EXP 1: Simulate the functioning of Lamport's Logical Clock in C

Descriptions:

The algorithm of Lamport timestamps is a simple algorithm used to determine the order of eventsin a distributed computer system. As different nodes or processes will typically not be perfectly synchronized, this algorithm is used to provide a partial ordering of events with minimal overhead, and conceptually provide a starting point for the more advanced vector clock method. They are named after their creator, Leslie Lamport.

Distributed algorithms such as resource synchronization often depend on some method of ordering events to function. For example, consider a system with two processes and a disk. The processes send messages to each other, and also send messages to the disk requesting access. Thedisk grants access in the order the messages were sent. For example, process {\displaystyle

A} sends a message to the disk requesting write access, and then sends a read instruction messageto process {\display style

B} Process {\display style B} receives the message, and as a result sends its own read request message to the disk. If there is a timing delay causing the disk to receive both messages at the same time, it can determine which

Program:

```
#include<stdio.h>
#include<conio.h>
#include<iostream.h>
#include<stdlib.h>
#include<graphics.h>
#include<string.h>
#include<dos.h>

void main(){
int s[4][9],n,m=0; int i,j,next=0,step=0;
int msg[10][4]={0},totmsg;char op;
int pi,pj,ei,ej;clrscr();
cout<<"\nProgram for Lamport Logical Clock";cout<<"\nEnter Number Of Process ";
cin>>n; for(i=0;i<n;i++){
cout<<"\nEnter number of STATES of process P"<<i<<" ";cin>>s[i][8];
for(j=1;j<=s[i][8];j++){s[i][j]=j;
        }
}       cout<<"\nEnter message transit"; cout<<"\nFROM ->\nEnter Process Number P";cin>>msg[m][0];
        cout<<"\nEnter Event Number e";cin>>msg[m][1];
        cout<<"\nTO ->\nEnter Process Number P";cin>>msg[m][2];
        cout<<"\nEnter Event Number e
```

```
 cin>>msg[m][3];
 cout<<"\n\nPress 'y' to continue";op=getch();
 cout<<op;m++;
 totmsg=m;

 }
 while(op=='y'); m=0;
 for (i=0;i<totmsg;i++){pi=msg[i][0];
 ei=msg[i][1];
 pj=msg[i][2];
 ej=msg[i][3];
 if(s[pj][ej]< (s[pi][ei]+1)){s[pj][ej]=s[pi][ei]+1;
 for (j=ej+1;j<=s[pj][8];j++){
 s[pj][j]=s[pj][j-1]+1;
 }}
 }
 int gd=DETECT,gm; initgraph(&gd,&gm,"C:\\TC\\BGI"); outtextxy(200,15,"Program For Lamport
 Logical Clock");
 //drawing process and eventsfor(i=0;i<n;i++){
 char* p1; itoa(i,p1,10);
 outtextxy(5,100+next,"P"); outtextxy(13,100+next,p1); line(100,100+next,600,100+next);
 for(j=1;j<=s[i][8];j++){
 char* p2; itoa(j,p2,10);
   outtextxy(100+step,90+next,"e"); outtextxy(110+step,90+next,p2);
 //timestampchar* p3;
 itoa(s[i][j]-1,p3,10); outtextxy(100+step,110+next,"t");outtextxy(110+step,110+next,p3);
 circle(105+step,100+next,5); step+=50;
     }
  step=0;     next+=100;
      }
  delay(2000);
  //drawing message transit     for(m=0;m<totmsg;m++){
 setlinestyle(SOLID_LINE,1,3);setcolor(m+4);
 line(msg[m][1]*50+50,msg[m][0]*100+100,msg[m][3]*50+50,msg[m][2]*100+100);if
(msg[m][2]>msg[m][0]){
line(msg[m][3]*50+50,msg[m][2]*100+100,msg[m][3]*50+50,msg[m][2]*100+90);
line(msg[m][3]*50+50,msg[m][2]*100+100,msg[m][3]*50+40,msg[m][2]*100+90);
} else{
line(msg[m][3]*50+50,msg[m][2]*100+100,msg[m][3]*50+50,msg[m][2]*10+110);
line(msg[m][3]*50+50,msg[m][2]*100+100,msg[m][3]*50+40,msg[m][2]*100+110);
}
}
getch();
}
```

EXP 2: Simulate the Distributed Mutual Exclusion in C

Descriptions:

Mutual exclusion: Concurrent access of processes to a shared resource or data isexecuted in mutually exclusive manner.

Only one process is allowed to execute the critical section (CS) at any given time.

In a distributed system, shared variables (semaphores) or a local kernel cannot be used toimplement mutual exclusion.

Message passing is the sole means for implementing distributed mutual exclusion. Distributed mutual exclusion algorithms must deal with unpredictable message delays andincomplete knowledge of the system state.

Three basic approaches for distributed mutual exclusion:

Token based approach

Non-token based approach

Quorum based approach

Token-based approach

A unique token is shared among the sites.

A site is allowed to enter its CS if it possesses the token.

Non-token based approach Two or more successive rounds of messages are exchanged amongthe sites to determine which site will enter the CS next.

Quorum based approach: Each site requests permission to execute the CS from a subset of sites (called a quorum). Any two quorums contain a common site. This common site is responsible tomake sure that only one request executes the CS at any time.

Program:

```
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>
void *functionC();
pthread_mutex_t mutex1 = PTHREAD_MUTEX_INITIALIZER;int counter = 0;
main ()
{int rc1, rc2;
pthread_t thread1, thread2;
/* Create independent threads each of which will execute functionC */
if( (rc1=pthread_create( &thread1, NULL, &functionC, NULL)) )
{printf("Thread creation failed: %d\n", rc1); }
if( (rc2=pthread_create( &thread2, NULL, &functionC, NULL)) )
{ printf("Thread creation failed: %d\n", rc2);
}
/* Wait till threads are complete before main continues. Unless we */
/* wait we run the risk of executing an exit which will terminate */
/* the process and all threads before the threads have completed. */pthread_join( thread1, NULL);
pthread_join( thread2, NULL);exit(0);
}
```

```
void *functionC()
{pthread_mutex_lock( &mutex1 );counter++;
printf("Counter value: %d\n",counter);pthread_mutex_unlock( &mutex1 );
}
Compile: cc -lpthread mutex1.c Run: ./a.out Results:
Counter value: 1 Counter value: 2join1.c
#include <stdio.h> #include <pthread.h> #define NTHREADS 10
void *thread_function(void *);
pthread_mutex_t mutex1 = PTHREAD_MUTEX_INITIALIZER;int counter = 0;
main()
{
pthread_t thread_id[NTHREADS];int i, j;
for(i=0; i < NTHREADS; i++)
{
pthread_create( &thread_id[i], NULL, thread_function, NULL );}
for(j=0; j < NTHREADS; j++)
{
pthread_join( thread_id[j], NULL);
}
/* Now that all threads are complete I can print the final result. */
/* Without the join I could be printing a value before all the threads */
/* have been completed.*/
printf("Final counter value: %d\n", counter);
}
void *thread_function(void *dummyPtr)
{
printf("Thread number %ld\n", pthread_self());pthread_mutex_lock( &mutex1 );
counter++;
pthread_mutex_unlock( &mutex1 );
}
```

