BINDURA UNIVERSITY OF SCIENCE EDUCATION
FACULTY OF SCIENCE AND ENGINEERING
DEPARTMENT COMPUTER SCIENCE
BSc HONS DEGREE IN COMPUTER SCIENCE/INFORMATION TECHNOLOGY

CS415: DISTRIBUTED SYSTEMS

DURATION: 2 HOURS 30 MINUTES TOTAL MARKS: 100

INSTRUCTIONS TO CANDIDATES

Answer all questions.

Question 1

a) Describe the role of middleware in a distributed system? [4]

b) Briefly explain each of the following:

i) Remote procedure call [4]

ii) object orientated middleware [4]

iii) message orientated middleware [4]

Your explanation should highlight the significant differences between these forms of middleware and should mention any application areas for which each is especially suited.

Question 2

(a) Define publish/subscribe communication. [2]

(b) Explain any **two** advantages and disadvantages of offering publish/subscribe as the only communication service in a distributed system? [8]

(c) Multicast operations provide a natural mechanism for implementing group communication in distributed systems. A message can be sent to all of the processes in a group by issuing a single multicast operation. It would be ideal to

have all of the multicast messages delivered instantaneously and in the same order that they were sent. However, this is not realistic in practice. Why? **[6]**

(d) Define role-based access control. **[2]**

(e) What are the advantages and disadvantages of using role names for access control and communication in such a distributed system? **[8]**

Question 3

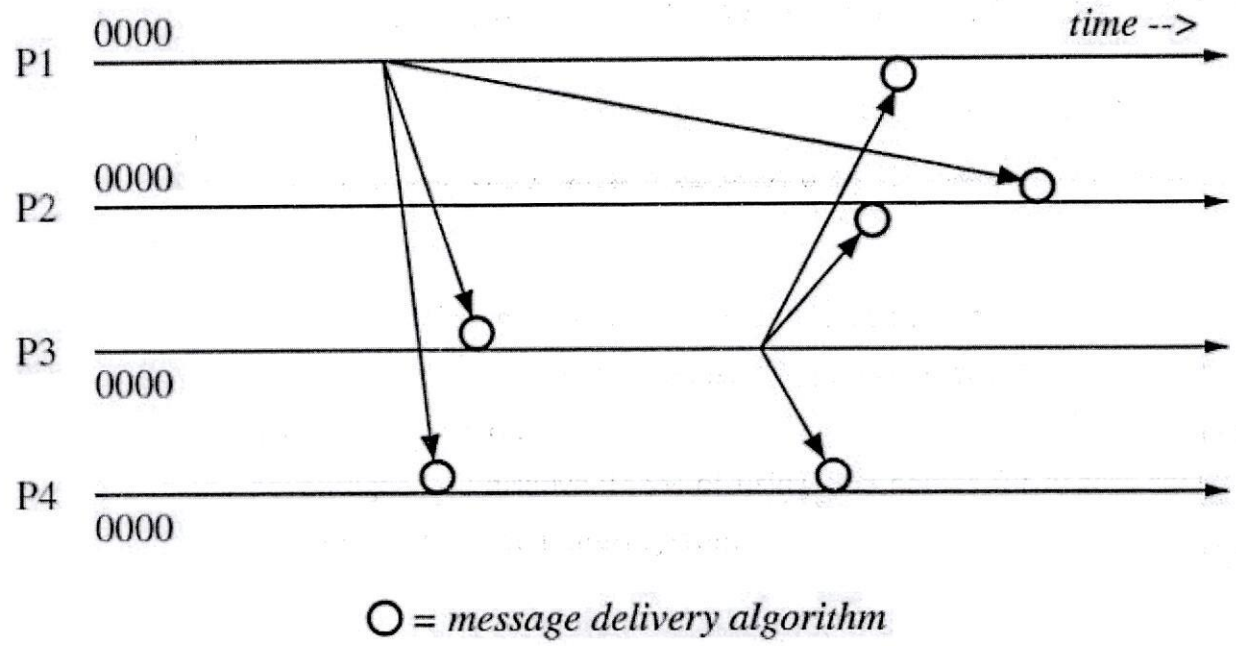

Figure 1: Multicast messaging

The figure 1 above represents a process group that communicates by means of multicast messages. At each process-hosting node, message delivery software decides whether a given incoming message should be delivered to the process or buffered for later delivery. This is achieved by the use of vector clocks.

a) Describe using the above example given above, the vector clock algorithm for delivery of messages in causal order and insert the relevant vector time stamps. **[15]**

b) With the aid of a similar example, show that total ordering of messages is not achieved by this algorithm. **[5]**

Question 4

The figure 2 below shows a successful execution of two-phase commit. The client asks the transaction manager (TM) to organize an atomic transaction involving servers A, B, and C.

