National College of Ireland

National College of Ireland

MSc in Cloud Computing – Full-time – Year 1 – MSCCLOUD_JAN19
Postgraduate Diploma in Cloud Computing – Full-time – Year 1 – PGDCLOUD

Semester Two Examinations – 2018/19

Tuesday 7th May 2019
2.00pm – 4.30pm

Cloud Architecture

Dr Ted Scully
Dr Horacio González-Vélez
Mr David Tracey

Answer ALL questions

Duration of exam: 2.5 hours
Attachments: None
Required: Calculator

1) Based on the wider concept on Virtualisation in computing.
   a) Name and briefly explain the 5 levels of virtualisation
      [2 marks per level (one for name and one for explanation). Max 10 marks]

   b) Initially developed by Microsoft Research in early 2000s, F# is a strongly-typed (functional) programming language. It requires the use of the .NET Framework and its Common Language Runtime (CLR) to run code. Explain how an F# (or a Java) application executes on any given platform. Justify your answer via a virtualisation level and its possible advantage(s) and disadvantage(s).
      [8 marks for chosen level and justification]

   c) Discuss the importance of virtualisation in Cloud Computing. **[7 marks]**

[Total 25 Marks]

2) Using the Berkeley's View on Serverless Computing[1]**:**
   a) Define Serverless Computing with special consideration to cost **[10 marks]**;

   b) Describe the three critical distinctions between serverless and serverful computing; and, **[3 marks per distinctions (up to 9 marks)]**

   c) Mention an application that is ***unsuitable*** for serverless computing, describing the reasons why it cannot be currently deployed on serverless infrastructures **[6 marks]**.

[Total: 25 marks]

3) Dublin-based Cloudenci is considering a new public cloud offering that assures a maximum time to repair (MTTR) of 600 seconds for any given failed component in its cloud infrastructure. Assuming a maximum of one failure per year:

   a) Calculate the annual availability without planned downtime **[6 marks]**

   b) If Cloudenci wants to offer a five nines SLA based on the availability, what is an acceptable MTTR assuming 1 failure per year with no planned downtime? **[4 marks]**

   c) Discuss one of the following design approaches and its impact on failure in clouds: Service degradation, Buffering, Automation **[5 marks]**

   d) Discuss Brewer's CAP Theorem[2] and the design choices it provides to handle failures **[10 marks]**

[TOTAL: 25 marks]

[1] Eric Jonas et al.: *Cloud Programming Simplified: A Berkeley View on Serverless Computing*. Technical Report No. UCB/ EECS- 2019-3 (2019)

[2] Eric Brewer: CAP twelve years later: How the "rules" have changed. *Computer* 45(2): 23-29 (2012)

4) Modern multicore processors have variable core speeds e.g. the 9th generation Intel i9-9900K multicore processor has variable frequency in its 8 cores (3.60Ghz base, 5Ghz maximum).

Consider a given parallel task—composed of **DAXPY**[3] functions only—executing on a variable-speed multicore processor, which employs 4 heterogeneous cores labelled C1, C2, C3, and C4. Assume cores C1 and C4 operate at the same speed. C2 runs twice as fast as C1 and core C3 runs 3 times faster than C1.

Assume all four cores start executing DAXPY at the same time and no cache misses are encountered on any core operation. Suppose the parallel task uses two vectors **x** and **y** with 1024 elements for all DAXPY operations. Assume 1 unit of time for C1 (or C4) to compute DAXPY.

Given the following division of labour in four cores:

C1: 128 elements	C2: 512 elements	C3: 256 elements	C4: 128 elements

a) Calculate the total execution time (in time units) for the four cores to compute the parallel task on the 1024-element array **[5 marks].**

b) Propose an improved allocation elements-to-cores and calculate the new total execution time and utilisation **[5 marks]**.

c) Using the Flynn's taxonomy, define MIMD and SIMD **[5 marks]**.

d) The development team is considering using GPU use. Critically compare GPU, GPGPU, and multicore CPU and explain the advantages and disadvantages of each, giving examples **[10 marks]**.

[TOTAL: 25 marks].

[3] N.B. DAXPY functions sum two vectors **x,y** with a scalar **a** multiplier applied during the sum operation: **ax + y**