TCSS 562: SOFTWARE ENGINEERING FOR CLOUD COMPUTING

Cloud Computing Concepts and Models

Wes J. Lloyd
Institute of Technology
University of Washington - Tacoma

OBJECTIVES

- Term project proposal
- Cloud Computing Concepts and Models
  - Roles and boundaries
  - Cloud characteristics
  - Cloud delivery models
  - Cloud deployment models

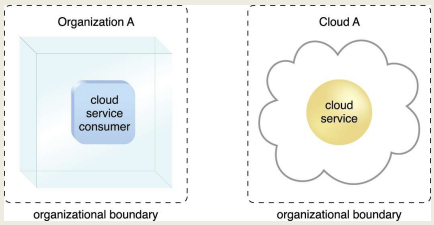
ROLES

- **Cloud provider**
  - Organization that provides cloud-based resources
  - Responsible for fulfilling SLAs for cloud services
  - Some cloud providers "resell" IT resources from other cloud providers
    - Example: Heroku sells PaaS services running atop of Amazon EC2
- **Cloud consumers**
  - Cloud users that consume cloud services
- **Cloud service owner**
  - Both cloud providers and cloud consumers can own cloud services
  - A cloud service owner may use a cloud provider to provide a cloud service (e.g. Heroku)

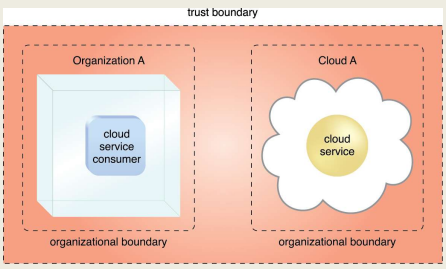
ROLES - 2

- **Cloud resource administrator**
  - Administrators provide and maintain cloud services
  - Both cloud providers and cloud consumers have administrators
- **Cloud auditor**
  - Third-party which conducts independent assessments of cloud environments to ensure security, privacy, and performance.
  - Provides unbiased assessments
- **Cloud brokers**
  - An intermediary between cloud consumers and cloud providers
  - Provides service aggregation
- **Cloud carriers**
  - Network and telecommunication providers which provide network connectivity between cloud consumers and providers

ORGANIZATION BOUNDARY



TRUST BOUNDARY



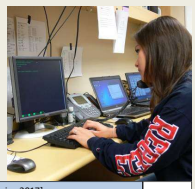
CLOUD CHARACTERISTICS

- On-demand usage
- Ubiquitous access
- Multitenancy (resource pooling)
- Elasticity
- Measured usage
- Resiliency

- Assessing these features helps measure the value offered by a given cloud service or platform

ON-DEMAND USAGE

- The freedom to self-provision IT resources
- Generally with automated support
- Automated support requires no human involvement
- Automation through software services interface



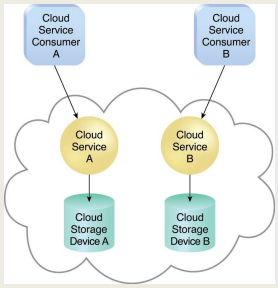
UBIQUITOUS ACCESS

- Cloud services are widely accessible
- Public cloud: internet accessible
- Private cloud: throughout segments of a company's intranet
- 24/7 availability

MULTITENANCY

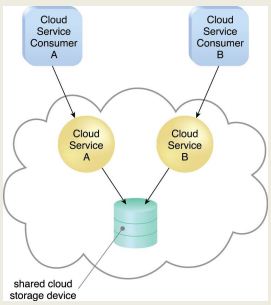
- Cloud providers pool resources together to share them with many users
- Serve multiple cloud service consumers
- IT resources can be dynamically assigned, reassigned based on demand
- Multitenancy can lead to performance variation