Compile:cc-lpthreadjoin1.c Run:./a.out Results:

```
Thread number 1026
Thread number 2051
Thread number 3076
Thread number 4101
Thread number 5126
Thread number 6151
Thread number 7176
Thread number 8201
Thread number 9226
Thread number 10251 Final counter value: 10cond1.c
```

```
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>
pthread_mutex_t count_mutex = PTHREAD_MUTEX_INITIALIZER;pthread_cond_t condition_var
= PTHREAD_COND_INITIALIZER;
void *functionCount1();void *functionCount2();
```

```
int count = 0;#define COUNT_DONE 10#define COUNT_HALT1 3
#define COUNT_HALT2 6main()
{ pthread_t thread1, thread2;
pthread_create( &thread1, NULL, &functionCount1, NULL); pthread_create( &thread2, NULL,
&functionCount2, NULL); pthread_join( thread1, NULL);
pthread_join( thread2, NULL); printf("Final count: %d\n",count);exit(0);}
// Write numbers 1-3 and 8-10 as permitted by functionCount2()void *functionCount1()
{
for(;;)
{
// Lock mutex and then wait for signal to relase mutexpthread_mutex_lock( &count_mutex );
// Wait while functionCount2() operates on count
//mutex unlocked if condition varialbe in functionCount2() signaled.
pthread_cond_wait( &condition_var, &count_mutex );
count++;
printf("Counter value functionCount1: %d\n",count);pthread_mutex_unlock( &count_mutex );
if(count >= COUNT_DONE) return(NULL);
}
}
// Write numbers 4-7 void *functionCount2()
{
for(;;)
{ pthread_mutex_lock( &count_mutex);
if( count < COUNT_HALT1 || count > COUNT_HALT2 )
{
// Condition of if statement has been met.
// Signal to free waiting thread by freeing the mutex.
// Note: functionCount1() is now permitted to modify "count".
pthread_cond_signal( &condition_var );
}
else
{
count++;
printf("Counter value functionCount2: %d\n",count);
}
pthread_mutex_unlock( &count_mutex ); if(count >= COUNT_DONE) return(NULL);}}
```

Compile: cc -lpthread cond1.c Run: ./a.out Results: Counter value functionCount1: 1
Counter value functionCount1: 2 Counter value functionCount1: 3 Counter value functionCount2: 4
Counter value functionCount2: 5 Counter value functionCount2: 6 Counter value functionCount2: 7
Counter value functionCount1: 8 Counter value functionCount1: 9 Counter value functionCount1: 10
Final count: 10

EXP 3: Implement a Distributed Chat Server using TCP Sockets in C

Descriptions:

TCP is a connection-oriented protocol that provides a reliable. flow of data between twocomputers. Example applications that. use such services are HTTP, FTP, and Telnet.

Program:

```
#include <stdio.h>
#include <errno.h>
#include <stdlib.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <netdb.h>
#define PORT 5555
#define MAXMSG 512intread_from_client (int filedes)

{char buffer[MAXMSG];int nbytes;
nbytes = read (filedes, buffer, MAXMSG);if (nbytes < 0)
{
/* Read error. */perror ("read");
exit (EXIT_FAILURE);
}
else if (nbytes == 0)
/* End-of-file. */return -1;
else
{/* Data read. */
fprintf (stderr, "Server: got message: `%s'\n", buffer);return 0;
}
}
Int main (void){
extern int make_socket (uint16_t port);int sock;
fd_set active_fd_set, read_fd_set; int i;
struct sockaddr_in clientname;size_t size;

/* Create the socket and set it up to accept connections. */sock = make_socket (PORT);
if (listen (sock, 1) < 0)
{vperror ("listen");
exit (EXIT_FAILURE);
}
/* Initialize the set of active sockets. */FD_ZERO (&active_fd_set);
FD_SET (sock, &active_fd_set);while (1){
/* Block until input arrives on one or more active sockets. */read_fd_set = active_fd_set;
if (select (FD_SETSIZE, &read_fd_set, NULL, NULL, NULL) < 0)
{
perror ("select");
```

```
exit (EXIT_FAILURE);
}
/* Service all the sockets with input pending. */for (i = 0; i < FD_SETSIZE; ++i)
if (FD_ISSET (i, &read_fd_set))
{
if (i == sock)
{
/* Connection request on original socket. */int new;
size = sizeof (clientname);new = accept (sock,
(struct sockaddr *) &clientname,&size);
if (new < 0){
perror ("accept");
exit (EXIT_FAILURE);
}
fprintf (stderr,
"Server: connect from host %s, port %hd.\n",inet_ntoa (clientname.sin_addr),
ntohs (clientname.sin_port)); FD_SET (new, &active_fd_set);
}
else
{
/* Data arriving on an already-connected socket. */if (read_from_client (i) < 0) {
close (i);
FD_CLR (i, &active_fd_set);
}}}}}
```

EXP 4: Implement Java RMI mechanism for accessing methods of remote systems.

Descriptions:

RMI stands for Remote Method Invocation. It is a mechanism that allows an object residing inone system (JVM) to access/invoke an object running on another JVM.
RMI is used to build distributed applications; it provides remote communication between Java programs. It is provided in the package java.rmi.

Algorithm:

```
import java.rmi.*;
 import java.rmi.server.*;
public class Hello extends UnicastRemoteObject implements HelloInterface {private String message;
public Hello (String msg) throws RemoteException {message = msg;
} public String say() throws RemoteException {return message;
}}
HelloClient.java
import java.rmi.Naming;public class HelloClient
{ public static void main (String[] argv) {try {
HelloInterface hello =(HelloInterface) Naming.lookup ("//192.168.10.201/Hello");System.out.println
(hello.say());
}
catch (Exception e){
System.out.println ("HelloClient exception: " + e);} }
}
HelloInterface.javaimport java.rmi.*;
public interface HelloInterface extends Remote {public String say() throws RemoteException;
}
HelloServer.java
import java.rmi.Naming; public class HelloServer}
public static void main (String[] argv)
{ try { Naming.rebind ("Hello", new Hello ("Hello,From Roseindia.net pvt ltd!"));System.out.println
("Server is connected and ready for operation."); }
catch (Exception e)
{
System.out.println ("Server not connected: " + e);
} } }
```

EXP 5: Simulate Balanced Sliding Window Protocol in C

Descriptions:

A sliding window protocol is a feature of packet-based data transmission protocols. Sliding window protocols are used where reliable in-order delivery of packets is required, such as in the Data Link Layer (OSI layer 2) as well as in the Transmission Control Protocol (TCP). Conceptually, each portion of the transmission (packets in most data link layers, but bytes in TCP) is assigned a unique consecutive sequence number, and the receiver uses the numbers to place received packets in the correct order, discarding duplicate packets and identifying missing ones. The problem with this is that there is no limit on the size of the sequence numberthat can be required.

