

CS5224: Cloud Computing

AY2020/21 – Semester 2



Teo Yong Meng

Room: Com2, #04-39

Department of Computer Science

National University of Singapore

Email: teoym@comp.nus.edu.sg

URL: www.comp.nus.edu.sg/~teoym

Tel: 6516 2830



Course Organization

- Lecture
 - zoom links: luminus -> conferencing
 - recorded lectures: luminus -> multimedia
 - 2 groups
 - **Group 1: Tue, 6.30-8.30pm** (MComp, SoC undergraduate and graduates)
 - **Group 2: Wed, 4-6pm** (MDSML, MSBA)
 - **Students must attend lectures for the group that they are registered**
- Tutor: Group 1 - Zhang Han & Phichayut Siripis (Com 2, #B1-01)
Group 2 – Gunjan Lal



Course Organization

- Web
 - Luminus for course announcement, quizzes, submission of assessments, test, ...
 - www.comp.nus.edu.sg/~teoym/cs5224-21 for lecture slides, assignments, etc.
- Microsoft Teams
 - group project management & discussion
 - scheduled consultation
 - **Group 1:** Sat, 2pm (Han & Phichayut)
 - **Group 2:** Wed, 12noon (Gunjan)
 - upload 1-slide self-introduction to Teams files -> 1-slide-self-introduction folder

Cloud Computing



[course page](#)

Cost of Computing

Computer prices, cost/MHz					
	1970	1984	1997	2007	2019
Cost (US\$)	4.6m	4K	1K	550	570
speed (MHz)	12.5	8.3	166	1600	4100
Cost/MHz	368K	482	6	0.34	0.14

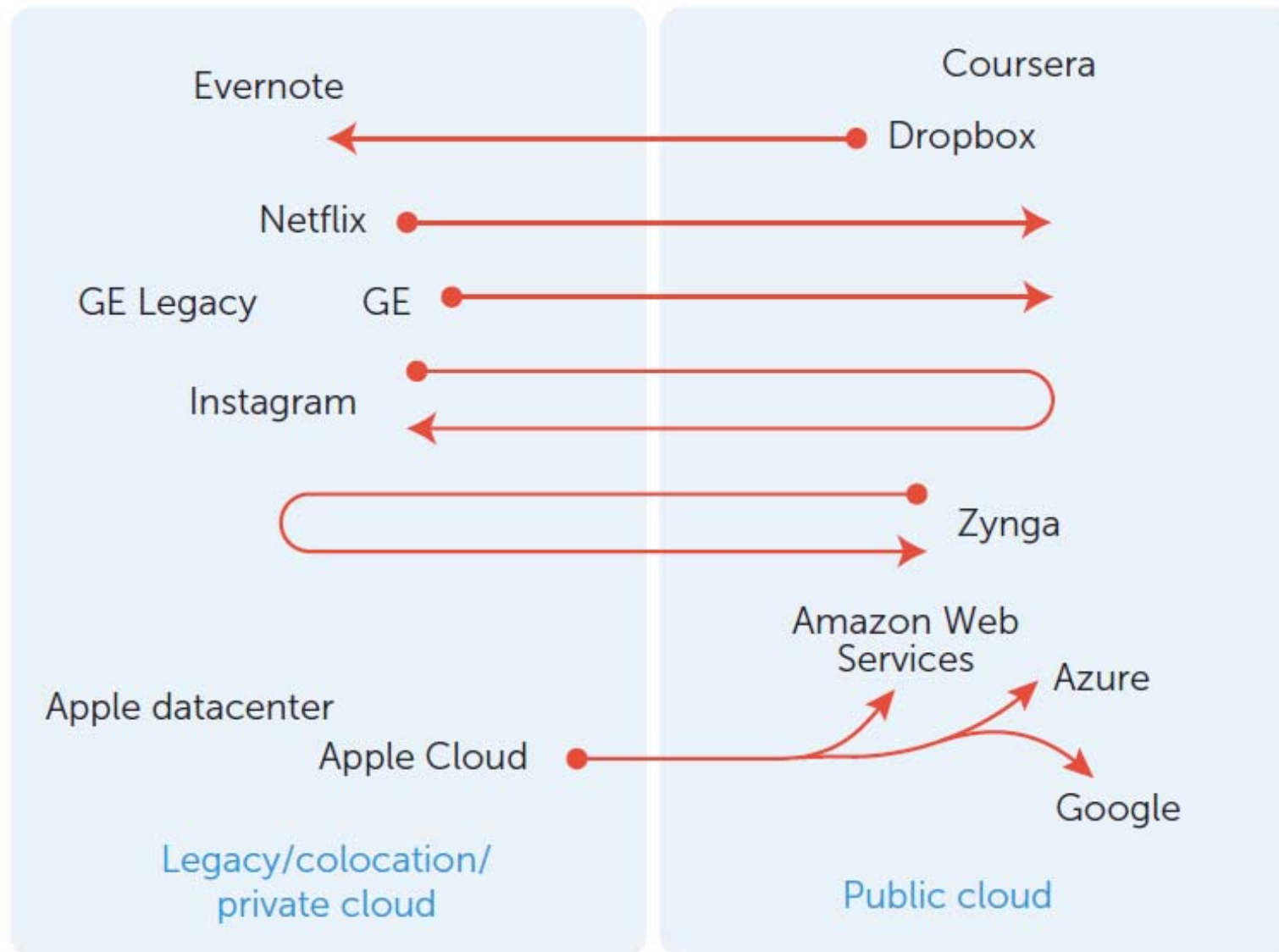


IBM Mainframe
Computer 1970

Dell Small
Desktop
3470

Amazon AWS (2019)
\$0.01 to 0.27 per hour

Cloud Migration



Migrating to or away from the Public Cloud, IEEE Cloud Computing, Mar 2016

Learning Objectives

1. explains and discusses fundamental aspects of cloud computing **concepts, models, technologies** and **applications**
2. hands-on: Amazon Web Services covering IaaS, PaaS, SaaS and FaaS
3. develop & implement business case for a cloud service

Learning Objectives

- Class with varied knowledge – MComp, MSBA, MDSML graduate, SoC undergraduate & graduate
- Covers key concepts with hands-on using Amazon Web Services
- Teaching mode: lectures, hands-on using Amazon AWS, group project (develop SaaS application that puts all you have learnt together)

What we Cover?

