

EBU7501: Cloud Computing

Week 1, Day 3: The Economics of Cloud Computing



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Lecture Aim and Outcome

◆ Aim

- This lecture teaches the students the economic impact of cloud computing and the future projections of its growth and influence to global economics.

◆ Outcome

- At the end of this lecture, students should be able to:
 - Understand the economic models used in cloud computing
 - Develop creative economic models for cloud computing
 - Forecast the future of cloud computing technology

Lecture Outline

- ◆ The Economics of Cloud Computing
- ◆ Historical Background of Similar Technologies
- ◆ The Big Players and their Economic Models
- ◆ Salesforce.com Cloud Economic Model
- ◆ Amazon Cloud Economic Model
 - Class Work
- ◆ Generic Cloud Economic Model Features
- ◆ The Impact of Cloud Computing in the Business of Supply Chain
- ◆ The Business Motivation for Cloud Providers and Subscribers
- ◆ Success Stories
- ◆ Competition in the Cloud Market
- ◆ The Current and Future Forecast
- ◆ The Different Offerings in Cloud and their Worth
- ◆ Cloud Assurance as an Economic Feature
- ◆ Cloud Accounting Models
- ◆ The Challenges and Opportunities
- ◆ Job Opportunities in Cloud Computing

Cloud Computing Service Model

- ◆ Cloud computing infrastructure is based on Service-Oriented Architecture (SOA): SaaS, PaaS, IaaS, etc
- ◆ The internet and the web provided seamless access to users around the world to access and use cloud resources provided as web services, eg Amazon Web Services (AWS) platform
- ◆ Part of the reason to adopt a SOA is the economic motivation to provide cloud resources to users as services for financial benefits

Cloud Computing Service Model

- ◆ This motivation is based on historical trends:
 - For over 3 decades, the world economy has moved from manufacturing to service-oriented
 - Today, 80% of the USA economy is driven by the service industry, with just 15% in manufacturing and 5% in agriculture and other sectors
 - Gartner stated that global public cloud computing services was \$209.2B last year (2016) and predicted that it will increase by 18% this year (2017) which will be worth \$246.8B
- (<http://www.gartner.com/newsroom/id/3616417>)

SOA Technology

- ◆ Service-Oriented Architecture (SOA) is a design of software system makes use of new or legacy programs as services through their published and discoverable interfaces.
- ◆ The World Wide Web Consortium (W3C) defines SOA as a form of distributed systems architecture with the following properties:
 - Logical view: SOA is an abstraction of logical view of actual programs, databases, business processes and many more carrying out some business-level actions
 - Message orientation: The internal structure of SOA consists of providers of services and requesters (consumers) of the services through a broker using messages to communicate
 - Description orientation: A service is described by machine executable metadata
 - Granularity: Services are carried out using small number of operations to perform complex tasks
 - Network orientation: Most services are offered through networks
 - Platform neutrality: Messages are sent in a platform neutral and standardised format delivered through the interfaces using XML (eXtensible Markup Language)

