UNIVERSITY OF COLOMBO, SRI LANKA

UCSC

BIT

UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING

DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY (EXTERNAL)

Academic Year 2018 – 3rd Year Examination – Semester 6

IT6505: Middleware Architecture

7th October, 2018
(TWO HOURS)

To be completed by the candidate

BIT Examination Index No: ....

Important Instructions:

- The duration of the paper is **2 (two) hours**.
- The medium of instruction and questions is English.
- This paper has **4 questions** and **17 pages**.
- **Answer all questions.**
- **Write your answers** in English using the space provided **in this question paper**.
- Do not tear off any part of this answer book.
- Under no circumstances may this book, used or unused, be removed from the Examination Hall by a candidate.
- Note that questions appear on both sides of the paper.
  If a page is not printed, please inform the supervisor immediately.
- Programmable Calculators or any other data storage devices are **not** allowed.

Questions Answered

Indicate by a cross (×), (e.g ☒) the numbers of the questions answered.

	Question numbers				
To be completed by the candidate by marking a cross (×).	**1**	**2**	**3**	**4**	
To be completed by the examiners:					

1)

(a) (i). Compare and contrast centralized systems and distributed systems with respect to components, technology, resources, and points of control and failure. You may choose from the terms *single, multiple, homogeneous, heterogeneous, autonomous, non-autonomous, shared* and *exclusive* to fill in the blanks.

(05 marks)

ANSWER IN THIS BOX

	Centralized	Distributed
Components	Non-autonomous	Autonomous
Technology	Homogeneous	Heterogeneous
Resources	Shared	May be used exclusively
Point of control	Single	multiple
Point of failure	Single	multiple

(ii). With reference to the five factors in part (a) (i) above or otherwise, explain why large-scale services such as Google and Facebook use distributed systems instead of centralized systems.

(04 marks)

ANSWER IN THIS BOX

Google, Facebook and such service providers provide service for large numbers of users. Further they also consists of various sub processes that require varies levels of resources. Hence a distributed system with autonomous components can function independently irrespective of other subsystems and failures, ➔ **1 mark** it also allows for different technologies which are optimized or suitable for different tasks to run concurrently in order to proved optimal services ➔ **1 mark**. As the resource requirements of various tasks and services may resources could be managed and when required exclusively allocated for particular processes ➔ **1 mark** Even though there are multiple points of failure and control and it proves a challenge, by managing the systems even if one or more systems fail the system can still provide a full or limited service. ➔ **1 mark** (iii). *Point of failure* is a challenge faced by distributed systems. Explain the concept and the instances at which such failures may occur in a distributed system.

(04 marks)

ANSWER IN THIS BOX

Distributed systems have multiple points of failure. They could be in any of the distributed components which provide service to complete a task ➔ **1 mark** or the network used for communication. ➔ **1 mark**

Approaches such as replication and group computing, virtual synchrony etc. help to address problems of multiple points of failure by still providing service even if a component is down by replacing it with another service provider. ➔ **2 mark**

(b) (i). When compared to the operating system and network services, middleware services provide a more functional set of application programming interfaces to the developer. List three (03) opportunities this provides for an application.

(03 marks)

ANSWER IN THIS BOX

- Locate transparently across the network, thus providing interaction with another service or application
- Filter data to make them friendly usable or public via anonymization process for privacy protection (for example)
- Be independent from network services
- Be reliable and always available
- Add complementary attributes like semantics

➔ **1 mark x 3**

(ii). List three (03) Integration category middleware and briefly explain each of them.

(03 marks)

ANSWER IN THIS BOX

- Procedural: It calls procedures on remote systems and is used to perform synchronous or asynchronous interactions between applications or systems
- MOM: is an infrastructure that supports the receiving and sending of messages over distributed applications.
- OOM: gives applications the ability to send objects and request services via an object-oriented system.
- Agent: Agents are considered a middleware that consists of several components: entities (objects, threads), media (communication between one agent and another), and laws (rules on agent's communication coordination). Media can be monitors, channels, or more complex types (e.g. pipelines).
- Component Based or Reflective Middleware: A component is described as a "program that performs a specific function and is designed in such a way to easily operate with other components and applications"

➔ **1 mark x 3**

(c) (i). What are the primary purposes of *Stubs* and *Skeletons* in a remote procedure call (RPC)?