A. PRINCIPLES OF CLOUD COMPUTING

L01: Introduction

L02: Concepts & Models

L03: Cloud Architecture

B. TECHNOLOGIES BEHIND CLOUD COMPUTING

L04: Resource Hosting and Datacenter

L05: Virtualization & Multitenancy

C. APPLICATIONS & PROGRAMMING

L06: Applications & Paradigms

L07: Examples: K-means Clustering & SaaS Video-Sharing

L08: Cloud Software Development

D. CLOUD MANAGEMENT

L09: Pricing Models and Modeling TCO

E. SUMMARY & CONCLUSION

L10: Summary and Open Issues

L11: Beyond Cloud Computing

Hands-on

AWS01: Amazon Web Services

AWS02: AWS Core Services

ASW03: Cloud Service Models

AWS04: AWS MapReduce

Luminus Forum

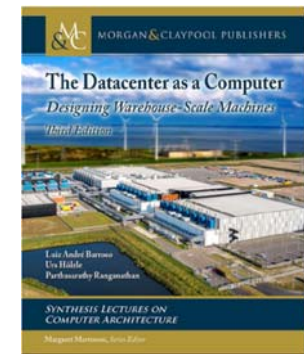
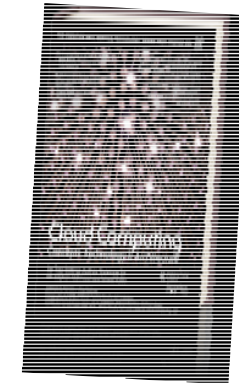
Additional avenue for discussion - using cloud services, assignments, project, etc

Please post to the respective forum pages:

1. Amazon Web Services
2. Assignments & Project

Main Text

1. *Cloud Computing: Concepts, Technology & Architecture*, Thomas Erl, et al., Prentice-Hall, 2013, 2 copies at RBR in Central Library.
[chapters 3, 4, 5, 11, 15 & 16]
2. *The Datacenter as a Computer – Designing Warehouse-Scale Machines*, 3rd Edition, Morgan & Claypool Publishers, 2019
(available online) [chapters 1, 2, 3, 4, 6]
3. *AWS Certified Solutions Architect*, Official Study Guide, Sybex, 2017.



Module Assessment

100% CA

1. Luminus Quizzes: 20%
2. Lab Assignments: 20%
3. Group Project (4): 30%
4. Final Test (closed book): 30%

Luminus Quizzes (20%)

- objective: review key concepts covered in lectures and labs; ensure that you keep up with the module
- 7 online quizzes: each quiz covers topics in lectures and labs
- Each quiz – will take the best of 2 attempts
- Total – take best 5 out of 7

Labs and Lab Assignments (20%)

- Objective: learn cloud application programming using Amazon Web Services; learn by example; not a class on learning programming language
- Teaching mode: each set of lab consists of 2 parts: an overview (covered during lecture) and step-by-step exercise (done as homework); 2 lab assignments to reinforce what you have learnt
- Labs
 - AWS01: Amazon Web Services
 - AWS02: AWS Core Services
 - AWS03: Cloud Service Models
 - AWS04: AWS MapReduce

Group Project (30%)

- Objective: apply all you have learnt to develop and implement a business case for one cloud service of general interest; working prototype is expected
- Group of 4 members including group leader
- Timeline
 - 5 Feb: form group and submit project title and brief description
 - 5 Mar: preliminary report (10%)
 - 9 Apr: final report, etc (20%)
- Project management and discussion: using Microsoft Teams (Group 1: Zhang Han & Phichayut Siripis, Group 2: Gunjan Lal)

Final (Closed Book) Test (30%)

- One common test for both groups, no retest
- **Luminus Test on Tue, 6.30pm, 13 Apr**

Questions

1. programming

- objective: concepts + practice (service & deployment models, design & implement cloud applications, ...)
- cloud platform: Amazon Web Services (IaaS, PaaS, SaaS, FaaS): learning by examples, jumpstart through detailed step-by-step lab exercises
- project: form team (4) that leverage on the class with diverse knowledge and expertise
- programming: heavy-duty programming, more specific on this, amount of programming in business case
- **bottom-line: do not like programming, this may not be for you**

2. choices of cloud platforms

- why not Microsoft Azure, Google cloud,
- lack of cloud interoperability standards, etc

History of CS5224

- **June 2012:** Hanoi Summer School (undergraduate) - CP3109: Introduction to Cloud Computing (1-day)
- **Jan 2014 – now:** CS5224 Cloud Computing (SoC undergraduate & graduate, MComp, MSBA, MDSML)
- **Jul 2017:** NUSRI Summer Course (undergraduate) – RI3009 Cloud Computing (1-month)
- **Aug 2017:** SoC Summer School (graduate) (half-day)
- **Jul 2018 & 2019:** SoC Summer Workshop (undergraduate) – SWS3004 Cloud Computing with Big Data [4 weeks]
- **Aug 2019 and Sep 2020:** Industry Technology Assessment Course (1-day) – Cloud Computing: Development & Future Trends [designed for China North Industries Group Corporation]