SOA Design

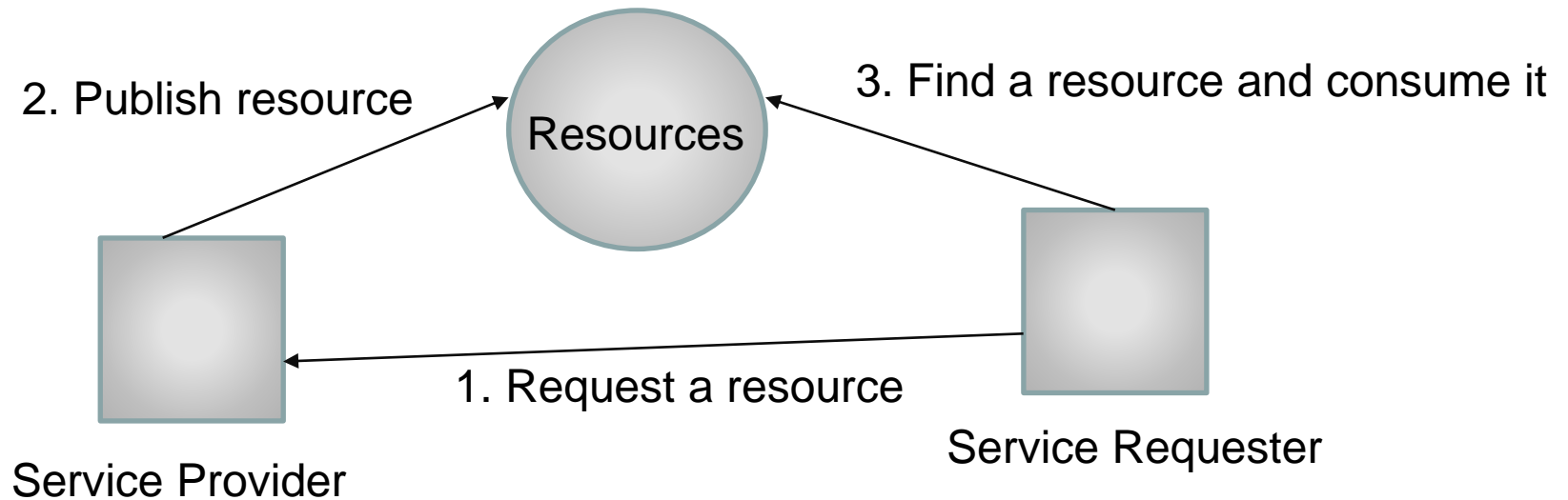
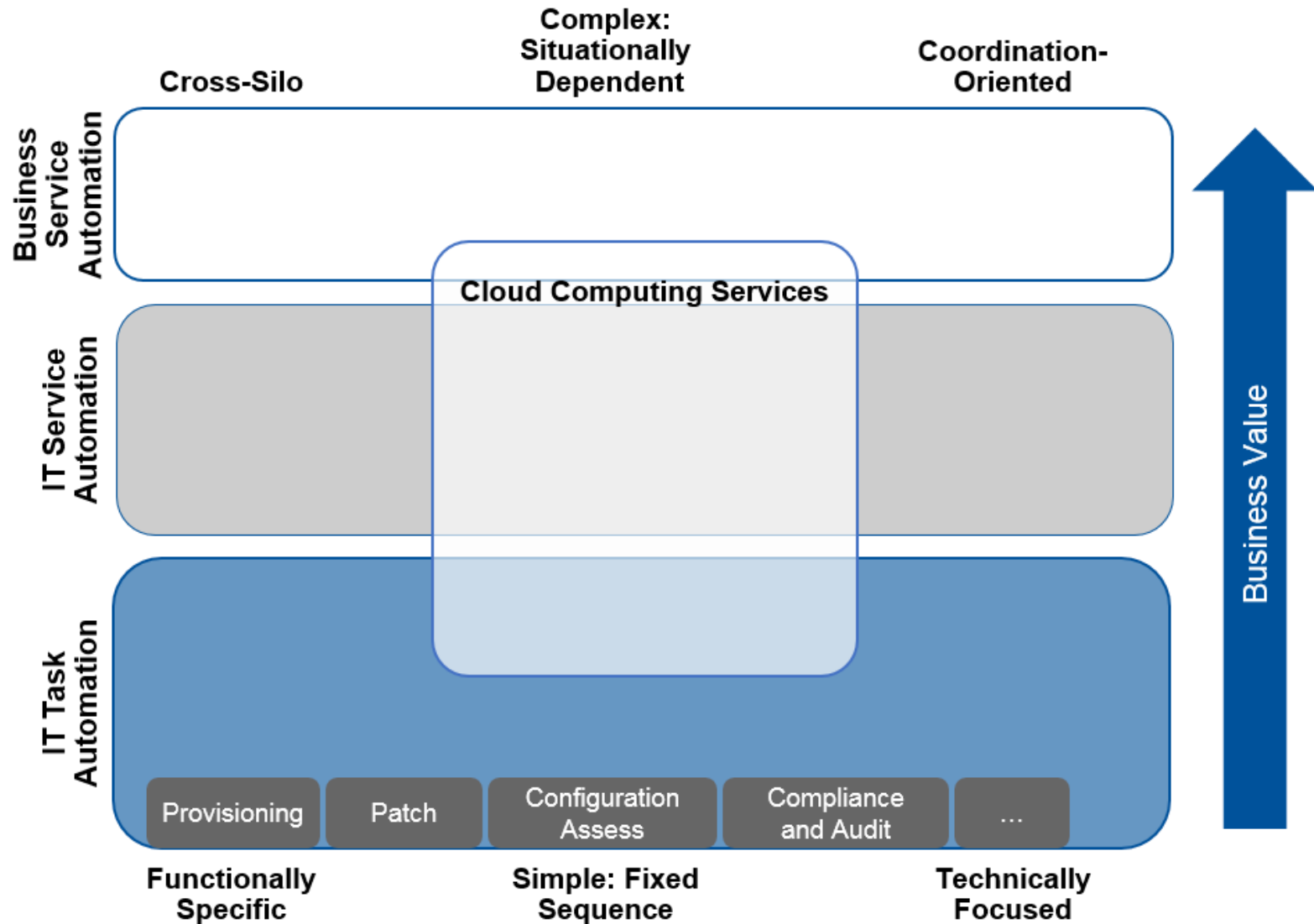


Table 1. Worldwide Public Cloud Services Forecast (Millions of Dollars)