Program:

```
#include <STDIO.H>
#include <iostream.h>
#include <string>
#define THANKS -1 void main()
{
FILE *r_File1; FILE *w_File2; int m_framecount;
int frameCount = 0; long currentP = 0; long sentChar = 0; long recvedChar = 0;char s_name[100];
char d_name[100]; char *sp = s_name; char *dp = d_name; int slidingWin;
int frameSize;int dataSize;
bool isEnd = false;struct  FRAME{ int s_flag; intsequenceNo; char data[90]
int n_flag;
};
FRAME frame;
frame.s_flag = 126;
//set start flag
frame.n_flag = 126;
//set end flag
memset(frame.data, 0, 91);//use 0 to fill full the member array in structure frame.struct ACK{
int s_flag; int nextSeq;int n_flag;
}ack;
//initialize start flag and end flag in structure ack.ack.s_flag = 126;
ack.n_flag = 126; ack.nextSeq = NULL;
//ask user to enter file name and size of sliding window. lable1 : cout <<"Please enter source file's
name!"<<endl;cin >> sp;
cout <<"Please enter destination file's name!"<<endl;cin >> dp;
lable2: cout <<"Please chose size of sliding window 2--7"<<endl;cin >> slidingWin;
if((slidingWin >7 )| (slidingWin < 2))
{ cout << "wrong enter"<<endl;goto lable2;
}
lable3: cout<< "Please enter the size of frame 14--101 Only!" << endl;cin >>frameSize;
if((frameSize > 101) | (frameSize < 14))
{ cout << "please enter right number!"<< endl;goto lable3;
```

```
}
//use frameSize to decide the size of data array in structor frame.dataSize = frameSize - 12;
//dynamic generate a frame array with user enter's size of sliding windowFRAME *pf = new
FRAME[slidingWin];
int seqNo = 0;
//strat loop for transmission. while (ack.nextSeq != THANKS)
{ cout << "THE PROCESS ON SENDER SIDER..."<<endl;
//open a source file by read mode. if((r_File1 = fopen(sp, "rb")) == NULL)
{ cout << "source file could not be opened please check it and re-start!" <<endl;goto lable1;
}
else
{cout<<"Opening a file for read...";cout <<endl;
cout <<endl;
//after open the file, use fseek to resume the last position of a file pointer.
//Then start to read from that position.
fseek(r_File1,currentP,SEEK_SET);
//start loop for create frame array
for (int i = 0; i < slidingWin ; i++)// i is the frame array's index
{ frame.sequenceNo = seqNo;if ((seqNo >= 7) == true)
{ seqNo = 0;//set sequencce number
} else { seqNo = seqNo +1; }
//This loop is used to fill the characters read from opened file to char array data which
//is a memeber of structure frame.
//we have to reseve a byte for \0 which is used to identify the end of the data array.
//that means each time we only read datasize -1 characters to the data array.
for (int j = 0; j < dataSize -1; j++)
{ //if it is not end of file read a character from file then save it into data
//field in frame structure. frame.data[j]= fgetc(r_File1);
sentChar++;//calculate how many characters will be sent.*/if (frame.data[j]
{ cout<< "There is the end of file"<<endl;isEnd = true;
//sentChar++;break;
} }if (isEnd == true)
{ pf[i] = frame; //save a frame into frame array.
//frameCount = i; frameCount++; m_framecount = i +1;cout <<endl;
cout << "The squence number is " << pf[i].sequenceNo <<endl;cout << "The start flag is " <<
pf[i].s_flag <<endl;
cout << "The Data is     >" << pf[i].data <<endl;
cout << "The end flag is " << pf[i].n_flag <<endl;
cout << "There are " <<frameCount <<" frames has been created!"<<endl;cout << "frame " <<
pf[i].sequenceNo <<" has been transported!";
cout<< endl; fclose(r_File1);break;
}
pf[i] = frame;//sava current frame to frame buffer.
//display some informaiton of frame buffer.frameCount++;
m_framecount = i +1;cout <<endl;cout << "The squence number is " << pf[i].sequenceNo <<endl;
cout << "The start flag is " << pf[i].s_flag <<endl;
cout << "The Data is     >" << pf[i].data <<endl;
cout << "The end flag is " << pf[i].n_flag <<endl;
cout << "There are total " <<frameCount <<" frames has been created!"<<endl;
cout << "frame " << pf[i].sequenceNo <<" has been transported!";cout<< endl;
currentP = ftell(r_File1);//to record the current position of a file pointer
```

```
}
fflush(r_File1);//refresh
}
//print out some information.cout <<endl;
cout <<"Total " << sentChar << " characters have been sent on this session!"<<endl;cout <<endl;
cout << "waiting for ACK!" <<endl;cout <<endl;
cout <<endl;
int nextNoRecord = 0;
cout<<"THE PROCESS ON RECEIVER SIDE..."<<endl;
//open a file for write
if((w_File2 = fopen(dp, "ab")) != NULL)
{cout<<"opening a file for write..."<<endl;for (int m = 0; m < m_framecount ; m++)
{
for (int n = 0; n < dataSize -1; n++)
{
//check whether islast character.if(pf[m].data[n]
{
ack.nextSeq = THANKS;
//fputc(pf[m].data[n],w_File2);recvedChar++;
Break }
//write the character from current frame 's which in t index of data flied.
fputc(pf[m].data[n],w_File2);
recvedChar++;
}
cout << "The string       >" << pf[m].data <<" written succeed"<<endl;
fflush(w_File2);//refresh if(ack.nextSeq == THANKS)
{
fclose(w_File2);break;
} nextNoRecord= pf[m].sequenceNo;
}
cout <<endl;
cout <<"Total "<<recvedChar << " characters have been received on this session"<<endl;cout
<<endl; cout << "send acknowledgement!" <<endl;cout <<endl;
cout <<endl;
if (ack.nextSeq != THANKS)
{ cout<<"CheckACK"<<endl;if (nextNoRecord
{ ack.nextSeq =0 ;
} else
{ ack.nextSeq = nextNoRecord +1;
}
cout << "The next expect frame is " << ack.nextSeq <<endl;
}
else
{ cout<<"CheckACK"<<endl;
cout << "The acknowledgement is thanks. The transmission complete..."<<endl;
//delete the frame buffer array .delete []pf;
}
}
else
{cout << "File could not be opened" << endl;}cout <<endl;
cout <<endl;
```

```
}
/*can be used to check how many bytes in the specified fill
numRead = 0; fseek(r_File1,0,SEEK_END);numRead = ftell(r_File1);
cout << "There are " << numRead <<" Bytes in the file" << endl;*/
}
```

OUTPUT

1: use fixed source file name and fixed destination file name and fixed sliding window size (5) to test program.Read file successfully.
Create frames successfully.
Save frames into frame buffer which is size 5 successfully.Write data from frames successfully.
Returns to ACK successfully.
Re-create new frames successfully. Search the end of source file successfully.
2: use keyboard to input the "source file name", "destination file name", "slidingwindows size", and "frame size" to test program
Read file successfully. Create frames successfully.
Save frames into frame buffer which is size 5 successfully.Write data from frames successfully.
Returns to ACK successfully.
Re-create new frames successfully. Search the end of source successfully.

EXP 6: Implement CORBA mechanism by using „C++“ program at one end and „Java“ program on the other.

Description:

CORBA is essentially a design specification for an Object Request Broker (ORB), where an ORB provides the mechanism required for distributed objects to communicate with one another, whether locally or on remote devices, written in different languages, or at different locations on a network.

Program:

Creating the Server

```
#include <iostream>
 #include "OB/CORBA.h"
#include <OB/Cosnaming.h>
#include "crypt.h"
#include "cryptimpl.h"using namespace std;
int main(int argc, char** argv)
{
// Declare ORB and servant object CORBA::ORB_var orb; CryptographicImpl* CrypImpl = NULL;
try
{ // Initialize the ORB.
orb = CORBA::ORB_init(argc, argv);
// Get a reference to the root POA CORBA::Object_var rootPOAObj =
orb->resolve_initial_references("RootPOA");
// Narrow it to the correct type PortableServer::POA_var rootPOA =
PortableServer::POA::_narrow(rootPOAObj.in());
// Create POA policies CORBA::PolicyList policies;policies.length(1); policies[0] =
rootPOA->create_thread_policy (PortableServer::SINGLE_THREAD_MODEL);
// Get the POA manager object
PortableServer::POAManager_var manager = rootPOA->the_POAManager();
// Create a new POA with specified policies PortableServer::POA_var myPOA = rootPOA-
>create_POA("myPOA", manager, policies);
// Free policies
CORBA::ULong len = policies.length();for (CORBA::ULong i = 0; i < len; i++) policies[i]-
>destroy();
// Get a reference to the Naming Service root_contextCORBA::Object_var rootContextObj =orb-
>resolve_initial_references("NameService");
// Narrow to the correct type CosNaming::NamingContext_var nc =
CosNaming::NamingContext::_narrow(rootContextObj.in());
// Create a reference to the servant
CrypImpl = new CryptographicImpl(orb);
// Activate object
PortableServer::ObjectId_var myObjID =myPOA->activate_object(CrypImpl);
// Get a CORBA reference with the POA through the servant
CORBA::Object_var o = myPOA->servant_to_reference(CrypImpl);// The reference isconverted to a
character string
```

```
CORBA::String_var s = orb->object_to_string(o); cout << "The IOR of the object is: " << s.in() <<
endl;CosNaming::Name name;
name.length(1);
name[0].id = (const char *) "CryptographicService";name[0].kind = (const char *) "";
// Bind the object into the name servicenc->rebind(name,o);
// Activate the POA manager->activate();
cout << "The server is ready.
Awaiting for incoming requests..." << endl;
// Start the ORBorb->run();
} catch(const CORBA::Exception& e) {
// Handles CORBA exceptionscerr << e << endl;
}
// Decrement reference countif (CrypImpl)
CrypImpl->_remove_ref();
// End CORBA
if (!CORBA::is_nil(orb))
{ try
{
orb->destroy();
cout << "Ending CORBA..." << endl;
}  catch (const CORBA::Exception& e)
{ cout << "orb->destroy() failed:" << e << endl;return 1;
}
} return 0; }
```