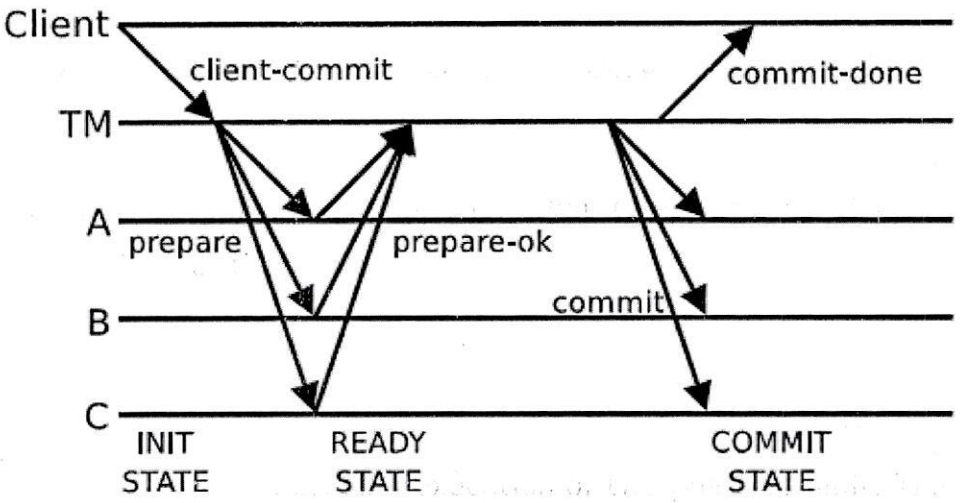

Figure 2: Two-phase commit protocol

a) Explain how agreement is reached in two-phase commit protocol. **[6]**

b) What is the challenge of using two-phase commit protocol in transaction agreements? **[4]**

c) How does three phase commit solve the problem explained in part *(b)* above? **[4]**

Question 5

a) With the aid of an example, describe when cryptography can be used to protect information in a distributed system? **[4]**

b) Explain what is meant by the term nonce. **[2]**

c) Explain the reason for using a nonce in challenge-response protocols. **[2]**

d) In Figure 3 below is an authentication protocol, which is a form of a two-way authentication using challenge-response protocol.

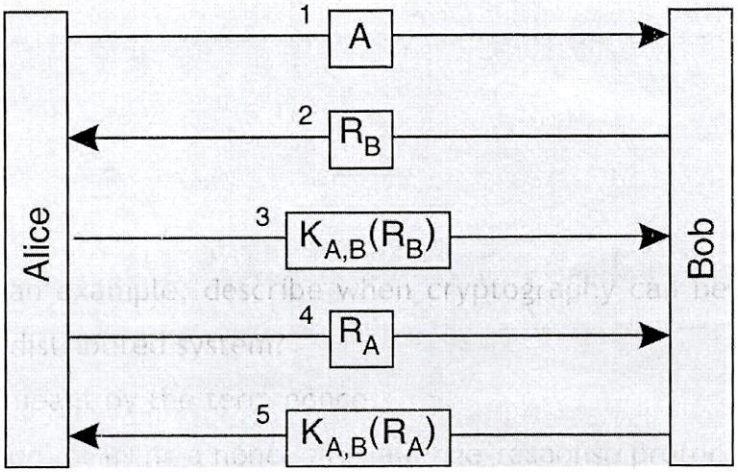

Figure 2: Authentication protocol

i) Which type of cryptography is being used in the authentication protocol in figure 3 above. **[2]**

ii) Explain how authentication is achieved using the authentication protocol in Figure 3 above. **[10]**

iii) Can Alice be sure that he is communicating with Bob after sending message R_A? Explain. **[4]**

END OF PAPER