Source: Gartner (February 2017)

Year	2016	2017	2018	2019	2020
Cloud Business Process Services (BPaaS)	40,812	43,772	47,556	51,652	56,176
Cloud Application Infrastructure Services (PaaS)	7,169	8,851	10,616	12,580	14,798
Cloud Application Services (SaaS)	38,567	46,331	55,143	64,870	75,734
Cloud Management and Security Services	7,150	8,768	10,427	12,159	14,004
Cloud System Infrastructure Services (IaaS)	25,290	34,603	45,559	57,897	71,552
Cloud Advertising	90,257	104,516	118,520	133,566	151,091
Total Market	209,244	246,841	287,820	332,723	383,355

Cloud Computing Services



Source: Gartner (July 2016)

Cloud Design Objectives for Economic Acceptability

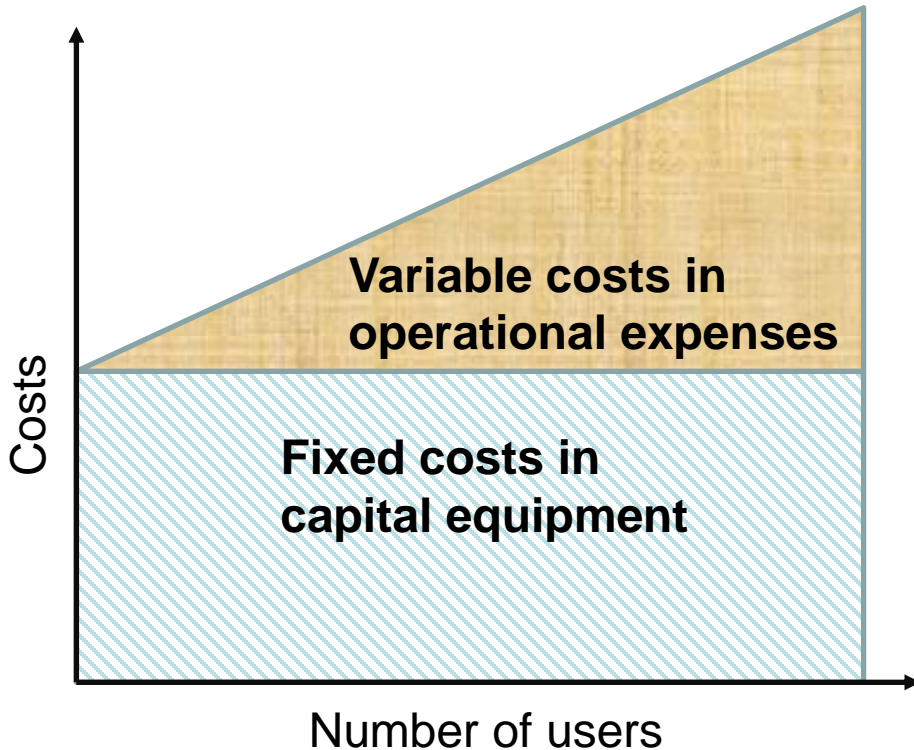
- ◆ Trust, security and assurance
 - For the cloud service to be accepted by users, it must provide services in a trusted, secure manner. This will give customers the assurance to subscribe for the services
- ◆ Data privacy protection
 - This is similar to the first point. Can customers trust data centres to handle their private data and records? No business will entrust its business data if it can be compromised or leaked to its competitors.
- ◆ Service provisioning and cloud economics of scale
 - Providers and customers will sign SLAs that services must be efficient, reliable and cheaper because of its scale
- ◆ Scalability of performance
 - The cloud platform and software must be able to scale as the demand increases or decreases for additional resources but still maintaining its performance

