



**Galway-Mayo Institute of Technology**  
**Semester 1 Examinations 2019/2020**

**MODULE:** COMP08011 – Distributed Systems

**PROGRAMME(S):**  
GA\_KSOAG\_H08 BACHELOR OF SCIENCE (HONOURS) IN COMPUTING  
IN SOFTWARE DEVELOPMENT

**YEAR OF STUDY:** 4

**EXAMINERS:**  
Dr. John French (Internal)  
Mr. Tom Davis (External)  
Dr. Des Chambers (External)

**TIME ALLOWED:** 2 hours

**INSTRUCTIONS:** **Answer 4 questions. All questions carry equal marks.**

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The use of programmable or text storing calculators is expressly forbidden. Please note that where a candidate answers more than the required number of questions, the examiner will mark all questions attempted and then select the highest scoring ones.

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There are no additional requirements for this paper.

**Question 1** (25 marks)

- (a) Explain what is meant by heterogeneity in distributed systems, giving examples of ways in which distributed systems can be heterogeneous. (15 marks)
- (b) What is the role of middleware in a distributed system? (5 marks)
- (c) Explain what is meant by distribution transparency in a distributed system, giving examples of types of transparency. (5 marks)

**Question 2** (25 marks)

- (a) Explain what is meant by Data Serialisation, and discuss why it is necessary for distributed systems. (5 marks)
- (b) Discuss the relative merits of the following types of Serialisation formats, and give a specific example of each type: (15 marks)
  - Text-Based
  - Semi-Compiled
  - Binary
- (c) Write a Protocol Buffer message definition for a `Person` message, with fields `name` (string), `id` (integer), and `email` (string). Either proto2 or proto3 syntax is acceptable. (5 marks)

**Question 3** (25 marks)

- (a) Processes can communicate with each other by passing messages in different ways. Explain what is meant by the following types of inter-process messaging: (10 marks)
  - Persistent
  - Transient
  - Synchronous
  - Asynchronous
- (b) Describe the functioning of the Remote Procedure Call (RPC) model for inter-process communication, using diagrams as necessary, and the gRPC framework as a specific example. (15 marks)

**Question 4** (25 marks)

- (a) Discuss the ways in which the REST architectural style for web services differs from traditional web services based on SOAP and XML-RPC. Your answer should include a description of REST's reliance on web protocols. (15 marks)
- (b) Explain what the OpenAPI specification is, and discuss the role of OpenAPI/Swagger in developing RESTful web services. (10 marks)

**Question 5** (25 marks)

- (a) Replication and Partitioning are fundamental techniques employed in the design and implementation of distributed data stores. Explain what is meant by these two terms, and discuss why they are useful. (10 marks)
- (b) Describe the MapReduce programming model for distributed batch processing of large datasets. (10 marks)
- (c) Give an example of how MapReduce could be used to determine the frequency with which different URLs are accessed based on logs of web page requests. (5 marks)