(02 marks)

ANSWER IN THIS BOX

Stub – On the Client End, Converts/marshals the parameters into a bit string and send the message over the network. When it receives a response converts/unmarshals the bit string back into parameters. ➔ **1 mark**

Skeleton – On the Server End, Receives a bit string and converts/unmarshals into parameters then calls the server procedure. The server response is then converted/mashalled back to a bit string and sent over the network. ➔ **1 mark**

(ii). Consider the following RPC Language file *simp.x*. Clearly explain the function of each line of the code in this segment.

```
#define VERSION_NUMBER 1
struct operands{
    int x;
    int y;
}
program SIMP_PROG {
    version SIMP_VERSION {
        int ADD(operands) = 1;
        int SUB(operands) = 2;
    } = VERSION_NUMBER;
} = 0x20000001;
```

(04 marks)

ANSWER IN THIS BOX

Each line of code will receive ½ mark, a total of 4 marks, excluding line 3, 4 & 5

1. Define a constant value VERSHION_NUMBER equal to 1
2. Defines a structured data type operands and with 2 integer values x and y
3.
4.
5.
6. The Version SIMP_VERSION (remote program version) will be assigned 1
7. Creating a single data structure to be sent to the server
8. ADD is declared to be procedure 1
9. SUB is declared to be procedure 2
10. In version 1 of the remote programme
11. SIMP_PROG, with the program number 0x20000001

2)

(a) (i). Define what is meant by *Distributed Transaction* in a single sentence. Provide an example of a scenario where distributed transactions may occur (other than a banking/financial transaction) and give a reason why it needs to be distributed.

(05 marks)

ANSWER IN THIS BOX

Distributed transaction processing is about having more than one database participate in one transaction ➔**1 mark**

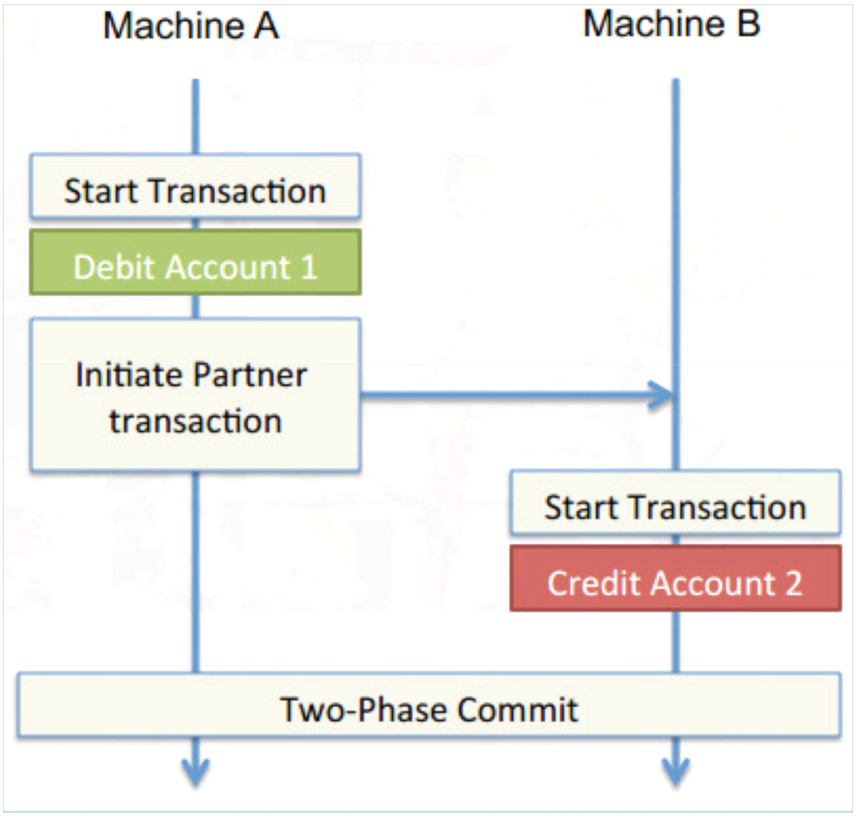
For example scenorio ➔**1 mark**

justification ➔ **3 mark**

(ii). The XYZ Bank provides customers with a mobile app which allows users to conduct banking transactions through their smartphones. A user requires transferring money from his account in XYZ Bank to his friend's account which is in the ABC Bank. Using a diagram explain how this transaction would be carried out using distributed transaction processing. Clearly identify any key protocols used and their purpose.