Cloud Design Objectives for Economic Acceptability

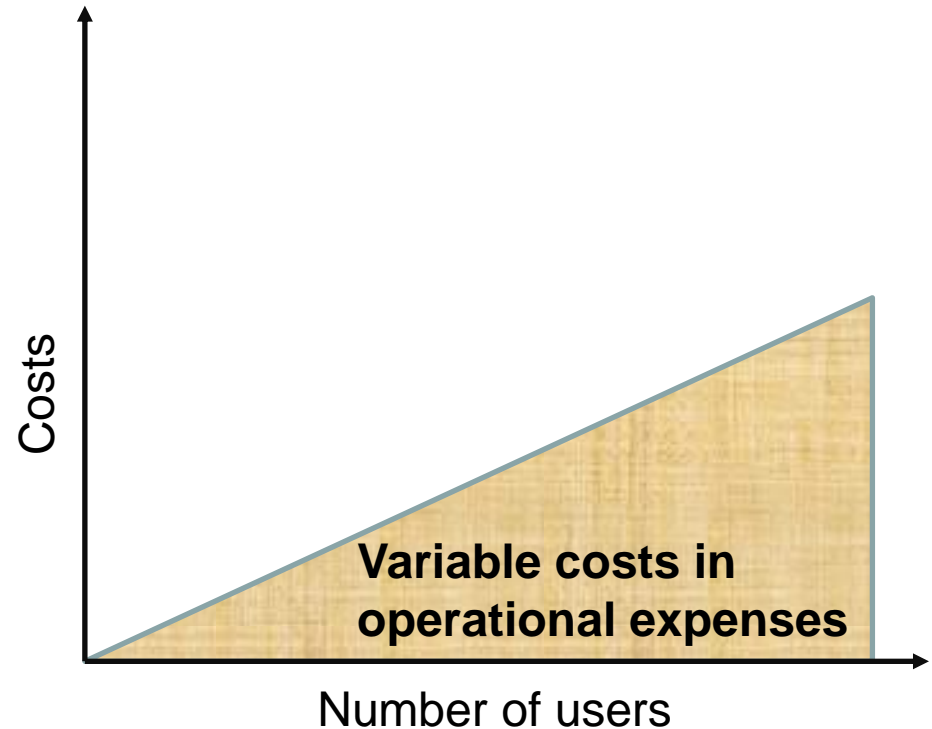
- ◆ Shifting computing from desktops to data centres
 - The power of computation and processing is now not your personal responsibility, but delegated to data centres, relieving you from the troubles of owning, maintaining and recruiting staff for your computing requirements
- ◆ High quality of cloud services
 - The quality of service (QoS) of cloud resources must be standardised to meet customers
- ◆ New standards and interfaces
 - The data associated requirements and APIs must be universally acceptable with intuitive end-user interfaces. Standards for costing and pricing of cloud services should be transparent to the customers

Cloud Cost Model

(a) Traditional IT cost model



(b) Cloud computing cost model



Traditional IT Cost = Upfront Capital Costs + Variable Costs

Cloud Computing Cost = Variable Costs (No any upfront capital costs)

Cloud Computing Cost = Traditional IT Cost - Upfront Capital Costs

Cloud Cost Model

- ◆ In traditional IT computing, users and organisations must spend money at the beginning of their business to acquire their own computers and peripheral equipment as capital expenses in addition to operational expenditures on variable operational costs as shown in (a).
 - Customers must spend the same amount on fixed cost even when they have few users and whether they use them or not
 - Setting up traditional IT system is expensive and time consuming
- ◆ In cloud computing, customers only pay for their operational costs, as shown in (b)
 - This cost increases only when your users increase and decreases when your users decrease or when you use less resources
 - This means that cloud computing can reduce cost significantly for both small and large scale users

The Economics of Cloud Computing

- ◆ This is the tangible benefits and incentives created from cloud technologies based on favourable and positive return on investments (ROI) by countries, organizations and individuals
 - This is usually measured in terms of the profit made by organizations in investing and providing cloud technologies for subscribers
 - It increases the GDP (Gross Domestic Product) of countries that provide cloud services
 - The subscribers in turn also realised a lot of benefits in terms of cost savings, efficiency and competitive advantage over their competitors
 - This usually translates into profit also, as they win more customers to their business
- ◆ Cloud computing is estimated to be worth \$USD 200B by the year 2016 (Gartner 2013)
- ◆ It is the driving force for the innovation and fierce competition in the industry

The Economics of Cloud Computing

- ◆ It is also the reason why universities want to equip students with the required practical skills to fill in the increasing demand for cloud computing professionals
 - It reduces the number of unemployment in countries that provide the right skills
 - By reducing the number of unemployment, you create a large number of middle class
 - When you create a large number of the middle class, you increase the purchasing power of the population
 - By increasing the purchasing power of the population, businesses will flourish and increase
- ◆ Universities work with the business community to drive innovation that meets future demands

Historical Background of Similar Technologies

- ◆ National Science Foundation (NSF) in the US
 - The characteristics of technologies that have potential economic impact
 - Distribution across networks
 - Can be located across the world
 - Provision as a service
 - Likely to have end users
 - Shared source of resources
 - Takes advantage of economic of scale
- ◆ Examples
 - Transport system
 - Railway
 - Airlines
 - Road transport
 - Electricity grid
 - Banking system
 - Internet

The Big Players and their Economic Models

- ◆ Amazon
 - Amazon Web Services (AWS),
 - AWS Elastic Compute Cloud (EC2)
 - AWS Simple Storage Services (S3)
- ◆ Microsoft
 - Windows Azure Cloud
 - Office 365
- ◆ Oracle
 - Oracle Cloud
- ◆ Google
 - Google Apps Business
- ◆ Salesforce.com
 - Salesforce.com Cloud Platform
 - Salesforce.com AppExchange
- ◆ Alibaba
 - Aliyun
- ◆ Rackspace
- ◆ Tencent

