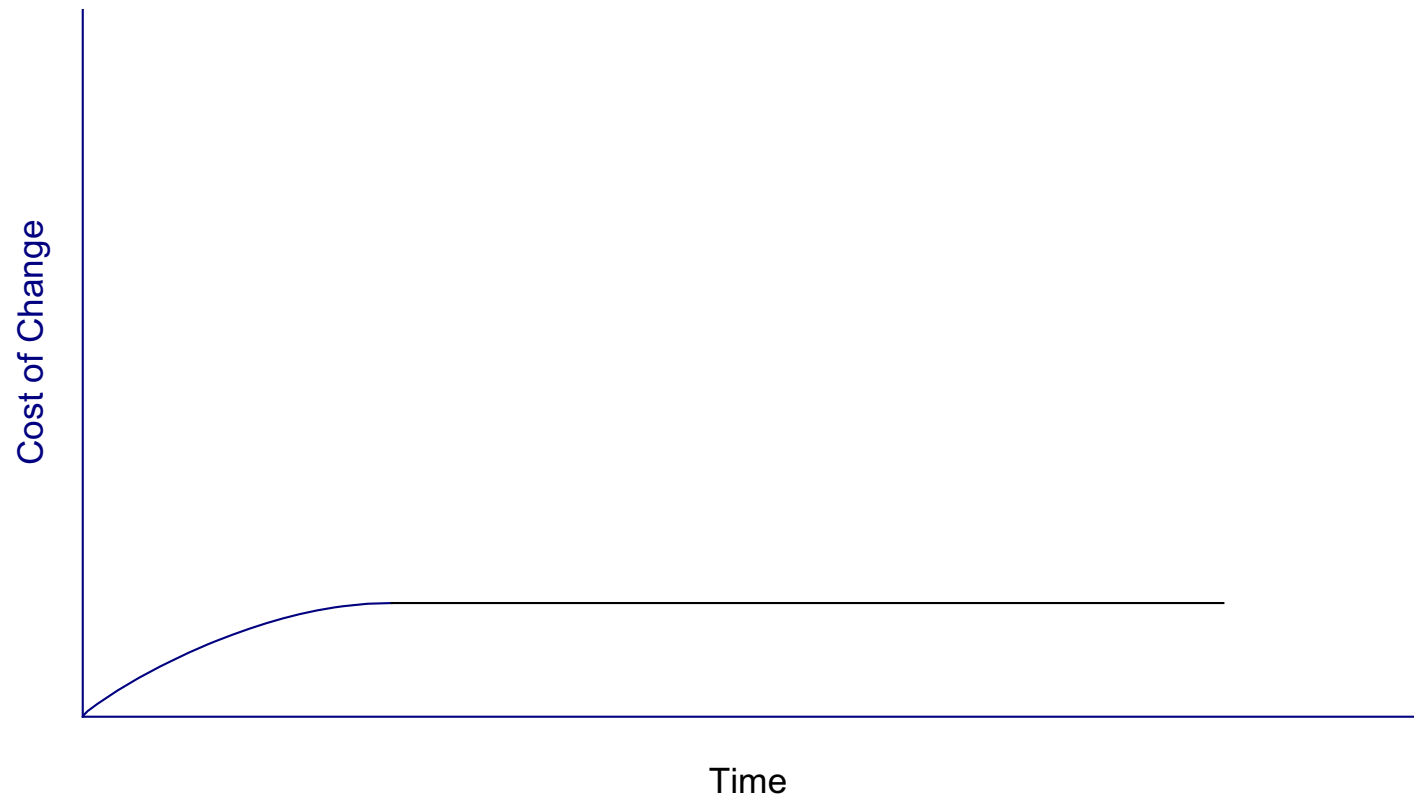


In this methodology, requirements analysis, design, and architecture are done each iteration.

A final system is complete after many iterations. Requirements, design, and architecture are added each iteration.

This methodology is typically part of lean or agile software methodologies, like SCRUM.

# What Agile Claims



# Thoughts on Cloud and Agile

- The cost of change decreases when software applications are put in the cloud
- Architecture up front becomes more important because change must be seamless



# **SOFTWARE ARCHITECTURE IN THE CLOUD**

# Examples

- Make the hardware peripheral available to mobile users without installed a driver. In this case the services of the peripheral are offered up to cloud users.
- Allow a hardware peripheral to automatically order parts and supplies from the cloud when it needs them
- Have each peripheral send text data about the software. The software has been embedded with commands to write text out to files. Peripheral trends can be observed.