(05 marks)

ANSWER IN THIS BOX



➔**3 marks**

Two-Phase Commit Protocol – to guarantee a successful transaction ➔**2 marks** (iii). Identify two (02) flaws in the Distributed Transaction Processing mechanism used above.

(05 marks)

ANSWER IN THIS BOX

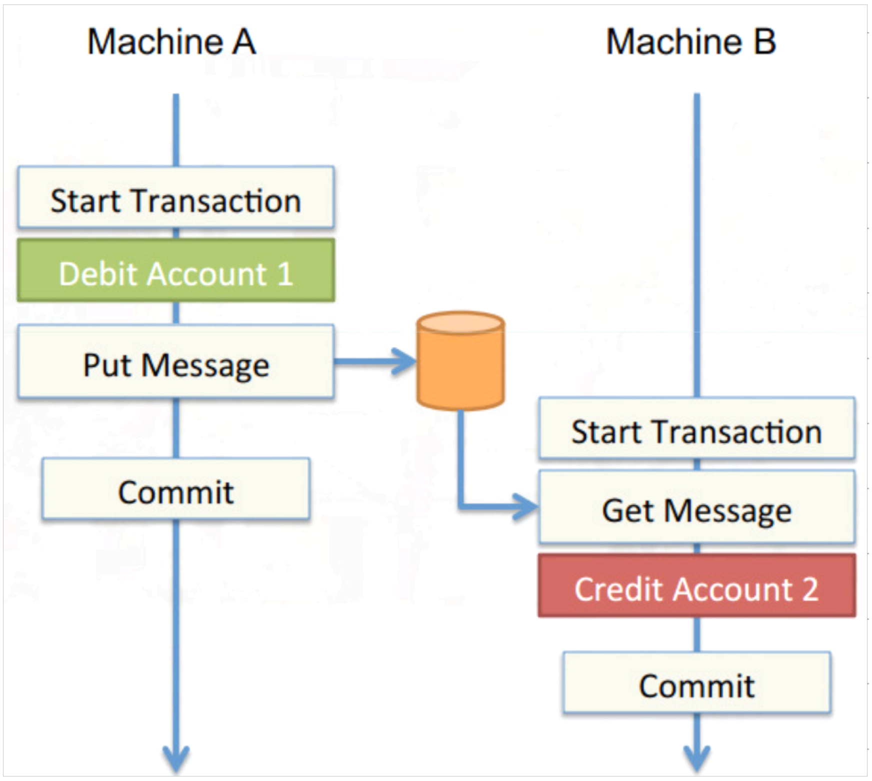
The performance is degraded due to the addition overhead of sending messages required by the two-phase commit protocol ➔**2 ½ marks**

If either of the machines/servers or the network is down the transaction cannot take place ➔**2 ½ marks**

(b) (i). Using a diagram illustrate how the transaction scenario in part (a) section (ii) could be implemented using Message Oriented Middleware.

(05 marks)