Salesforce.com Cloud Economic Model

- ◆ Sales
 - Sales cloud
 - Automation and CRM (Customer Relation Management)
 - Data.com
 - B2B (Business to Business) management and data cleansing
 - Work.com
 - Performance management
- ◆ Service
 - Service cloud
 - Support and helpdesk
 - Desk.com
 - All-in-one integrated customer support for small scale businesses
- ◆ Market
 - Marketing cloud
 - Emails, social media, mobile and websites marketing strategies
 - Pardot
 - Automation of B2B marketing

Salesforce.com Cloud Economic Model

◆ Build and Innovate

– Platform

- Application development platform on the cloud

– AppExchange

- Application marketplace

- Where you can offer application for sale or look for application to buy

◆ Collaborate

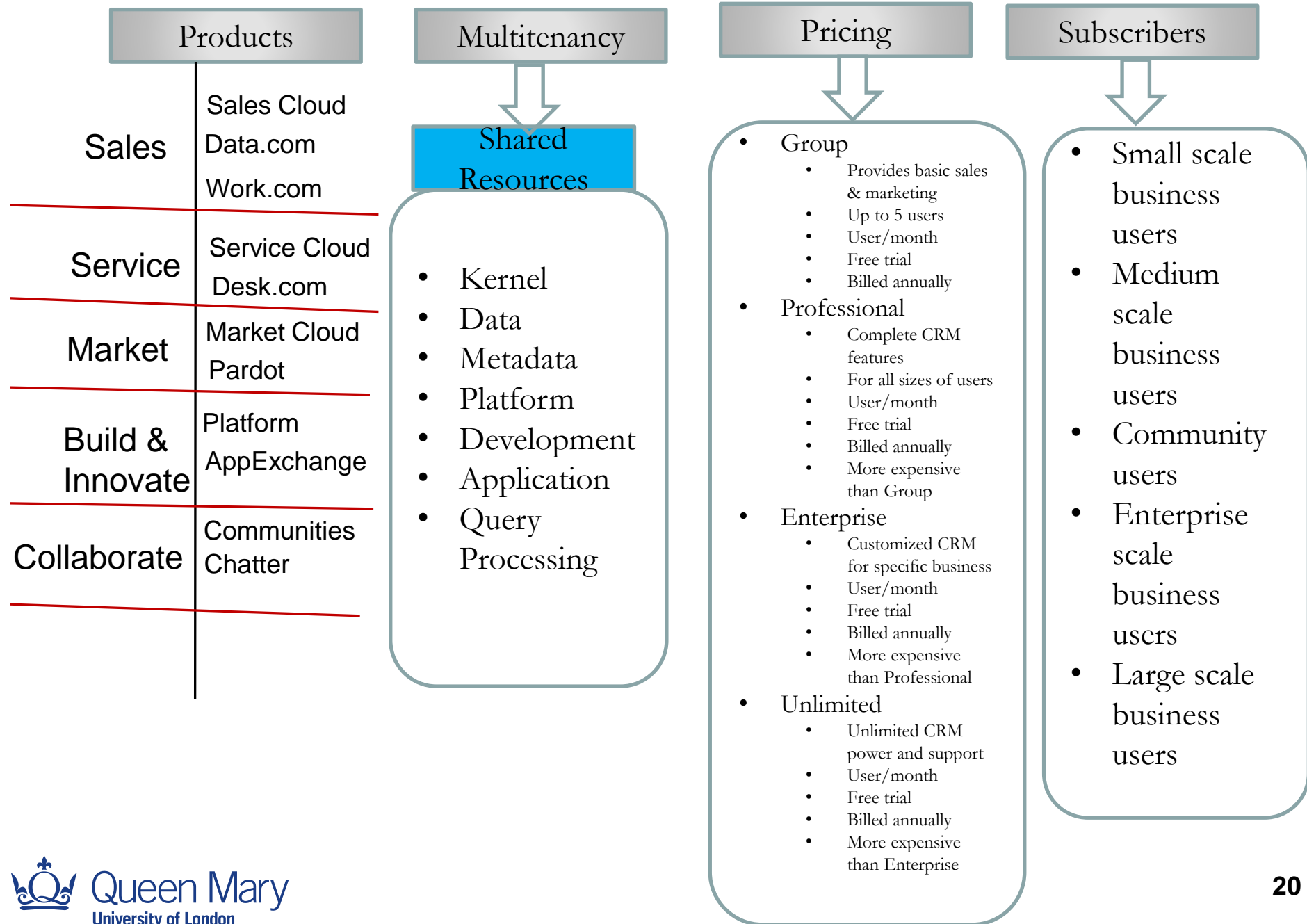
– Communities

- Connecting communities, employees and business partners

– Chatter

- Salesforce social network to introduce new products, get feedbacks on products and to promote collaboration

Salesforce.com Cloud Economic Model



Amazon Cloud Economic Model

◆ Class Work

- Read about the AWS Cloud Economic Model for Discussion in the Class
- Go to www.aws.amazon.com to find out:
 - Products
 - Pricing systems
 - Free offerings
 - E.t.c.