SINGLE TENANT MODEL

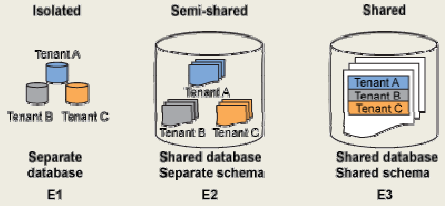


MULTITENANT MODEL

- Resource is "multiplexed" and share amongst multiple users
- Goal is to increase utilization
- Often server resources are underutilized
- There are many "sunk costs" whether usage is 0% or 100%
- Cloud computing tries to maximize "sunk cost" investments

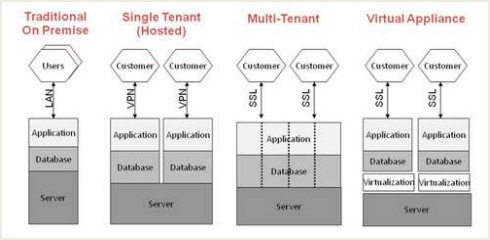


MULTITENANT DATABASE



MULTITENANCY OF RESOURCES

- Where is the multitenancy?

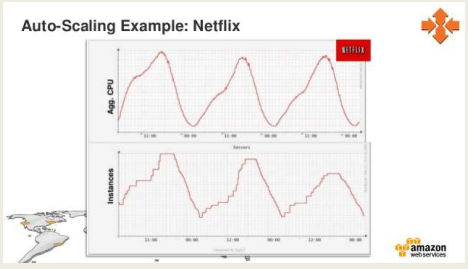


ELASTICITY

- Automated ability of cloud to transparently scale resources
- Scaling based on runtime conditions or pre-determined by cloud consumer or cloud provider
- Threshold based scaling
  - `CPU-utilization > threshold_A, Response_time > 100ms`
  - Application agnostic vs. application specific thresholds
  - Why might an application agnostic threshold be non-ideal?
- Load prediction
  - Historical models
  - Real-time trends

PREDICTABLE DEMAND

- Example:

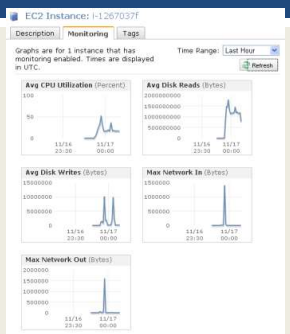


MEASURED USAGE

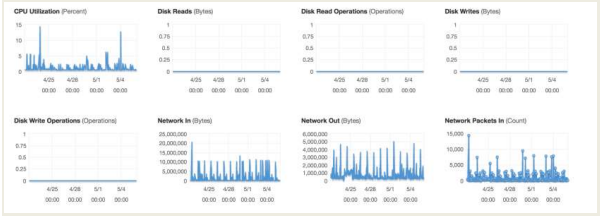
- Cloud platform tracks usage of IT resources
- For billing purposes
- Enables charging only for IT resources actually used
- Can be time-based (minute, hour, day)
- Can be throughput-based (MB, GB)

- Not all measurements are for billing
- Some measurements can support auto-scaling
- For example CPU utilization

EC2 CLOUDWATCH METRICS

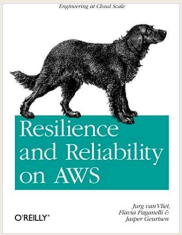


EC2 CLOUDWATCH METRICS

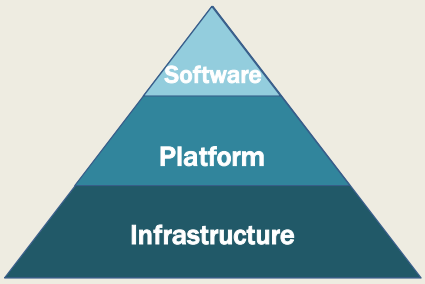


RESILIENCY

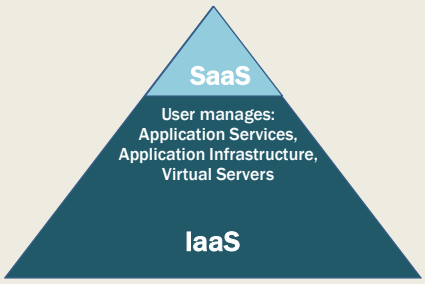
- Distributed redundancy across physical locations
- Used to improve reliability and availability of cloud-hosted applications
- Very much an engineering problem
- No "resiliency-as-a-service" for user deployed apps
- Unique characteristics of user applications make a one-size fits all service solution challenging