Implementing the Client

```
#include <iostream>
#include <string>
#include "OB/CORBA.h"
#include "OB/Cosnaming.h"
#include "crypt.h"
using namespace std;
int main(int argc, char** argv)
{
// Declare ORB CORBA::ORB_var orb;try
{
// Initialize the ORB
orb = CORBA::ORB_init(argc, argv);
// Get a reference to the Naming ServiceCORBA::Object_var rootContextObj =
orb->resolve_initial_references("NameService"); CosNaming::NamingContext_var nc =
CosNaming::NamingContext::_narrow(rootContextObj.in());CosNaming::Name name;
name.length(1);
name[0].id = (const char *) "CryptographicService";name[0].kind = (const char *) "";
// Invoke the root context to retrieve the object referenceCORBA::Object_var managerObj = nc-
>resolve(name);

// Narrow the previous object to obtain the correct type
::CaesarAlgorithm_var manager =
::CaesarAlgorithm::_narrow(managerObj.in());string  info_in,exit,dummy; CORBA::String_var
info_out;
```

```
::CaesarAlgorithm::charsequence_var inseq;unsigned long key,shift;
Try
{do
{
cout << "\nCryptographic service client" << endl;cout << "....." << endl;
do
{
 // Get the cryptographic keyif
(
 cin.fail())
 {cin.clear();
 cin >> dummy;
 }
 cout << "Enter encryption key: ";cin >> key;
 } while (cin.fail());do
 {
 // Get the shift
 if (cin.fail())
 {
 cin.clear();
 cin >> dummy;
 }
 cout << "Enter a shift: ";cin >> shift;
 } while (cin.fail());
 // Used for debug pourposes
 //key = 9876453;
 //shift = 938372;
 getline(cin,dummy);
 // Get the text to encryptcout << "Enter a plain text to encrypt: "; getline(cin,info_in);
 // Invoke first remote methodinseq = manager->encrypt (info_in.c_str(),key,shift);
 cout << "....."
 << endl;
 cout << "Encrypted text is: "
 << inseq->get_buffer() << endl;
 // Invoke second remote method
 info_out = manager->decrypt(inseq.in(),key,shift);cout << "Decrypted text is: "<< info_out.in() <<
 endl;
 cout << "....."<< endl;
 cout << "Exit? (y/n): ";
 cin >> exit;
 }
 while (exit!="y");

 // Shutdown server messagemanager->shutdown();
 } catch(const std::exception& std_e)
 {cerr << std_e.what() << endl;
 } }catch(const CORBA::Exception& e)
 {
 // Handles CORBA exceptionscerr << e << endl;
 }
 // End CORBA
```

```
if (!CORBA::is_nil(orb)){try
{ orb->destroy();
cout << "Ending CORBA..." << endl;
} catch(const CORBA::Exception& e)
{ cout << "orb->destroy failed:" << e << endl;return 1;
} }
return 0;
}
```

OUTPUT

Running the Client-server Application Once we have implemented the client and the server, it"s time to connect them. Because our demonstration client and server exchange object references via the naming service, we must ensure that the naming service (which is called nameserv in Orbacus) is running. We use some command-line options to tell the naming service the host and port on which it should listen. nameserv -OAhost localhost -OAport 8140 After this, we can start the server with a command-line option to tell it how to contact the naming service. server -ORBInitRef NameService=corbaloc:iiop:localhost:8140/NameServiceFinally we can start the client, again with a command-line option to tell it how to contact the naming service. client -ORBInitRef NameService=corbaloc

EXPERIMENT 7

AIM: Write a program to implement RPC mechanism for a file transfer across a network.

THEORY:

In distributed computing, a remote procedure call (RPC) is when a computer program causes a procedure (subroutine) to execute in a different address space (commonly on another computer on a shared network), which is coded as if it were a normal (local) procedure call, without the programmer explicitly coding the details for the remote interaction. That is, the programmer writes essentially the same code whether the subroutine is local to the executing program, or remote. This is a form of client–server interaction (caller is client, executor is server), typically implemented via a request–response message-passing system. In the object-oriented programming paradigm, RPCs are represented by remote method invocation (RMI). The RPC model implies a level of location transparency, namely that calling procedures are largely the same whether they are local or remote, but usually they are not identical, so local calls can be distinguished from remote calls. Remote calls are usually orders of magnitude slower and less reliable than local calls, so distinguishing them is important.

RPCs are a form of inter-process communication (IPC), in that different processes have different address spaces: if on the same host machine, they have distinct virtual address spaces, even though the physical address space is the same; while if they are on different hosts, the physical address space is different. Many different (often incompatible) technologies have been used to implement the concept.

Sequence of events

- The client calls the client stub. The call is a local procedure call, with parameters pushed on to the stack in the normal way.
- The client stub packs the parameters into a message and makes a system call to send the message. Packing the parameters is called marshalling.
- The client's local operating system sends the message from the client machine to the server machine.
- The local operating system on the server machine passes the incoming packets to the server stub.
- The server stub unpacks the parameters from the message. Unpacking the parameters is called unmarshalling.
- Finally, the server stub calls the server procedure. The reply traces the same steps in the reverse direction.

CODE:

```
// server code for UDP socket programming
#include <arpa/inet.h>
#include <netinet/in.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/socket.h>
#include <sys/types.h>
#include <unistd.h>

#define IP_PROTOCOL 0
#define PORT_NO 15050
#define NET_BUF_SIZE 32
#define cipherKey 'S'
#define sendrecvflag 0
#define nofile "File Not Found!"

// function to clear buffer
void clearBuf(char* b)
{
        int i;
        for (i = 0; i < NET_BUF_SIZE; i++)
                b[i] = '\0';
}

// function to encrypt
char Cipher(char ch)
{
        return ch ^ cipherKey;
}

// function sending file
int sendFile(FILE* fp, char* buf, int s)
{
        int i, len;
        if (fp == NULL) {
                strcpy(buf,  nofile);
                len = strlen(nofile);
                buf[len] = EOF;
                for (i = 0; i <= len; i++)
                        buf[i] = Cipher(buf[i]);
```

```
            return 1;
        }

        char ch, ch2;
        for (i = 0; i < s; i++) {
                ch = fgetc(fp);
                ch2 = Cipher(ch);
                buf[i] = ch2;
                if (ch == EOF)
                        return 1;
        }
        return 0;
}

// driver code
int main()
{
        int sockfd, nBytes;
        struct sockaddr_in addr_con;
        int addrlen = sizeof(addr_con);
        addr_con.sin_family = AF_INET;
        addr_con.sin_port = htons(PORT_NO);
        addr_con.sin_addr.s_addr = INADDR_ANY;
        char net_buf[NET_BUF_SIZE];
        FILE* fp;

        // socket()
        sockfd = socket(AF_INET, SOCK_DGRAM, IP_PROTOCOL);

        if (sockfd < 0)
                printf("\nfile descriptor not received!!\n");
        else
                printf("\nfile descriptor %d received\n", sockfd);

        // bind()
        if (bind(sockfd, (struct sockaddr*)&addr_con, sizeof(addr_con)) == 0)
                printf("\nSuccessfully binded!\n");
        else
                printf("\nBinding Failed!\n");

        while (1) {
                printf("\nWaiting for file name...\n");

                // receive file name
```