Amazon Cloud Economic Model

- ◆ Different Purchasing Options
 - Reserved Capacity: Reserve instances to get discount in price of using instances and services that you use frequently.
 - Reserved Instances (RIs) Types:
 - All-Upfront RI (AURI)-pay all amount at once and get huge savings in cost
 - Partial-Upfront RI (PURI)-pay part of the amount and get less savings in cost
 - No-Upfront RI (NURI)-Pay nothing upfront and get just very little or no savings in cost
 - On-demand Instances: You pay only for what you use (pay-as-you-go)
 - Dedicated Instances: Have your resources run on a separate dedicated physical servers at AWS datacenter
- ◆ Free Tier resources for 12 months (eg EC2)

Amazon Cloud Economic Cost Optimisation Tools

- ◆ Use AWS Trusted Advisor: An online service that helps customers to suggest ways of reducing cost, improve performance and increase security
 - Use AWS Trusted Advisor or Amazon EC2 usage reports to identify the compute resources that you use most of the time that you should consider reserving. Depending on your Reserved Instance purchases, the discounts will be reflected in the monthly bill.
- ◆ Use AWS TCO Calculator (Total Cost of Ownership Calculator) to estimate the cost savings when using AWS resources compared to on-premise traditional IT systems.
 - The calculator also give you the option to modify assumptions that best meet your business needs
- ◆ Use AWS Simple Monthly Calculator to estimate your AWS monthly bills based on your business requirements

Generic Cloud Economic Model Features

- ◆ Multi-tenancy model
- ◆ Virtualization technology
- ◆ Pricing and accounting system
- ◆ Differentiations in product offerings
- ◆ Differentiation in target customers
- ◆ The basis is large scale provisioning to accommodate all types of users
- ◆ Takes advantage of economics of scale to provide affordable products and services

The Business Motivation for Cloud Providers and Subscribers

◆ Subscribers

- Cost savings
 - Power consumption
 - Manpower
 - Software licenses
 - Maintenance
 - Support
 - Cooling
- Increase in profit margin as a result of cost savings
- Innovation
- Staff productivity
- Competitive advantage
- Shorter time and ease of deployments
- Automation
- Reliability and availability
- Scalability and resilience
- Elastic consumption and self services

The Business Motivation for Cloud Providers and Subscribers

◆ Providers

- Economics of scale based on shared resources
 - Multiple users can subscribe resources from a single physical machine
- Location independent
- Variety of customers
 - Small, medium and large scale users
- Variety of products and services
 - Compute, storage, software, platforms, CRMs, ERPs
- Virtualization technology
- Zero waste of compute resources
 - Scaling of resources based on demand

Cost Metrics and Pricing Models

◆ Business cost metrics

- This compares and evaluates the cost of using cloud resources to buying and maintaining IT resources by a company
- The types of costs are
 - Up-front costs for on-premise IT resource
 - The cost of initial investment such as purchasing hardware, software, labour, etc and deployment of IT resources.
 - This can be very high and expensive
 - Up-front costs for subscribing cloud resources
 - This is the initial cost of registering and subscribing for cloud-based resources.
 - This is usually lower than for on-premise resources. This can include virtual servers, databases and environments
 - On-going cost for on-premise IT resources
 - This is the day-to-day cost of running IT resources
 - This can be licensing fees of software, electricity, updates, insurance, salaries of staff
 - On-going cost for cloud-based resources
 - This is the cost of the continued usage of cloud-based resources
 - This includes virtual hardware usage fee, bandwidth, support and labour

Cost Metrics and Pricing Models

◆ Cloud usage cost metrics

- These are metrics used for calculating the cost of using cloud-based resources
- They are
 - Network usage-inbound, outbound and intra-cloud network traffic
 - Server usage-virtual server allocation
 - Cloud storage device-storage capacity allocation
 - Cloud service-subscription duration, number of access users and number of transactions

Cost Metrics and Pricing Models

◆ Cost management considerations

- This is the process of managing the lifecycle phases of cloud services
- The can be described as:
 - Cloud service design and development: this cost is defined in cost templates by the cloud service provider to the subscriber
 - Cloud service deployment: this is done during deployment of cloud services
 - This includes the backend architecture, billing related data collection, pay-per usage monitor and billing management system are implemented
 - Cloud service contracting: this is when the service provider and consumer negotiates terms of the contract and prices of cloud resources
 - Cloud service offering: this is the details of the resources to be offered by the provider
 - Cloud service provisioning: these are the cloud service usage and instance creation threshold
 - Cloud service operation: this is when active cloud service usage produced cost incurred data
 - Cloud service decommissioning: this is when a cloud service is temporarily or permanently deactivated and discontinued.