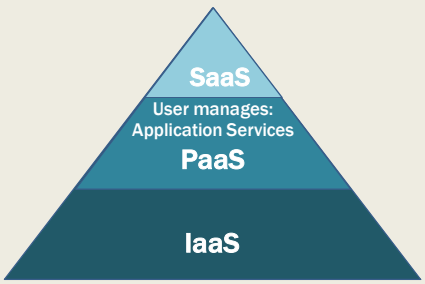
CLOUD DELIVERY MODELS



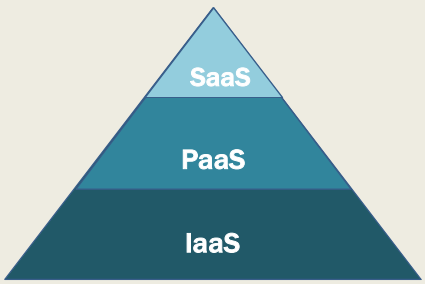
CLOUD DELIVERY MODELS



CLOUD DELIVERY MODELS

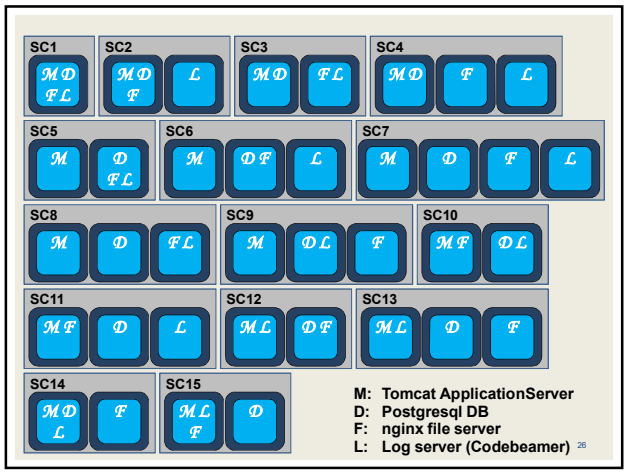


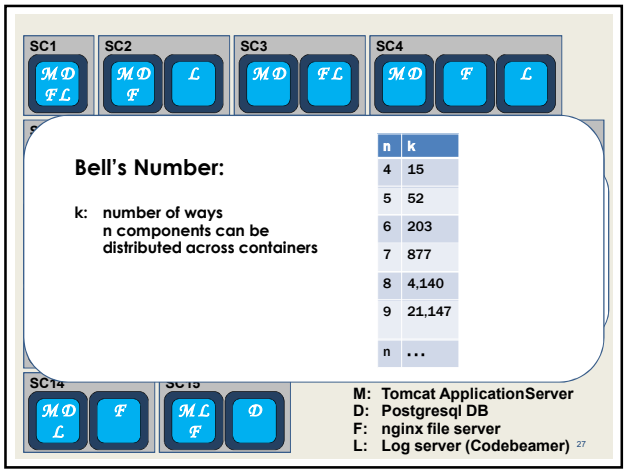
CLOUD DELIVERY MODELS

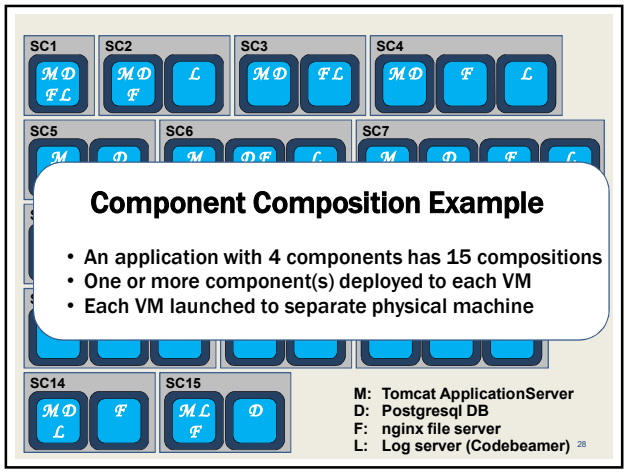


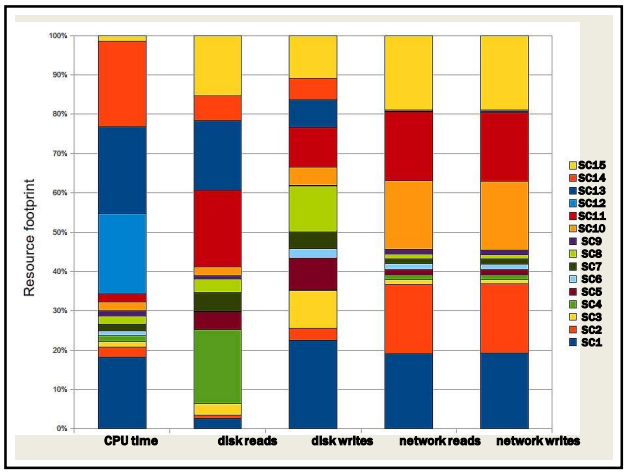
INFRASTRUCTURE-AS-A-SERVICE

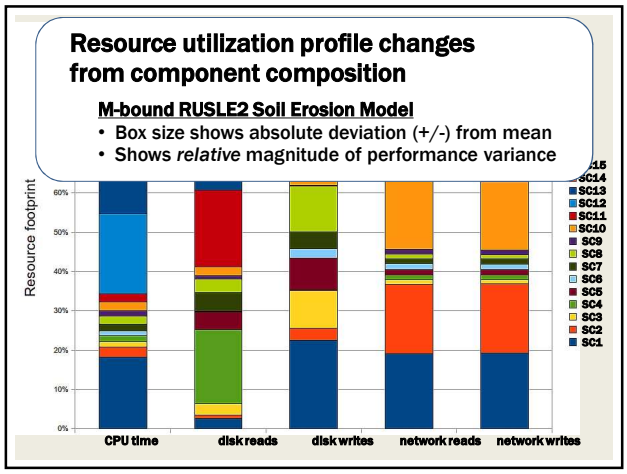
- Compute resources, on demand, as-a-service
  - Generally raw "IT" resources
  - Hardware, network, containers, operating systems
- Typically provided through virtualization
- Generally not-preconfigured
- Administrative burden is owned by cloud consumer
- Best when high-level control over environment is needed
- Scaling is generally **not** automatic…
- Resources can be managed in bundles
- AWS CloudFormation: Allows specification in JSON/YAML of cloud infrastructures

