GMIT
INSTITIÚID TEICNEOLAÍOCHTA NA GAILLIMHE-MAIGH EO
GALWAY-MAYO INSTITUTE OF TECHNOLOGY

SCHOOL OF SCIENCE

GMIT EXAMINATIONS

SESSION: DECEMBER 2015

PROGRAMME: **BACHELOR OF SCIENCE (HONS)
IN SOFTWARE DEVELOPMENT**

YEAR/STAGE: 4

MODULE: **DISTRIBUTED SYSTEMS**

INTERNAL EXAMINER(S): **Dr. John Healy**

EXTERNAL EXAMINER(S): **Dr. Michael Schukat
Mr. Tom Davis**

TIME ALLOWED: **2 HOURS**

INSTRUCTIONS TO CANDIDATES:

ATTEMPT ANY 4 QUESTIONS

Attachments: **details:**	**Yes**	□	**No**	□	**If yes, please list**
Special Requirements: **details:**	**Yes**	□	**No**	□	**If yes, please list**
Calculators Permitted:	**Yes**	X	**No**	□	**Not applicable**

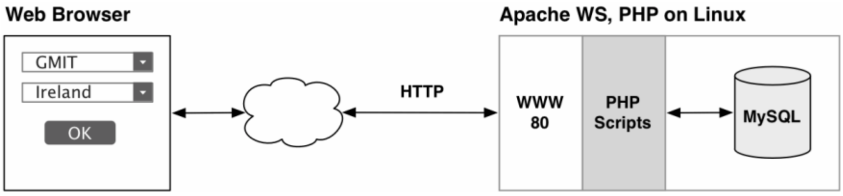
1. (a) Explain, using diagrams and examples, the following terms as they apply to distributed systems:

- Heterogeneity **(5 Marks)**
- Transparency **(5 Marks)**
- Openness **(5 Marks)**

(b) Discuss how **message queues** can be used to augment traditional client-server communication with both synchronous and asynchronous capabilities. Illustrate your answer with UML diagrams where appropriate.

(10 Marks)

2. The following diagram depicts the system architecture for a web-based e-commerce application that allows users to purchase concert tickets online:



While the system operates well for small to medium sized concerts, concerns have been raised about the scalability of the system, after users experienced a major degradation in performance when making bookings for a recent 50,000-ticket Beyoncé concert at the Aviva Stadium.

You are required to provide a re-design of the system that will:

- Allow the system to scale to support thousands of concurrent users.
- Enable the system to be extended to support the aggregation of additional functionality from separate heterogeneous remote services.
- Allow the system to be remotely queried using different request protocols from different types of devices, including Windows and Linux workstations, Android tablets and IPhones.

Your answer should include a fully labelled diagram of the new system architecture along with a description of the roles of its constituent technologies and platforms.

(25 Marks)

3. *"Marshalling is a salient and essential component of distributed systems, promoting both loose-coupling and support for heterogeneity."*

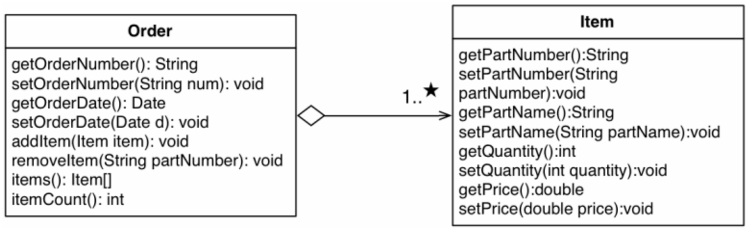
Discuss this statement. Your answer should address the centrality of ***marshalling*** and the role of ***middleware*** in distributed computing. Where appropriate, include system diagrams, UML designs and code snippets in your answer.

(25 Marks)

4. (a) Describe the function of the following components of the RMI architecture:

- The Remote Interface **(3 Marks)**
- The RMI Registry **(3 Marks)**
- Stubs and Skeletons **(4 Marks)**

(b) The following UML diagram depicts the composition relationship between an *Order* and a *LineItem* class. Both classes form part of an Order-Management system used by a local Galway company that specialises in the sale of novelty shirts and ties.


Order
getOrderNumber(): String
setOrderNumber(String num): void
getOrderDate(): Date
setOrderDate(Date d): void
addItem(Item item): void
removeItem(String partNumber): void
items(): Item[]
itemCount(): int
1..★
Item
getPartNumber():String
setPartNumber(String partNumber):void
getPartName():String
setPartName(String partName):void
getQuantity():int
setQuantity(int quantity):void
getPrice():double
setPrice(double price):void

Explain, using code examples and diagrams where appropriate, how the above classes can be incorporated into the RMI architecture. You should apply the ***Open-Closed Principle*** in your answer, i.e. the Order and Item classes should not require modification. You may assume that both classes already implement the interface *java.io.Serializable*.

(15 Marks)

5. (a) Discuss, citing examples, the difference between ***homogeneous*** and ***heterogeneous*** distributed database systems.

(8 Marks)

(b) Describe how the ***two-phase-commit protocol*** can be used to implement a distributed atomic transaction.

(8 Marks)

(c) Discuss how a ***hash-ring*** can be used in a distributed hash table as a mechanism for promoting with both high availability and scalability. Include in your answer a diagram showing how a hash ring is used to partition and locate database nodes.

(9 Marks)

6. (a) Using a fully labelled diagram, describe the main components of a CORBA orb. Include in your answer a description of the services provided by the CORBA object adapter.

(12 Marks)

(b) The following figure describes two Java interfaces that abstract a student and a class respectively:

```
public interface Student{
        public void setStudentName(String name,  int id);
        public String getStudentName(int id);
        public int getStudentId(String name);
        public boolean deleteStudent(int id);
}


import java.util.Vector;
public interface Class{
        public boolean addClass(String className,  int courseCode,  String lecturer);

        // returns a list of student objects
        public Vector getStudents(String className);
}
```

Show how ***Interface Definition Language*** (IDL) can be used to represent these interfaces in a CORBA architecture.

(8 Marks)

(c) Briefly describe the mechanism through which a CORBA orb can communicate directly with a J2EE container.

(5 Marks)