# Big Data Solution: Hadoop Architecture

- Open source framework,
  - originally developed at Google
  - for writing and running distributed applications that process large amounts of data
- Runs on cluster of servers
  - adaptable to cloud servers, which can automatically expand and contract as needed
- Code and data work together
  - user pushes programs to where the data is
- Write functional programs to analyze unstructured data

# Example Hadoop Code

```
#!/usr/bin/python
```

```
import sys
```

```
import re
```

```
def main(argv):
```

```
    line = sys.stdin.readline()
```

```
    pattern = re.compile("[a-zA-Z][a-zA-Z0-9]*")
```

```
    try:
```

```
        while line:
```

```
            for word in pattern.findall(line):
```

```
                print "LongValueSum:" + word.lower() + "\t" +
```

```
"1"
```

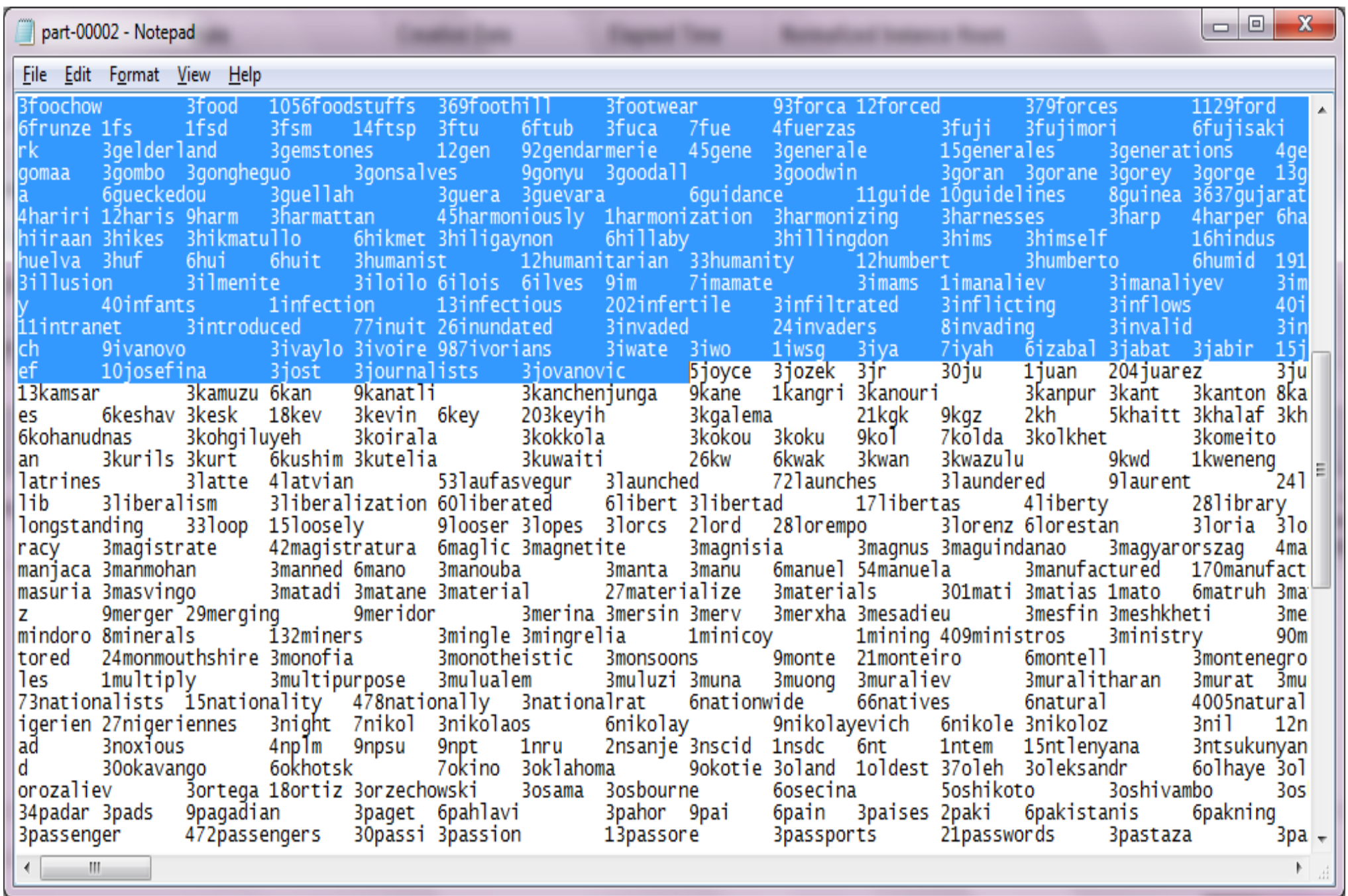
```
                line = sys.stdin.readline()
```

```
    except "end of file":
```

```
        return None
```

```
if __name__ == "__main__":
```

```
    main(sys.argv)
```