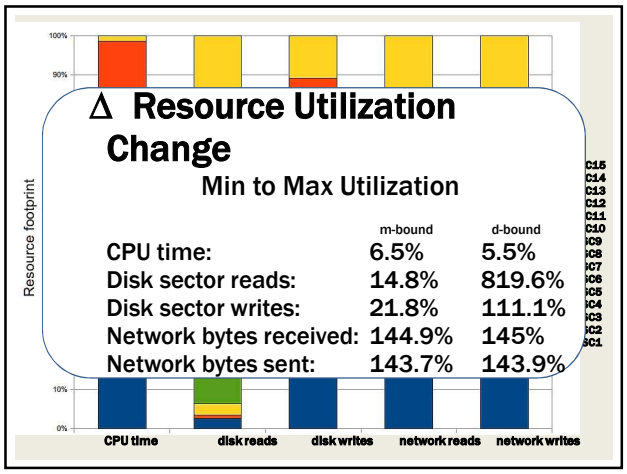


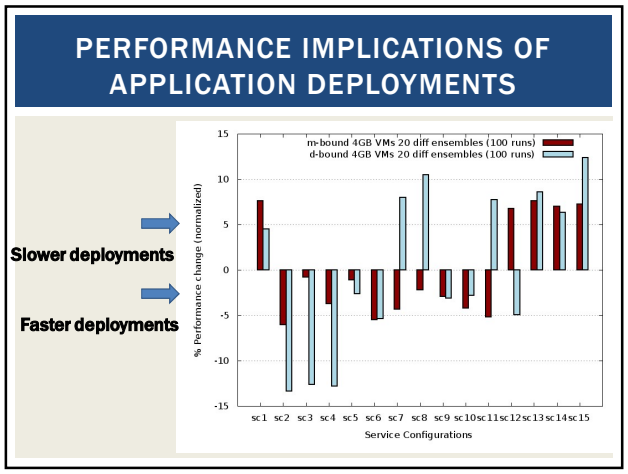


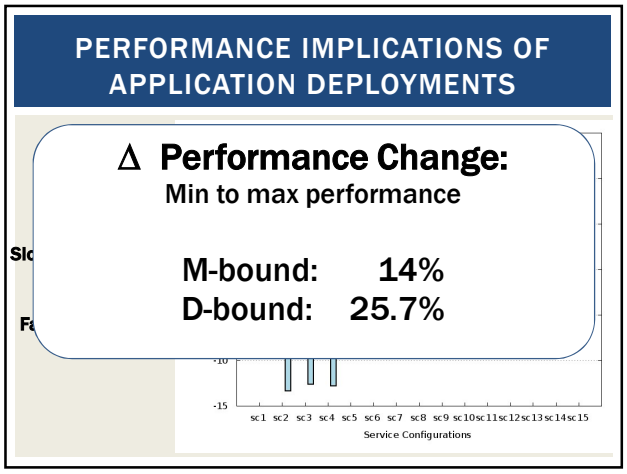


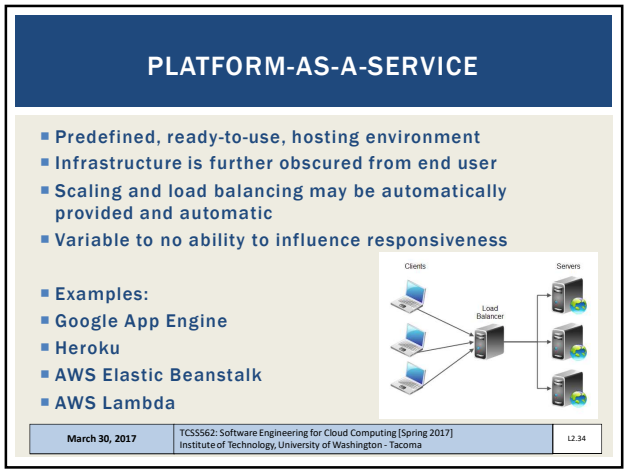


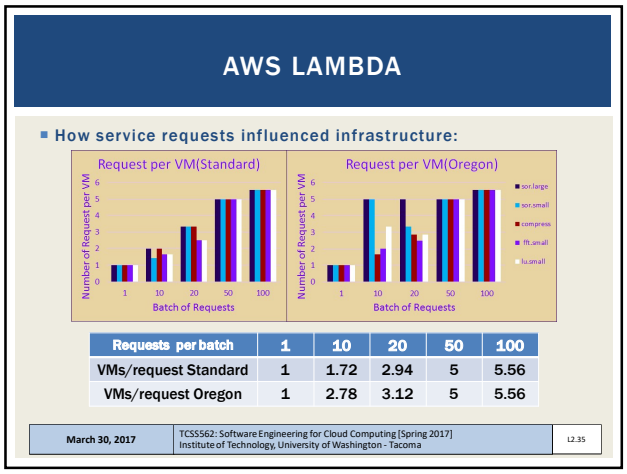


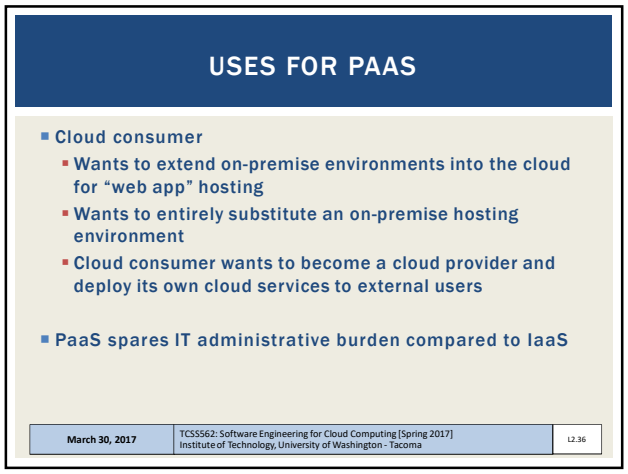

Δ Resource Utilization Change
Min to Max Utilization
m-bound d-bound
CPU time: 6.5% 5.5%
Disk sector reads: 14.8% 819.6%
Disk sector writes: 21.8% 111.1%
Network bytes received: 144.9% 145%
Network bytes sent: 143.7% 143.9%
Resource footprint
CPU time
disk reads
disk writes
network reads
network writes


PERFORMANCE IMPLICATIONS OF APPLICATION DEPLOYMENTS
Slower deployments
Faster deployments
m-bound 4GB VMs 20 diff ensembles (100 runs)
d-bound 4GB VMs 20 diff ensembles (100 runs)
% Performance change (normalized)
Service Configurations


PERFORMANCE IMPLICATIONS OF APPLICATION DEPLOYMENTS
Δ Performance Change:
Min to max performance
M-bound: 14%
D-bound: 25.7%
Service Configurations


PLATFORM-AS-A-SERVICE
Predefined, ready-to-use, hosting environment
Infrastructure is further obscured from end user
Scaling and load balancing may be automatically provided and automatic
Variable to no ability to influence responsiveness
Examples:
Google App Engine
Heroku
AWS Elastic Beanstalk
AWS Lambda
Clients