More on Business Drivers of Cloud Computing

- ◆ Cost and investment reduction
 - No need for technical personnel for operational purpose
 - No payments for upgrades and patches
 - No utility bills (electricity, cooling)
 - No need for admin and accounts staff
- ◆ Time savings
 - Thousands of virtual servers can be created and set up running within few hours
 - No need to raise purchase invoices and its attendant bureaucracy
- ◆ Organizational agility
 - You can easily scale up or down IT resources to adapt to your business needs
- ◆ Increased scalability
 - It can easily be expanded when your company increase in size
- ◆ Increased availability and reliability
 - The redundancy and replication of cloud resources by service providers make it reliable and readily available within reasonable time

Competition in the Cloud Market

- ◆ Different offerings to attract customers
 - Large Heavy-Reserved instances by AWS EC2
 - Glacier by AWS S3
 - <http://aws.amazon.com/glacier/>
- ◆ Innovative and creative products and platforms
- ◆ Constantly changing pricing and accounting methods
- ◆ Free instances and educational grants
 - <http://aws.amazon.com/grants/>
- ◆ Emerging architectures and models

Cloud Assurance as an Economic Feature

- ◆ Risk Mitigation Strategies is Part of Cloud Assurance
 - Backup, scalability, robust security and resilience
- ◆ Reputation of Service Provider
 - Past record of performance/delivery, customer experiences and global influence in this industry
- ◆ Size of the Provider
 - Economics of scale, customer base, number of zones/regions
- ◆ Market Value of the Provider
 - Shares, profit, stock market

Cloud Accounting Models

◆ Models

– Pay-As-You-Use

- Subscribers do not need to pay any money up-front
- This is the most popular
- Subscribers share the resources provided
- No dedicated computing resources for subscribers
- This is a good model for small companies and individuals

– Heavy-Reserved

- This model is good for medium users who intend to use the system continuously for over 1 to 3 years
- They can trade part of their unused resources
 - » AWS Market Place
- Subscribers must pay some money up-front depending on the number of years

Cloud Accounting Models

◆ Models

– Dedicated Reserved

- This is a good model for very big companies and institutions that need to use the system for long period of years
- Subscribers must pay some money upfront
- Subscribers have physical machines and resources dedicated for their use at the provider's datacenter
- Subscribers can trade part of the resources they are not using

◆ Payment methods

- Credit/debit cards
- Vouchers
- Online

Cloud-based Delivery Models

- ◆ This is a representation of a specific and pre-packaged combination of IT resources offered by cloud provider as a service
- ◆ This includes:
 - Infrastructure-as-a-Service: IaaS
 - This is a self-contained IT environment that can be accessed through cloud service interfaces
 - This consists of hardware, network connectivity, operating system
 - Platform-as-a-Service: PaaS
 - This is a ready-to-use environment that consist of resources that have been configured and deployed already
 - Examples are Software Development Kits (SDKs), Middleware

Cloud-based Delivery Models

- ◆ This includes:
 - Software-as-a-Service: SaaS
 - This is software program provided as a shared service to be used by cloud consumers
 - This is usually used in a generic way
 - Storage-as-a-Service: STaaS
 - ?
 - Database-as-a-Service: DBaaS
 - ?
 - Security-as-a-Service: SCaaS
 - ?
 - Etc...etc
 - ?

Cloud Deployment Models

- ◆ Public cloud
- ◆ Private cloud
- ◆ Community cloud
- ◆ Hybrid cloud

The Challenges and Opportunities

- ◆ Increasing demand for better features and support
- ◆ Fierce competition with increasingly new start-ups
- ◆ Security and trust
- ◆ Reliability and availability
- ◆ Accounting models
- ◆ Disruptive tendencies
- ◆ Quality of service (QoS)
- ◆ Meeting service level agreements

More on Risk and Challenges Associated with Cloud

- ◆ Security vulnerability
- ◆ Operational governance control
- ◆ Portability problem between different cloud providers
- ◆ Multi-regional cultural and legal problems

Job Opportunities in Cloud Computing

- ◆ Application programmers
- ◆ Solutions Architects
- ◆ Infrastructure experts
- ◆ Platform experts
- ◆ Middleware experts
- ◆ Virtualization administrators
- ◆ Network administrators
- ◆ Database and storage administrators
- ◆ Cloud security experts
- ◆ Mobile application programmers