ANSWER IN THIS BOX

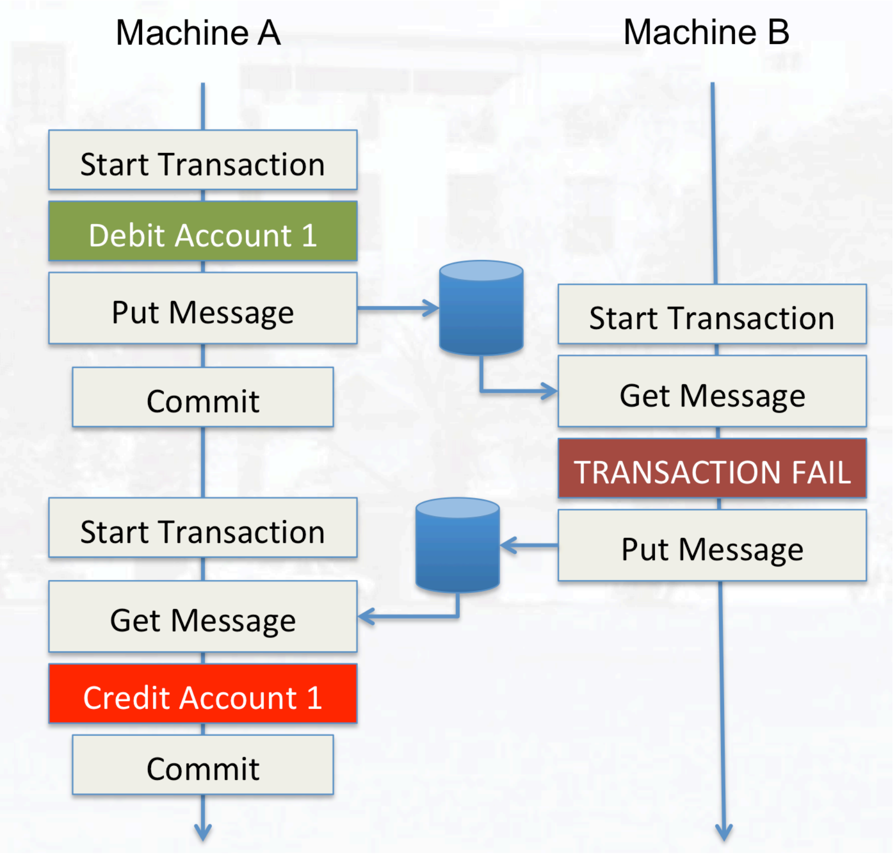


(ii). Identify a problem that could occur in the message oriented middleware implementation in part (b) section (i) above. Using a diagram illustrate how this problem could be solved.

(05 marks)

ANSWER IN THIS BOX

The problem is that if the sub transaction on Machine B fails the money taken from the 1st account will disappear. ➔**2 marks**



- Machine B will complete the transaction, however on failure it will have to send a message to Machine A to Revers the transaction ➔ **3 marks**

3)

(a) (i). In Sri Lanka's domestic cricket tournament, players need to be managed. Information of a player such as *id, name, date of birth, role* (batsmen, bowler, all-rounder etc.) is stored in a database. Data can be saved to database, retrieved from, and printed using the *PlayerStore* object. In addition, an object referred to as *Team* consists of a name which is read only, a list of players and an operation which will update the team's ranking in the tournament. Create a CORBA IDL file named *cricket.idl* and in it define a module *Cricket*, structured data types *Date_Of_Birth* and *Player*, interfaces for PlayerStore and Team, exception handlers and the required operations to carry out the actions described.

(15 marks)

