National College of Ireland

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MSc in Cloud Computing – Full-time – Year 1 – MSCCLOUDJAN18
MSc in Cloud Computing – Part-time – Year 1 – MSCLOUDE1

Semester Two Examination – 2017/18

Saturday 19th May 2018
2.00pm – 4.00pm

Cloud Architecture

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Answer ALL questions

Duration of exam: 2 hours
Attachments: None

1) Compare the three cloud computing delivery models, SaaS, PaaS, and IaaS, from the point of view of the *application developers* and the *users*. Discuss the security and the reliability of each one of them. Analyse the differences between the PaaS and the IaaS.

[TOTAL: 20 marks— 5 for each model; 5 marks for PaaS vs. IaaS analysis]

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2) The run time of a data-intensive application could be days, or possibly weeks, even on a powerful supercomputer. Checkpoints are periodically taken for a long-running computation and, when a crash occurs, the computation is restarted from the latest checkpoint.

a) Let σ be the slowdown due to checkpointing for a computation composed of **n** runs, when checkpoints are taken. Each run lasts **τ** units of time and each checkpoint requires **κ** units of time. Discuss optimal choices for **τ** and **κ**.

b) The checkpoint data can be stored locally, on the secondary storage of each processor, or on a dedicated storage server accessible via a high-speed network. Which solution is optimal and why?

[TOTAL: 20 marks— 15 marks for a): 10 marks slowdown calculation and 5 marks for optimal choices; 5 marks for b): checkpoint technology.]

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3) Parallel Architectures

a) Explain the Flynn's classification of computer architectures (SISD, SIMD, MIMD).

b) There are different models of MIMD parallelism and MPI is arguably one of the most scalable and widely used. The "Hello World" C-MPI program below is to be compiled onto an executable file named `./hello` and executed on a server with an Intel i7 8th Generation (6 cores with 2 threads per core) and 16GB of memory with Linux Ubuntu 16 and the full MPI library.

```
/* C Example */
#include <mpi.h>
#include <stdio.h>

int main (int argc, char* argv[])
{
  int rank, size;

  MPI_Init (&argc, &argv);      /* starts MPI */
  MPI_Comm_rank (MPI_COMM_WORLD, &rank);   /* get current process id */
  MPI_Comm_size (MPI_COMM_WORLD, &size);   /* get number of processes */
  printf( "Hello world from process %d of %d\n", rank, size );
  MPI_Finalize();
  return 0;
}
```

i) Define and briefly describe the operation of MPI.

ii) Is the `mpirun -np 24 ./hello` a valid execution command? Justify your answer and, if your answer is positive, provide the valid range of values for the variables `rank` and `size`.

[TOTAL: 30 marks—15 marks for a): 4 SISD, 4 SIMD and 7 MIMD;
15 marks for b): 8 marks for MPI description and 7 for command explanation]

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4) Virtualisation simplifies the use of resources, isolates users from one another, supports replication and mobility, but incurs a price in terms of performance and cost.

a) Analyse each one of these aspects for i) memory virtualisation, ii) processor virtualisation, and iii) virtualisation of a communication channel.

b) Describe the role of a hypervisor and its main functions.

[TOTAL: 15 marks. 6 for a): 2 marks per analysis (memory, processor and communication virtualisation); and 9 marks for b): 3 for description and 1.5 per function – up to 4.

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5) Define HDFS and highlight at least two key characteristics.

[TOTAL: 15 marks. 5 marks for definition and 5 marks for each characteristic.