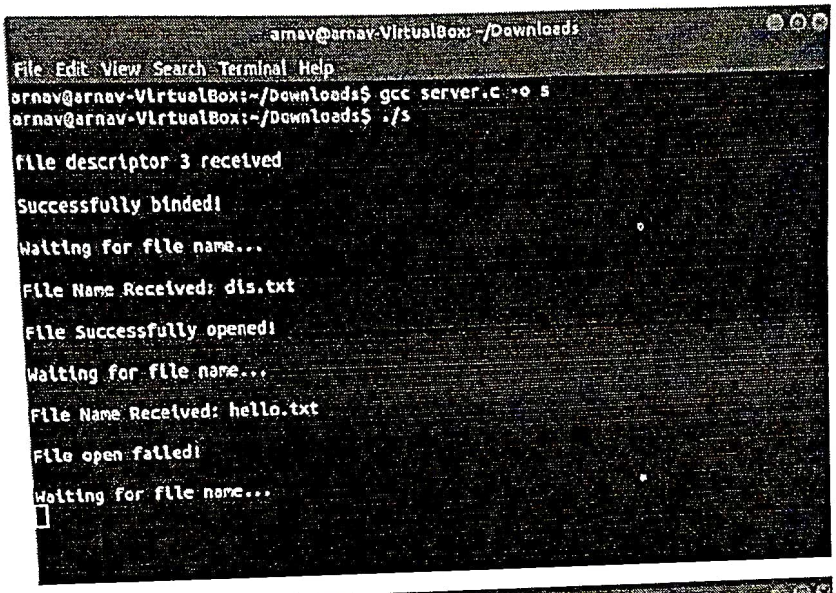
```
            clearBuf(net_buf);

            nBytes = recvfrom(sockfd, net_buf,
                                        NET_BUF_SIZE, sendrecvflag,
                                        (struct sockaddr*)&addr_con, &addrlen);

            fp = fopen(net_buf, "r");
            printf("\nFile Name Received: %s\n", net_buf);
            if (fp == NULL)
                    printf("\nFile open failed!\n");
            else
                    printf("\nFile Successfully opened!\n");

            while (1) {

                    // process
                    if (sendFile(fp, net_buf, NET_BUF_SIZE)) {
                            sendto(sockfd, net_buf, NET_BUF_SIZE,
                                    sendrecvflag,
                                    (struct sockaddr*)&addr_con, addrlen);
                            break;
                    }

                    // send
                    sendto(sockfd, net_buf, NET_BUF_SIZE,
                            sendrecvflag,
                            (struct sockaddr*)&addr_con, addrlen);
                    clearBuf(net_buf);
            }
            if (fp != NULL)
                    fclose(fp);
    }
    return 0;
}
```

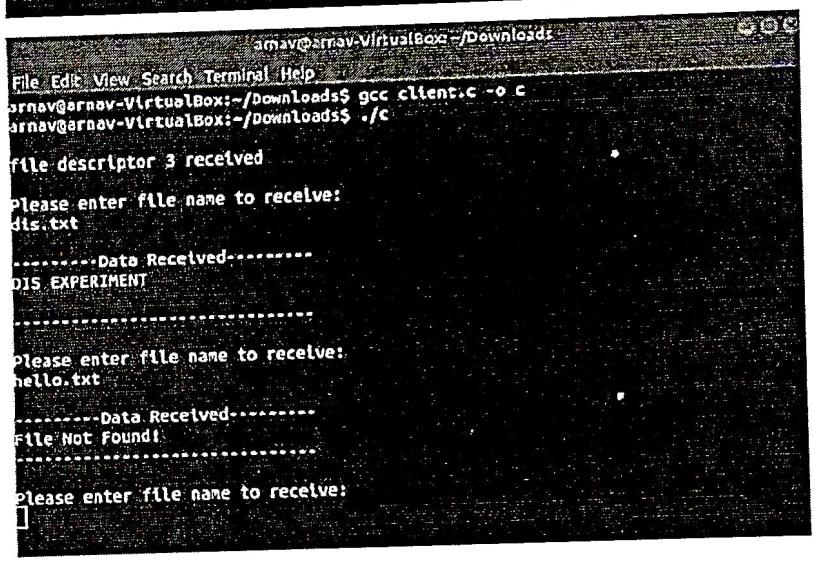
```
// client code for UDP socket programming
#include <arpa/inet.h>
#include <netinet/in.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/socket.h>
#include <sys/types.h>
#include <unistd.h>
```

```
#define IP_PROTOCOL 0
#define IP_ADDRESS "127.0.0.1" // localhost
#define PORT_NO 15050
#define NET_BUF_SIZE 32
#define cipherKey 'S'
#define sendrecvflag 0

// function to clear buffer
void clearBuf(char* b)
{
        int i;
        for (i = 0; i < NET_BUF_SIZE; i++)
                b[i] = '\0';
}

// function for decryption
char Cipher(char ch)
{
        return ch ^ cipherKey;
}

// function to receive file
int recvFile(char* buf, int s)
{
        int i;
        char ch;
        for (i = 0; i < s; i++) {
                ch = buf[i];
                ch = Cipher(ch);
                if (ch == EOF)
                        return 1;
                else
                        printf("%c", ch);
        }
        return 0;
}

// driver code
int main()
{
        int sockfd, nBytes;
        struct sockaddr_in addr_con;
        int addrlen = sizeof(addr_con);
```

```
    addr_con.sin_family = AF_INET;
    addr_con.sin_port = htons(PORT_NO);
    addr_con.sin_addr.s_addr = inet_addr(IP_ADDRESS);
    char net_buf[NET_BUF_SIZE];
    FILE* fp;

    // socket()
    sockfd = socket(AF_INET, SOCK_DGRAM,
                                IP_PROTOCOL);

    if (sockfd < 0)
        printf("\nfile descriptor not received!!\n");
    else
        printf("\nfile descriptor %d received\n", sockfd);

    while (1) {
        printf("\nPlease enter file name to receive:\n");
        scanf("%s", net_buf);
        sendto(sockfd, net_buf, NET_BUF_SIZE,
            sendrecvflag, (struct sockaddr*)&addr_con,
            addrlen);

        printf("\n---------Data Received -------- \n");

        while (1) {
            // receive
            clearBuf(net_buf);
            nBytes = recvfrom(sockfd, net_buf, NET_BUF_SIZE,
                                    sendrecvflag, (struct sockaddr*)&addr_con,
                                    &addrlen);

            // process
            if (recvFile(net_buf, NET_BUF_SIZE)) {
                break;
            }
        }
        printf("\n---------------------------------\n");
    }
    return 0;
}
```

OUTPUT:


arnav@arnav-VirtualBox: ~/Downloads
File Edit View Search Terminal Help
arnav@arnav-VirtualBox:~/Downloads$ gcc server.c -o s
arnav@arnav-VirtualBox:~/Downloads$ ./s
file descriptor 3 received
Successfully binded!
Waiting for file name...
File Name Received: dis.txt
File Successfully opened!
Waiting for file name...
File Name Received: hello.txt
File open failed!
Waiting for file name...


arnav@arnav-VirtualBox: ~/Downloads
File Edit View Search Terminal Help
arnav@arnav-VirtualBox:~/Downloads$ gcc client.c -o c
arnav@arnav-VirtualBox:~/Downloads$ ./c
file descriptor 3 received
Please enter file name to receive:
dis.txt
---------Data Received---------
DIS EXPERIMENT

Please enter file name to receive:
hello.txt
---------Data Received---------
File Not Found!

Please enter file name to receive:

EXPERIMENT 8:

AIM: Write a program for Program for implementing Vector Clock.

THEORY:

Introduction:

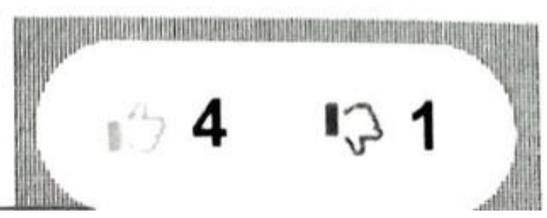
Vector Clock is an algorithm that generates partial ordering of events and detects causality violations in a distributed system. These clocks expand on Scalar time to facilitate a causally consistent view of the distributed system, they detect whether a contributed event has caused another event in the distributed system. It essentially captures all the causal relationships. This algorithm helps us label every process with a vector(a list of integers) with an integer for each local clock of every process within the system. So for N given processes, there will be vector/ array of size N.

How does the vector clock algorithm work :

- Initially, all the clocks are set to zero.
- Every time, an Internal event occurs in a process, the value of the processes's logical clock in the vector is incremented by 1
- Also, every time a process sends a message, the value of the processes's logical clock in the vector is incremented by 1.
- Every time, a process receives a message, the value of the processes's logical clock in the vector is incremented by 1, and moreover, each element is updated by taking the maximum of the value in its own vector clock and the value in the vector in the received message (for every element).