ANSWER IN THIS BOX

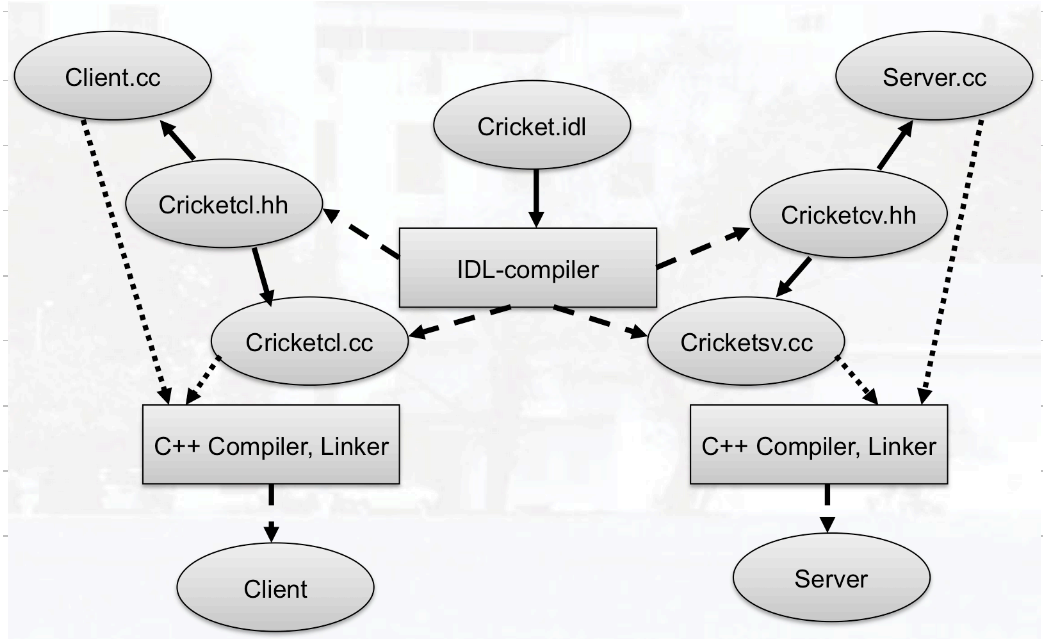
```
module Cricket ➔ 1 mark
        // defines a data structure date of birth
        typedef struct _Date_Of_Birth {
                int day;
                int month;
                int year;
        } Date_Of_Birth; ➔ 1 mark
        // defines a data structure Player
        typedef struct _Player { ➔ 1 mark
                short id,
                string name; ➔ 1 mark
                DOB date_of_birth; ➔ 1 mark
                string role;
        } Player;
        // Defines the interface
        interface PlayerStore { ➔ 1 mark
                // defines an exception
                exception PlayerNotFound { ➔ 1 mark
                        string message;
                };
                // defines an exception
                exception PlayerAlreadyExists {
                        string message;
                };
```

```
            // defines operations
            short save (in Player p) raises (PlayerAlreadyExists); ➔ 2
marks (1 mark for operation and 1 mark for exception)
            Player load (in dhort id) raises (PlayerNotFound); ➔ 1 mark
            void print(in Player p);
            // defines a sequence array
            typedef sequence<Player> PlayerList ➔ 1 mark
            interface Team { ➔ 1 mark
            // read only attribute
            readonly attribute string name; ➔ 1 mark
            attribute PlayerList players; ➔ 1 mark
            void update_rank(in short rank); ➔ 1 mark
```

(ii). Explain using a flow diagram, how the cricket.idl file would be used to develop the final client and server applications. List the compilers that would be used and corresponding files created and their purpose during this process.

(05 marks)

ANSWER IN THIS BOX



An IDL Compiler and a C++ Comiler/Linker ➔ **2 mark**

When the IDL is comiled it will create

- Cricketcl.cc – the code to create the client stub ➔ **½ mark**
- Cricketcl.hh – the header file for the client ➔ **½ mark**
- Cricketsv.cc – the code for the server skeleton ➔ **½ mark**
- Cricketsv.hh – the header file for the server ➔ **½ mark**

When the above files are liked with the Client.cc code and the Server.cc code and compiled using a C++ compiler it will create the Client and the Server applications ➔ **1 mark**

(b) (i). Unlike CORBA and COM, Java/RMI does not provide an Interface Definition Language. Clearly explain how Java/RMI achieves type safety (discourages and prevents type errors) and distribution of objects.

(02 marks)

ANSWER IN THIS BOX

Java was designed to be highly portable. This portability is achieved by provision of different VMs that interpret the byte code on different hardware and operating system platforms. A Java compiler creates byte- code, which is then interpreted byte virtual machine (VM). Since compilations happens within the same programming language, the compilers guarantee type safety, and require no external control ➔ **1 mark**

Java includes a distinction between interfaces and classes and by including Java Remote Method Invocation libraries and extending remote it allows for remote implementations ➔ **1 mark** (ii). In part (a) section (i), if the interface *PlayerStore* which is within the scope of the module *Cricket* were to be implemented using Java RMI, write the Java code required for it.

(03 marks)

ANSWER IN THIS BOX

```
package cricket; ➔ 1 mark
import java.rmi.*; ➔ ½ mark
interface PlayerStore extends remote { ➔ 1 mark
      short save () throws RemoteException; ➔ ½ mark
      Player load () throws RemoteException;
      void print() throws RemoteException;
}
```

4)

(a) (i). List and briefly explain three (03) advantages of the Service Oriented Architecture (SOA).