# Software Architecture

- Software architecture is the **fundamental organization** of a system, embodied in its **components**, their **relationships** to each other and the environment, and the principles governing its design and evolution.  
(IEEE 1471-2000)

# Software Architecture

- *A software architecture for a system is the structure or structures of the system, which comprise elements, their externally visible properties, and the relationships among them.*
- Bass, L.; Clements, P.; & Kazman, R. Software Architecture in Practice, Second Edition, Boston, MA; Addison-Wesley, 2003

# Cloud Software is architected to be...

- Loosely Coupled services
- Encapsulated
- Strung together using Web Services or RESTful HTTP  
([https://en.wikipedia.org/wiki/Representational state transfer](https://en.wikipedia.org/wiki/Representational_state_transfer)) calls
- Example:
  - Scan a file and deliver it to a web service that enhances the image, then deliver to a cloud storage facility.



# Quality Attributes

Quality attributes are properties of a software architecture by which stakeholders judge the quality of the architecture.

- Performances
- Security
- Modifiability
- Reliability
- Usability
- Availability
- Reusability
- Configurability
- Throughput
- Webifyability

# What –ilities are important in the Cloud?

- Security

- See

- <http://www.wired.com/gadgetlab/2012/08/apple-amazon-mat-honan-hacking/all/>

- Scalability

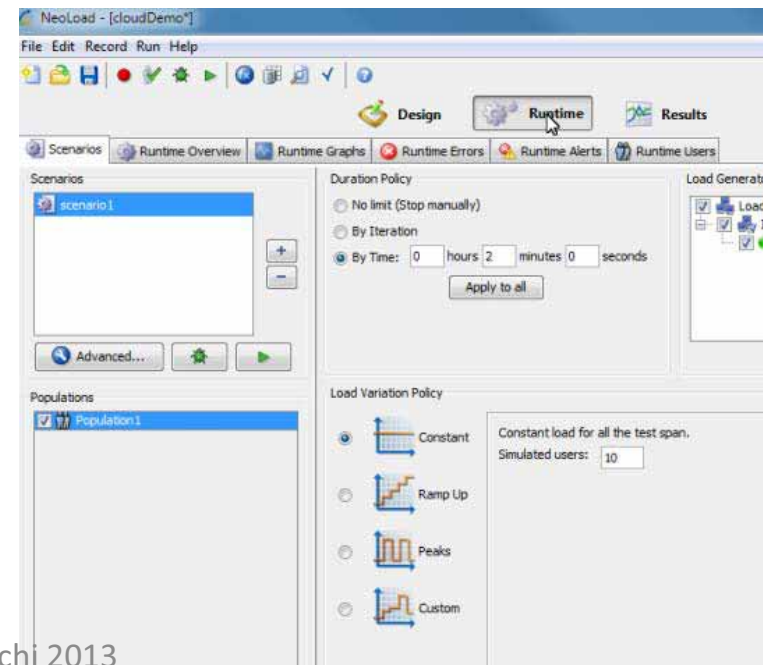
- Performance

# What –ilities are important?

<b>Traditional</b>	<b>Cloud</b>
Reliability	Scalability
Configurability	Security
Usability	Performance

# Testing in the Cloud

- All major providers allow the ability to load test services
- Cloud testing products simplify the process even further by providing front ends to load test, functional test, and measure performance



# Summary

- Priorities of –ilities change when software architecture moves to the cloud
- Testing the –ilities can be done by using cloud provider services such as load testing.

# About Me

- Principal Systems Engineer / Architect at Xerox Corporation
- MIT SDM graduate (entering class of 2000)
- Chair of the IEEE Computer Society Special Technical Community (STC) on Cloud Computing  
<http://www.computer.org/cc> - **Please join us!**
- Web site:  
<http://home.comcast.net/~cmiyachi/default.html>
- Blog on Software Architecture:  
<http://abstractsoftware.blogspot.com/> - re-launching this month!
- Thanks to my teacher Robert Bell, UMASS Lowell Cloud Computing teacher