CODE:

```
#include<stdio.h>
#include<stdio.h>
#include<stdlib.h>
long *p1(int i,long *comp);
long *p2(int i,long *comp);
long *p3(int i,long *comp);

void main() {
   long start[]={0,0,0},*vector;
   while(!kbhit()) {
      p1(1,&start[0]);
   }
   printf("\n Process Vector\n");
   vector=p1(0,&start[0]);
   printf("p1[%ld%ld%ld]\n",*vector,*(vector+1),*(vector+2));   vector=p2(0,&start[0]);
   printf("p2[%ld%ld%ld]\n",*vector,*(vector+1),*(vector+2)); vector=p3(0,&start[0]);
   printf("p3[%ld%ld%ld]\n",*vector,*(vector+1),*(vector+2));
}
```



```
long *p1(int i,long *comp) {
   static long a[]={0,0,0};
   int next;
   if(i==1) {
    a[0]++;
    if(*(comp+1)>a[1])
       a[1]=*(comp+1);
    if(*(comp+2)>a[2])
        a[2]=*(comp+2);
     next=random(2);
     if(next==0)
        p2(1,&a[0]);
     else if(next==1)
        p3(1,&a[0]);
     return(&a[0]);
   }
   else
     return(&a[0]);
}
long *p2(int i,long *comp)
{
   static long b[]={0,0,0};
   int next;
   if(i==1)
   {
     b[i]++;
     if(*comp>b[0])
        b[0]=*(comp);
     if(*(comp+2)>b[2])
        b[2]=*(comp+2);
     next=random(2);
     if(next==0)
        p1(1,&b[0]);
     else if(next==1)
        p3(1,&b[0]);
     return &b[0];
   }
   else
     return &b[0];
}
long *p3(int i,long *comp) {
static long c[]={0,0,0}; int next;
if(i==1)
{
   c[2]++;
```

EXPERIMENT 9:

AIM: Write a program for simulating Lamport Logical Clock.

THEORY:

Introduction:

Lamport introduced a system of logical clocks in order to make the -> relation possible. It works like this: Each process Pi in the system has its own clock Ci. Ci can be looked at as a function that assigns a number, Ci (a) to an event a. This is the timestamp of the event a in process Pi. These numbers are not in any way related to physical time -- that is why they are called logical clocks. These are generally implemented using counters, which increase each time an event occurs. Generally, an event's timestamp is the value of the clock at that time it occurs.

Description:

Happened Before Relation (->). This relation captures causal dependencies between events, That is ,whether or not events have a cause and effect relation.
This relation (->) is defined as follows:

- a -> b, if a and b are in the same process and a occurred before b.
- a -> b, if a is the event of sending a message and b is the receipt of that message by another process.
- If a -> b and b -> c, then a -> c - that is, the relation has the property of transitivity.
- Causally Related Events: If event a -> event b, then a causally affects b.
- Concurrent Events: Two distinct events a and b are concurrent (a || b) if (not) a -> b and (not) b > a. That is, the events have no causal relationship. This is equivalent to b || a.
- For any two events a and b in a system, only one of the following is true: a -> b, b -> a, or a || b. e11 → e12 , e12 → e22e21 → e13 , e14 || e24

Conditions Satisfied by the Logical Clock system:

For any events a and b, if a -> b, then C(a) < C(b). This is true if two conditions are met:

- If a occurs before b, then Ci(a) < Ci(b).
- If a is a message sent from Pi and b is the recept of that same message in Pj, then Ci(a) < Cj(b).
- Implementation Rules Required:
- Clock Ci is incremented for each event: Ci := Ci + d (d > 0)
- if a is the event of sending a message from one process to another, then the receiver sets its clock
- to the max of its current clock and the sender's clock - that is, Cj := max(Cj, tm + d) (d> 0)

Limitation of Lamport's Clocks:

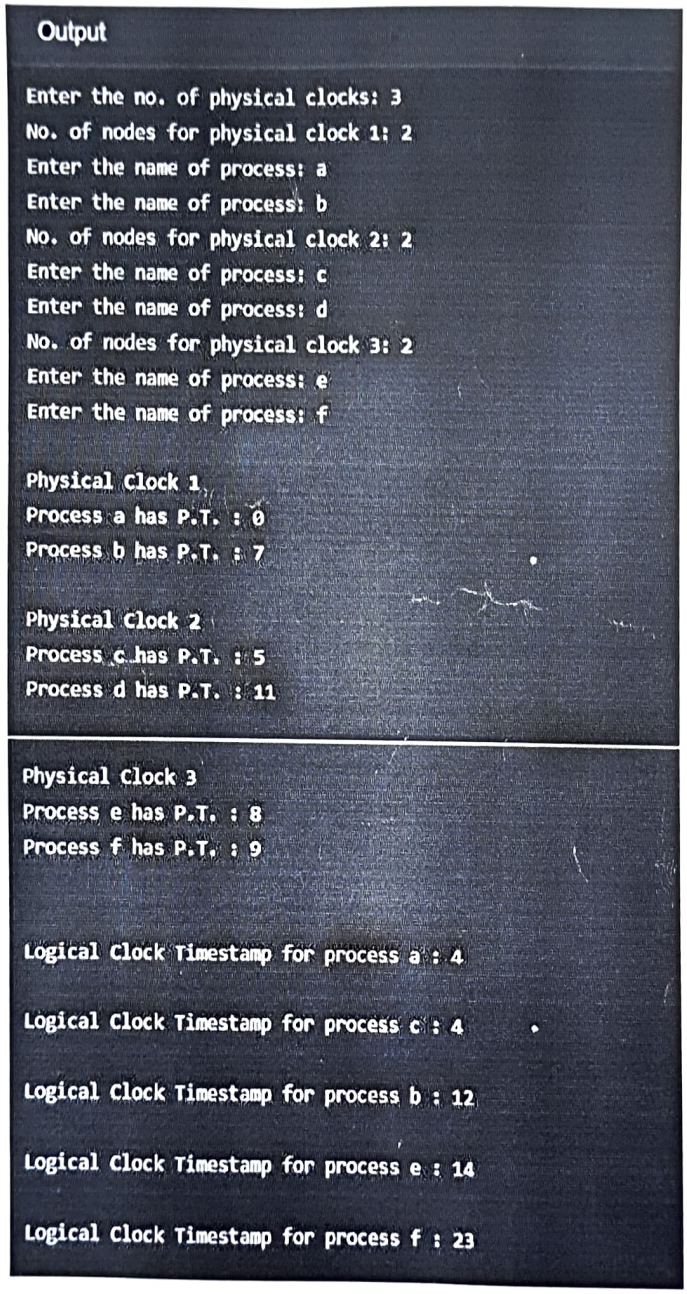
- if a → b then C(a) < C(b) but C(a) < C(b) does not necessarily imply a → b

CODE:

```
#include <stdio.h>
#include <stdlib.h>

void main()
{
   int i,j,k; int x=0;
   char a[10][10];
   int n,num[10],b[10][10];

   printf("Enter the no. of physical clocks: ");
   scanf("%d",&n);
   for(i=0;i<n;i++)
   {
      printf("\nNo. of nodes for physical clock %d: ",i+1);
      scanf("%d",&num[i]);
      x=0;
      for(j=0;j<num[i];j++)
      {
         printf("\nEnter the name of process: ");
         scanf("%s",&a[i][j]);
         b[i][j]=x + rand() % 10;
         x=b[i][j]+1;
      }
   }
   printf("\n\n");
   for(i=0;i<n;i++)
   {
      printf("Physical Clock %d",i+1);
      for(j=0;j<num[i];j++){
         printf("\nProcess %c",a[i][j]);
         printf(" has P.T. : %d ",b[i][j]);
      }
      printf("\n\n");
   }
   x=0;
   for(i=0;i<10;i++)
      for(j=0;j<n;j++)
         for(k=0;k<num[j];k++)
            if(b[j][k]==i)
            {
               x = rand() % 10 + x;
               printf("\nLogical Clock Timestamp for process %c",a[j][k]); printf(" : %d ",x);
               printf("\n");
```

```
        }
  return;
}
```

OUTPUT:



Program – 10

AIM: To implement 2-Phase Commit client-server.