(03 marks)

ANSWER IN THIS BOX

- Adapt applications to changing technologies.
- Easily integrate applications with other systems.
- Leverage existing investments in legacy applications.
- Quickly and easily create a business process from existing services.
- Re-use of existing applications
- Interoperability between heterogeneous applications and technologies.

➔ 1 mark x 3

(ii). Briefly explain three (03) characteristics of a Service in the Service Oriented Architecture model.

(03 marks)

ANSWER IN THIS BOX

- A well defined function.
- Self contained
- Does not depend on the context or state of other services.
- Is the endpoint of a connection.
- Has some type of underlying computer system that supports the connection offered.

➔ **1 mark x 3**

(iii). The web site www.bookdb.lk offers a SOAP web service which provides book information. The service requires the service requester to pass the ISBN number of the book to *GetBookInfo* service located at http://www.booksdb.lk/webservice. The xml name space is referred from http://www.w3.org/2001/12/soap-envelope and the encoding style is http://www.w3.org/2001/12/soap-encoding. Create the SOAP message that the requester should send to the service provider. (You may decide the namespace).

(06 marks)

ANSWER IN THIS BOX

```
<?xml version="1.0"?>
<soap:Envelope ➔ 1 mark
xmlns:soap="http://www.w3.org/2001/12/soap-envelope” ➔ 1 mark
soap:encodingStyle="http://www.w3.org/2001/12/soap-encoding"> ➔ 1 mark
<soap:Body xmlns:m="http://www.w3.org/webservice"> ➔ 1 mark
        <m:GetBookInfo> ➔ 1 mark
                <m:ISBN>978-1449365110</m:ISBN> ➔ 1 mark
        </m:GetBookInfo>
</soap:Body>
</soap:Envelope>
```

(b) (i). Constraining the REST web services interface to be uniform has some advantages. List and briefly explain three (03) such advantages.

(03 marks)

ANSWER IN THIS BOX

- Familiarity – Id you have a URI that points to a service, you know exactly which methods are available on that resource. You don't need an IDL-like file describing which methods are available. All you require is an HTTP client library. No stubs are requires.
- Interoperability – HTTP is a very ubiquitous protocol. Most programming languages have an HTTP client library; hence it is likely that more service requesters can use your service.
- Scalability – as the methods are well-defined, you have predictable behaviour that can give performance benefits. Caching for example will save a huge amount of network traffic and bring performance benefits.

➔ **1 mark x 3**

(ii). In RESTful services, we can observe *states* and *operations*. Using an example explain the difference between such states and operations.

(02 marks)

ANSWER IN THIS BOX

A book may be in-print or out-of-print hence there would be a field that would give this information. This would be a status. ➔**1 mark** However this status might need to be changed in this is done as an operation. ➔**1 mark**

(c) Consider the scenario in part (a) section (iii) above.

(i). Write the code to retrieve book details with RESTful web services using JAX-RS and XML. Assume we use webservice/{isbn} where {isbn} represents the ISBN of the book we query. (The body of the method need not be implemented)

(04 marks)

ANSWER IN THIS BOX

```
@GET  ➔ 1 mark
@Path(“webservice/{isbn}”)  ➔ 1 mark
@Produces(“application/xml”)  ➔ 1 mark
public StreamingOutput getBookInfo (@PathPram(“isbn”) String
isbn){
// Implementation
}  ➔ 1 mark
```

(ii). What would be a possible response to the service requester by the web service when the *GetBookInfo()* method is called with an ISBN number that exists in the database? (You may decide the namespace and details of the book passed in the response).

(04 marks)

ANSWER IN THIS BOX

```
HTTP/1.1 201 Created ➔ 2 marks
Content-Type: application/xml ➔ ½ marks
Location: http://www.booksdb.lk/webservice/978-1449365110-➔ ½ marks

<isbn id=978-1449365110> ➔ ½ marks
     <link rel="self"
href="http://www.bookdb.lk/webservice/978-1449365110"/> ➔ ½ marks
     <authors></authors>
     <title></title>
     <edition></edition>
     <publisher> </publisher>
     <year></year>
</isbn>
```

*****