CS 843 - Distributed Computing Systems - Mid-Term Exam - Name: _____
Date: Wednesday, March 16, 2005

Part 1: (24 points - 3 points for each problem)

(D) 1. Which of following transparency exists in a network operating system?
(A) Migration (B) Relocation (C) Transaction (D) None of above

(B) 2. Which is not a scaling technique?
(A) Distribution (B) Relocation (C) Caching (D) None of above

(A) 3. In which case is reliable communication not required?
(A) The operating system blocks a sender until a message is sent.
(B) The operating system blocks a sender until a message is received.
(C) The operating system blocks a sender until a message is delivered.
(D) None of above

(D) 4. One way RPC is an example of:
(A) Transient synchronous communication (B) Persistent asynchronous communication
(C) Persistent synchronous communication (D) None of above

(C) 5. Which is not a benefit of using microkernels?
(A) Modularity (B) Flexibility (C) Availability (D) None of the above

(B) 6. Which action should be taken when a code using a fastened resource by identifier is migrated to another machine?
(A) Copy the value of resource (B) Move the resource
(C) Rebind process to locally available resource (D) None of above

(C) 7. What is a property common to all software agents?
(A) Adaptive (B) Mobile (C) Proactive (D) None of above

(B) 8. The collection of all directory entries in an X.500 directory service is called a
(A) Directory Allocation Table (DAT) (B) Directory Information Base (DIB)
(C) Directory Service Entry (DSE) (D) None of above

Part 2: (76 points)

1. (12 pts.) Briefly explain these terminologies. If they are acronyms, also write what they stand for.

   (a) **MOM** Message-Oriented Middleware (MOM) is a middleware that provides extensive support for persistent asynchronous communication.

   (b) **ORB** Object Request Broker (ORB) is CORBA's object broker that connects clients, objects, and services.

   (c) **RSVP** Resource reSerVation Protocol (RSVP) is a transport-level control protocol for enabling resource reservations in network routers.

   (d) **LDAP** The Lightweight Directory Access Protocol (LDAP) is a simplified protocol to accommodate X.500 directory services in the Internet.

2. (8 pts.) Fill out the following table of a comparison between different systems:

Item	**Distributed OS**	**Network OS**	**Middleware-based DS**
	Multiprocess		
Degree of transparency	Very high	Low	High
Basis for communication	Shared memory	Files	Model specific
Resource management	Global, central	Per node	Per node
Scalability	No	Yes	Varies

3. Consider the following code:

```
int f(x, y)
{
    x = x + 1 ;
    y = x + y;
    return(x * y);
}

main()
{
    int a, b;
    a = 2;
    b = f(a, a);
    printf("a = %d,  b = %d \n",a,b);
}
```

(a) (6 pts.) What will be printed if the parameters are passed using:

i. call-by-value?

ii. call-by-reference?

iii. call-by-copy/restore using C semantics?

(b) (2 pts.) Which of the above parameter passing method(s) cannot be easily implemented using remote procedure calls? Explain.

(a) i. a = 2, b = 15

ii. a = 6, b = 36

iii. a = 5, b = 15 (C semantics)

(b) Call-by-reference cannot be easily implemented because the reference addresses are different between the local and remote machines.

4. (a) (3 pts.) What is an idempotent operation?

(b) (4 pts.) Discuss whether the following operations are idempotent?

i. Update a database record using the SQL `update` command.

ii. Request the date/time of a remote machine.

(c) (3 pts.) In which invocation semantics of RPC is an idempotent operation required?

(a) An idempotent operation is an operation that can be performed repeatedly with the same effect.

- Using SOL `update` command to update a database record is an idempotent operation because the result is same with the same update values.
- Requesting the the date/time of a remote machine is an idempotent operation because each request does not change the date/time of the remote machine.

(b) In at-least-once invocation semantics an idempotent operation is required.

5. (a) (4 pts.) What is an isochronous data stream? Give an example.
   (b) (4 pts.) What is a closure mechanism? Give an example.
   (c) (4 pts.) What is a message broker? Give an example.
   (d) (4 pts.) What is a stateful server? Give an example.
   (e) (4 pts.) What is weak mobility? Give an example.

   (a) An isochronous data stream is a data stream required to define maximum and minimum end-to-end delay jitter is bounded. For example, audio/video stream.
   (b) Closure mechanism is knowing how and where to start name resolution. For example, Domain Name Service (DNS).
   (c) A stateful server keeps track of the status of its clients. For example, a TLS server.
   (d) A message broker is a special node that converts messages in heterogeneous message-queuing systems. For example, IBM WebSphere MQ.
   (e) Weak mobility is mobility where only code and initialization data segment are moved. For example, Java applet.

6. (18 pts.) Consider an application that implements a remote bank account. An account should have the information about account number, account name, and balance. The methods for this bank account should include open, deposit, withdraw, and balance inquiry.
   (a) Use Sun RPC IDL to specify this application.
   (b) Specify this application in a Java RMI interface file.
   (c) Use CORBA IDL to specify this application.

   (a) Sun RPC IDL

```
const SIZE = 40;
struct account {
  char name[SIZE];
  unsigned long number;
  double balance;
};

program ACCOUNTPROG {
  version ACCOUNTVERS {
    account OPEN(account) = 1;
    short DEPOSIT(account) = 2;
    short WITHDRAW(account) = 3;
    double BALANCE(account) = 4;
  } = 1;
} = 0x30090949;
```

   (b) Java RMI

```
import java.rmi.*;

class Account {
  String name;
  long number;
  double balance;
}

public interface AccountInterface extends Remote {
  public Account open(String name, long number, double amount) throws RemoteException;
  public short deposit(Account account, double amount) throws RemoteException;
  public short withdraw(Account account, double amount) throws RemoteException;
  public double balance(Account account) throws RemoteException;
}
```

(c) CORBA IDL

```
module BankApp {

  struct Account {
    string name;
    unsigned long number;
    double balance;
  };

  interface BankAccount {
    Account open (in string name, in unsigned long number, in double amount);
    short deposit (in Account account, in double amount);
    short withdraw (in Account account, in double amount);
    double balance(in Account account);
  };
};
```