Introduction and Theory

In a local database system, for committing a transaction, the transaction manager has to only convey the decision to commit to the recovery manager. However, in a distributed system, the transaction manager should convey the decision to commit to all the servers in the various sites where the transaction is being executed and uniformly enforce the decision. When processing is complete at each site, it reaches the partially committed transaction state and waits for all other transactions to reach their partially committed states. When it receives the message that all the sites are ready to commit, it starts to commit. In a distributed system, either all sites commit or none of them does.

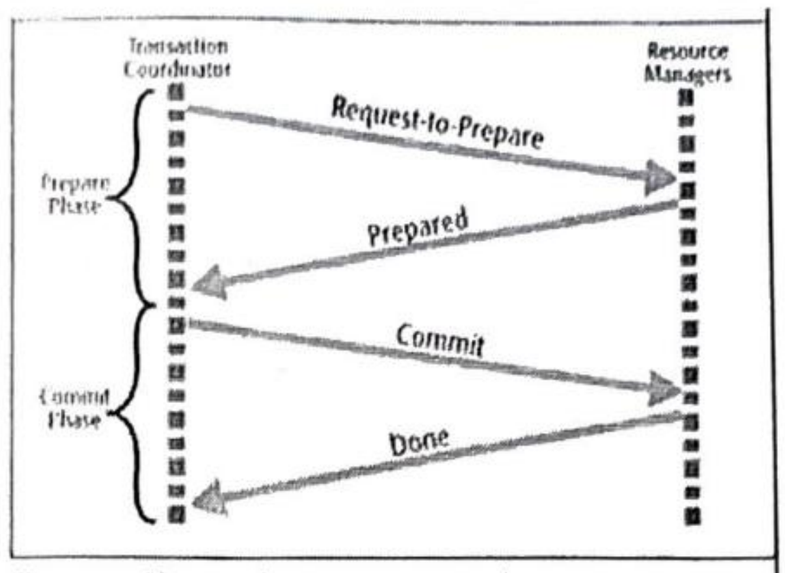


Figure 1 · The two-phase commit protocol

Distributed two-phase commit reduces the vulnerability of one-phase commit protocols. The steps performed in the two phases are as follows –

Phase 1: Prepare Phase

- After each slave has locally completed its transaction, it sends a "DONE" message to the controlling site. When the controlling site has received "DONE" message from all slaves, it sends a "Prepare" message to the slaves.
- The slaves vote on whether they still want to commit or not. If a slave wants to commit,it sends a "Ready" message.
- A slave that does not want to commit sends a "Not Ready" message. This may happen when the slave has conflicting concurrent transactions or there is a timeout.

Phase 2: Commit/Abort Phase

- After the controlling site has received "Ready" message from all the slaves –
  - The controlling site sends a "Global Commit" message to the slaves.
  - The slaves apply the transaction and send a "Commit ACK" message to the controlling site.
  - When the controlling site receives "Commit ACK" message from all the slaves, it considers the transaction as committed.
- After the controlling site has received the first "Not Ready" message from any slave –
  - The controlling site sends a "Global Abort" message to the slaves.
  - The slaves abort the transaction and send a "Abort ACK" message to the controlling site.
  - When the controlling site receives "Abort ACK" message from all the slaves, it considers the transaction as aborted.

Program – 10

Code

Server

```
1   #include <sys/socket.h>
2   #include <netinet/in.h>
3   #include <arpa/inet.h>
4   #include <stdio.h>
5   #include <stdlib.h>
6   #include <unistd.h>
7   #include <errno.h>
8   #include <string.h>
9   #include <sys/types.h>
10  #include <time.h>
11  #include <string.h>
12  #define MSG_CONFIRM 0
13
14
15  #define TRUE 1
16  #define FALSE 0
17  #define ML 1024
18  #define MPROC 32
19
20  typedef struct wireless_node
21  {
22      int priority;
23      int parent;
24  } wireless_node;
25
26  wireless_node w;
27
28  int max(int a, int b)
29  {
30      return a >= b? a:b;
31  }
32
33  int connect_to_port(int  connect_to)
34  {
35      int sock_id;
36      int opt = 1;
37      struct sockaddr_in server;
38      if ((sock_id = socket(AF_INET, SOCK_DGRAM, 0)) < 0)
39      {
40          perror("unable to create a socket");
41          exit(EXIT_FAILURE);
42      }
43      setsockopt(sock_id, SOL_SOCKET, SO_REUSEADDR, (const void
44  *)&opt, sizeof(int));
45      memset(&server, 0, sizeof(server));
46      server.sin_family = AF_INET;
47      server.sin_addr.s_addr = INADDR_ANY;
48      server.sin_port = htons(connect_to);
49
50      if (bind(sock_id, (const struct sockaddr *)&server,
51  sizeof(server)) < 0)
52  {
53          perror("unable to bind to port");
```

Program – 10

```
54              exit(EXIT_FAILURE);
55          }
56          return sock_id;
57      }
58
59      void send_to_id(int  to, int from, char message[ML])
60      {
61          struct sockaddr_in cl;
62          memset(&cl, 0, sizeof(cl));
63
64          cl.sin_family = AF_INET;
65          cl.sin_addr.s_addr = INADDR_ANY;
66          cl.sin_port = htons(to);
67
68          sendto(
69              from, \
70              (const char *)message, \
71              strlen(message), \
72              MSG_CONFIRM, \
73              (const struct sockaddr *)&cl, \
74              sizeof(cl));
75      }
76
77      void begin_commit(int  id, int *procs, int num_procs)
78      {
79          int itr;
80          char message[ML];
81          sprintf(message, "%s", "SCMT");
82          for (itr = 0; itr < num_procs; itr++)
83          {
84                  printf("Sending begin commit to: %d\n", procs[itr]);
85                  send_to_id(procs[itr], id, message);
86          }
87      }
88
89      void announce_action(int  self, int *procs, int num_procs, char
90      msg[ML])
91      {
92          int itr;
93
94          for (itr = 0; itr < num_procs; itr++)
95          {
96              send_to_id(procs[itr], self, msg);
97          }
98      }
99
100
101     int main(int argc, char* argv[])
102     {
103         int self = atoi(argv[1]);
104         int n_procs = atoi(argv[2]);
105         int procs[MPROC];
106         int sender, okcnt = 0, nocnt = 0, dncnt = 0;
107         int sock_id, coord_id;
108         int itr, len, n, start, ix;
109
110         char buffer[ML], flag[ML], p_id[ML], msg[256];
```

Program – 10

```
111
112         struct sockaddr_in from;
113
114         for(itr = 0; itr < n_procs; itr += 1)
115             procs[itr] = atoi(argv[3 + itr]);
116         printf("Creating node at %d\n", self);
117         sock_id = connect_to_port(self);
118         begin_commit(sock_id, procs, n_procs);
119         while(TRUE)
120         {
121             sleep(2);
122             memset(&from,  0, sizeof(from));
123             // printf("Tring read\n");
124             n = recvfrom(sock_id, (char *)buffer, ML, MSG_WAITALL,
125     (struct sockaddr *)&from, &len);
126             buffer[n] = '\0';
127             printf("Recieved: %s\n", buffer);
128
129             if (strcmp(buffer, "CMOK") == 0)
130             {
131                 okcnt += 1;
132             }
133             else if (strcmp(buffer, "CMNO") == 0)
134             {
135                 nocnt += 1;
136             }
137             if ((nocnt + okcnt) == n_procs)
138             {
139                 printf("Recieved replies from all clients\n");
140                 if (okcnt == n_procs)
141                 {
142                     printf("Announcing complete commit\n");
143                     announce_action(sock_id, procs, n_procs, "CDON");
144                 }
145                 else
146                 {
147                     printf("Announcing abort commit\n");
148                     announce_action(sock_id, procs, n_procs, "CABT");
149                 }
150             }
151             if (strcmp(buffer, "DONE") == 0)
152             {
153                 dncnt += 1;
154                 printf("clients confirmed commit\n");
155                 if (dncnt == n_procs)
156                 {
157                     printf("All process announced commit action\n");
158                     exit(EXIT_SUCCESS);
159                 }
160             }
161             // printf("Waiting\n");
162         }
163         return 0;
164     }
```