Servers
Load Balancer
March 30, 2017
TCSS562: Software Engineering for Cloud Computing [Spring 2017]
Institute of Technology, University of Washington - Tacoma
L2.34


AWS LAMBDA
How service requests influenced infrastructure:
Request per VM(Standard)
Request per VM(Oregon)
Number of Request per VM
Batch of Requests
Requests per batch 1 10 20 50 100
VMs/request Standard 1 1.72 2.94 5 5.56
VMs/request Oregon 1 2.78 3.12 5 5.56
March 30, 2017
TCSS562: Software Engineering for Cloud Computing [Spring 2017]
Institute of Technology, University of Washington - Tacoma
L2.35


USES FOR PAAS
Cloud consumer
Wants to extend on-premise environments into the cloud for "web app" hosting
Wants to entirely substitute an on-premise hosting environment
Cloud consumer wants to become a cloud provider and deploy its own cloud services to external users
PaaS spares IT administrative burden compared to IaaS
March 30, 2017
TCSS562: Software Engineering for Cloud Computing [Spring 2017]
Institute of Technology, University of Washington - Tacoma
L2.36

INTRODUCTIONS

- SPEAK SLOWLY
- Name
- What year of your program (quarter) are you in?
  - E.g. senior, 2nd quarter of MS, etc.
- Where are you from?
- What are your computer science and/or cloud/project interests?

QUESTIONS