Job Opportunities in Amazon AWS

- ◆ AWS Cloud Practitioner
- ◆ AWS Solution Architect
- ◆ AWS Developer
- ◆ AWS DevOps Engineer
- ◆ AWS SysOps Administrator
- ◆ AWS Security Expert
- ◆ AWS Big Data Expert
- ◆ AWS Networking Expert

AWS Certification Routes



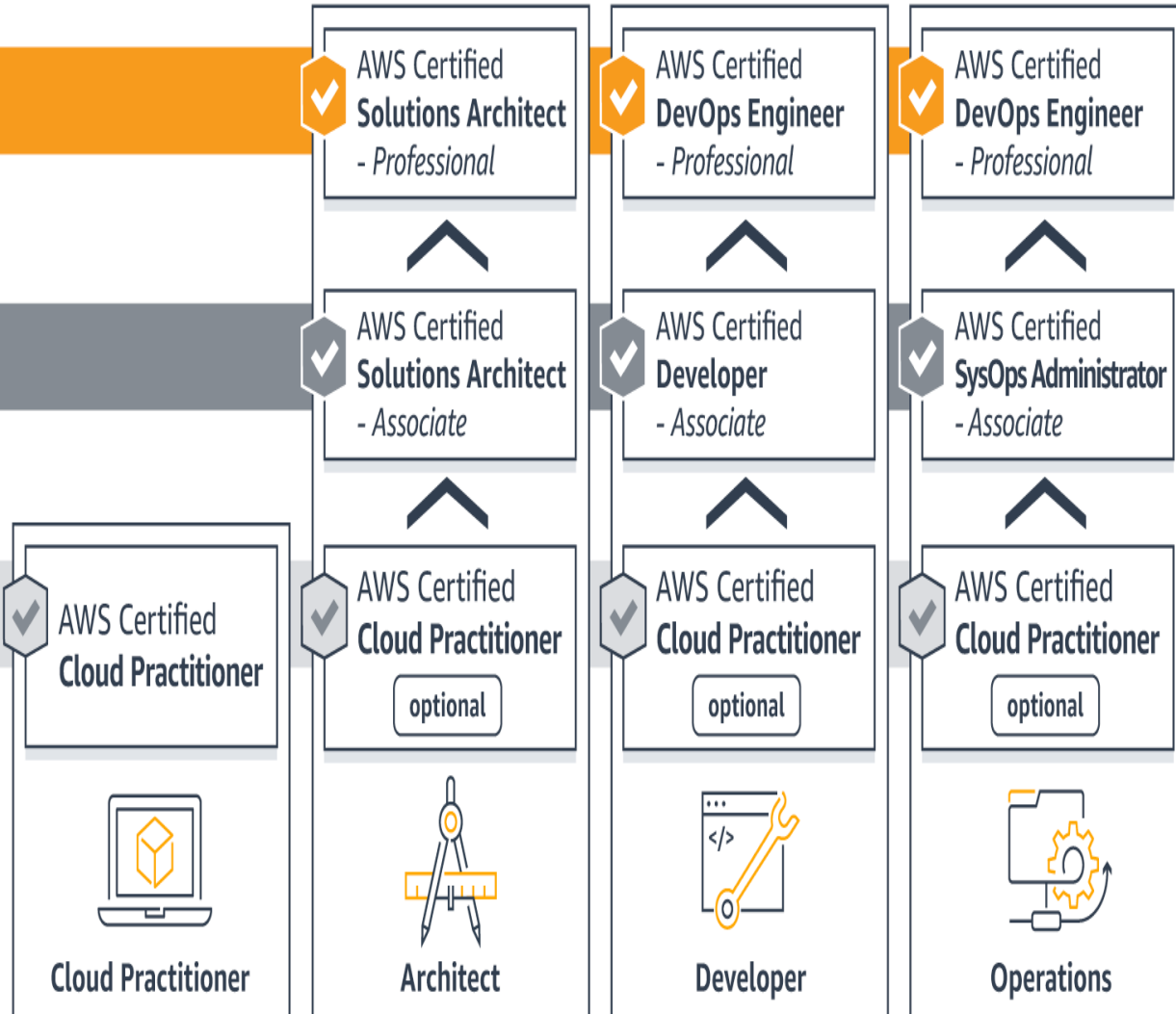
Role-Based Certifications

Specialty Certifications

Professional

Associate

Foundational



AWS Certified Advanced Networking
- Specialty



AWS Certified Big Data
- Specialty



AWS Certified Security
- Specialty

Class Task

- ◆ What is AWS Trusted Advisor?
- ◆ What are AWS TCO Calculator and AWS Simple Monthly Calculator? What are they used for?
- ◆ With the help of a diagram maths formulas, explain traditional IT cost model and Cloud cost model
- ◆ Discuss and design a creative economic model for next generation of cloud computing
 - In 3 groups