Program – 10

Client

```
1   #include <sys/socket.h>
2   #include <netinet/in.h>
3   #include <arpa/inet.h>
4   #include <stdio.h>
5   #include <stdlib.h>
6   #include <unistd.h>
7   #include <errno.h>
8   #include <string.h>
9   #include <sys/types.h>
10  #include <time.h>
11  #include <string.h>
12  #define MSG_CONFIRM 0
13
14
15  #define TRUE 1
16  #define FALSE 0
17  #define ML 1024
18  #define MPROC 32
19
20  typedef struct wireless_node
21  {
22      int priority;
23      int parent;
24  } wireless_node;
25
26  wireless_node w;
27
28  int max(int a, int b)
29  {
30      return a >= b? a:b;
31  }
32
33  int connect_to_port(int connect_to)
34  {
35      int sock_id;
36      int opt = 1;
37      struct sockaddr_in server;
38      if ((sock_id = socket(AF_INET, SOCK_DGRAM, 0)) < 0)
39      {
40          perror("unable to create a socket");
41          exit(EXIT_FAILURE);
42      }
43      setsockopt(sock_id, SOL_SOCKET, SO_REUSEADDR, (const void
44  *)&opt, sizeof(int));
45      memset(&server, 0, sizeof(server));
46      server.sin_family = AF_INET;
47      server.sin_addr.s_addr = INADDR_ANY;
48      server.sin_port = htons(connect_to);
49
50      if (bind(sock_id, (const struct sockaddr *)&server,
51  sizeof(server)) < 0)
52      {
53          perror("unable to bind to port");
54          exit(EXIT_FAILURE);
55      }
```

Program – 10

```
56      return sock_id;
57  }
58
59  void send_to_id(int  to, int from, char message[ML])
60  {
61      struct sockaddr_in cl;
62      memset(&cl, 0, sizeof(cl));
63
64      cl.sin_family = AF_INET;
65      cl.sin_addr.s_addr = INADDR_ANY;
66      cl.sin_port = htons(to);
67
68      sendto(
69          from, \
70          (const char *)message, \
71          strlen(message), \
72          MSG_CONFIRM, \
73          (const struct sockaddr *)&cl, \
74          sizeof(cl));
75  }
76
77  void begin_commit(int  id, int *procs, int num_procs)
78  {
79      int itr;
80      char message[ML];
81      sprintf(message, "%s", "SCMT");
82      for (itr = 0; itr < num_procs; itr++)
83      {
84              printf("Sending begin commit to: %d\n", procs[itr]);
85              send_to_id(procs[itr], id, message);
86      }
87  }
88
89  void announce_action(int  self, int *procs, int num_procs, char
90  msg[ML])
91  {
92      int itr;
93
94      for (itr = 0; itr < num_procs; itr++)
95      {
96          send_to_id(procs[itr], self, msg);
97      }
98  }
99
100
101 int main(int argc, char* argv[])
102 {
103     int self = atoi(argv[1]);
104     int server = atoi(argv[2]);
105     char *action = argv[3];
106     int sender, okcnt = 0, nocnt = 0, dncnt = 0;
107     int sock_id, coord_id;
108     int itr, len, n, start, ix;
109     char buffer[ML], flag[ML], p_id[ML], msg[256];
110     struct sockaddr_in from;
111     printf("Creating node at %d\n", self);
112     sock_id = connect_to_port(self);
```

Program – 10

```
113     while(TRUE)
114     {
115         sleep(2);
116         memset(&from, 0, sizeof(from));
117         // printf("Tring read\n");
118         n = recvfrom(sock_id, (char *)buffer, ML, MSG_WAITALL,
119 (struct sockaddr *)&from, &len);
120         buffer[n] = '\0';
121         printf("Recieved: %s\n", buffer);
122         if (strcmp(buffer, "SCMT") == 0)
123         {
124             printf("Sending %s to server\n", action);
125             send_to_id(server, sock_id, action);
126         }
127         else if (strcmp(buffer, "CDON") == 0)
128         {
129             printf("Got complete commit, committing to logs\n");
130             send_to_id(server, sock_id, "DONE");
131             exit(EXIT_FAILURE);
132         }
133         else if (strcmp(buffer, "CABT") == 0)
134         {
135             printf("Got abort commit, deleting updates\n");
136             send_to_id(server, sock_id, "DONE");
137             exit(EXIT_FAILURE);
138         }
139         // printf("Waiting\n");
140     }
141     return 0;
142 }
143
```

Program – 10

Results and Outputs:

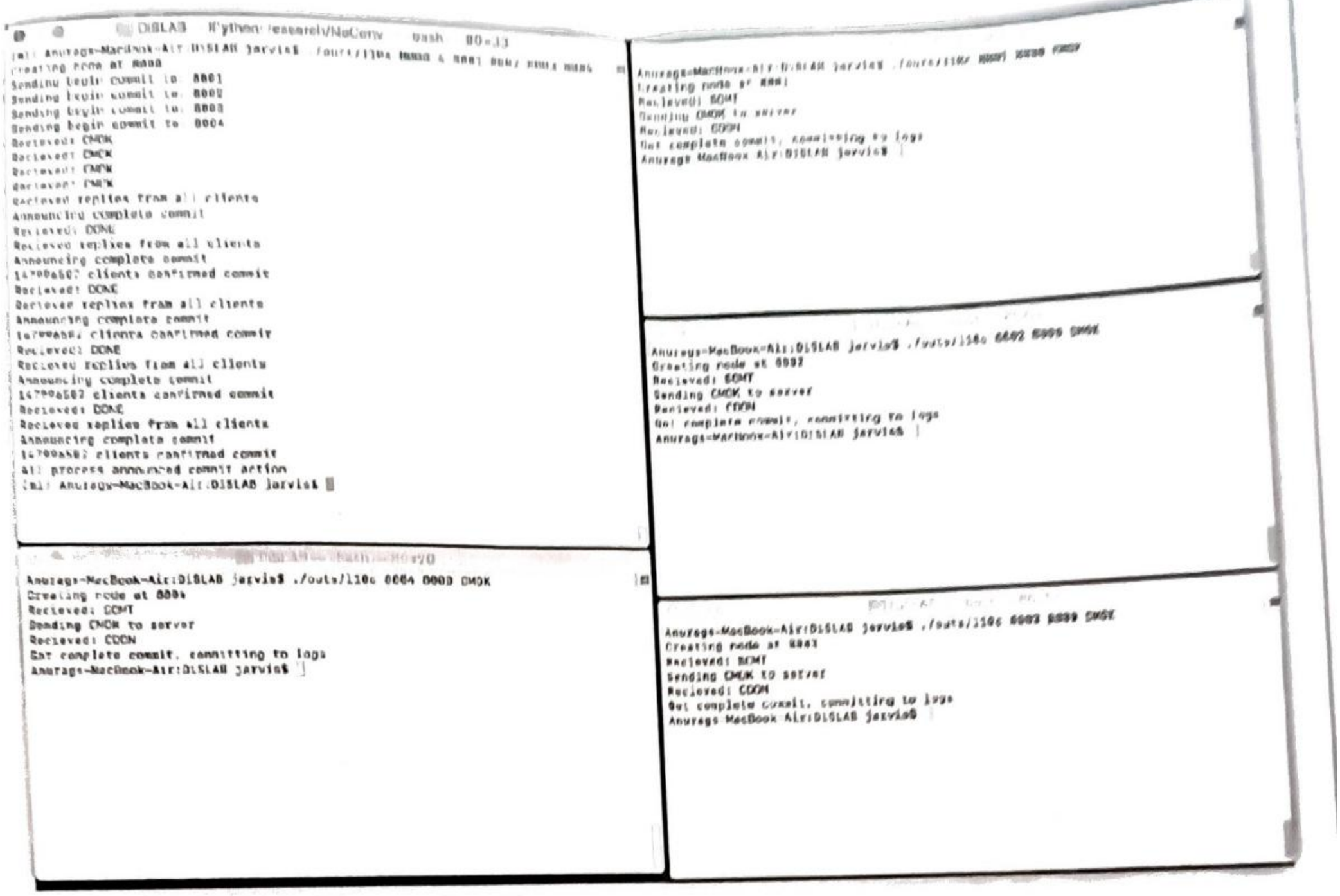


Figure 1 Normal Operation

Program – 10

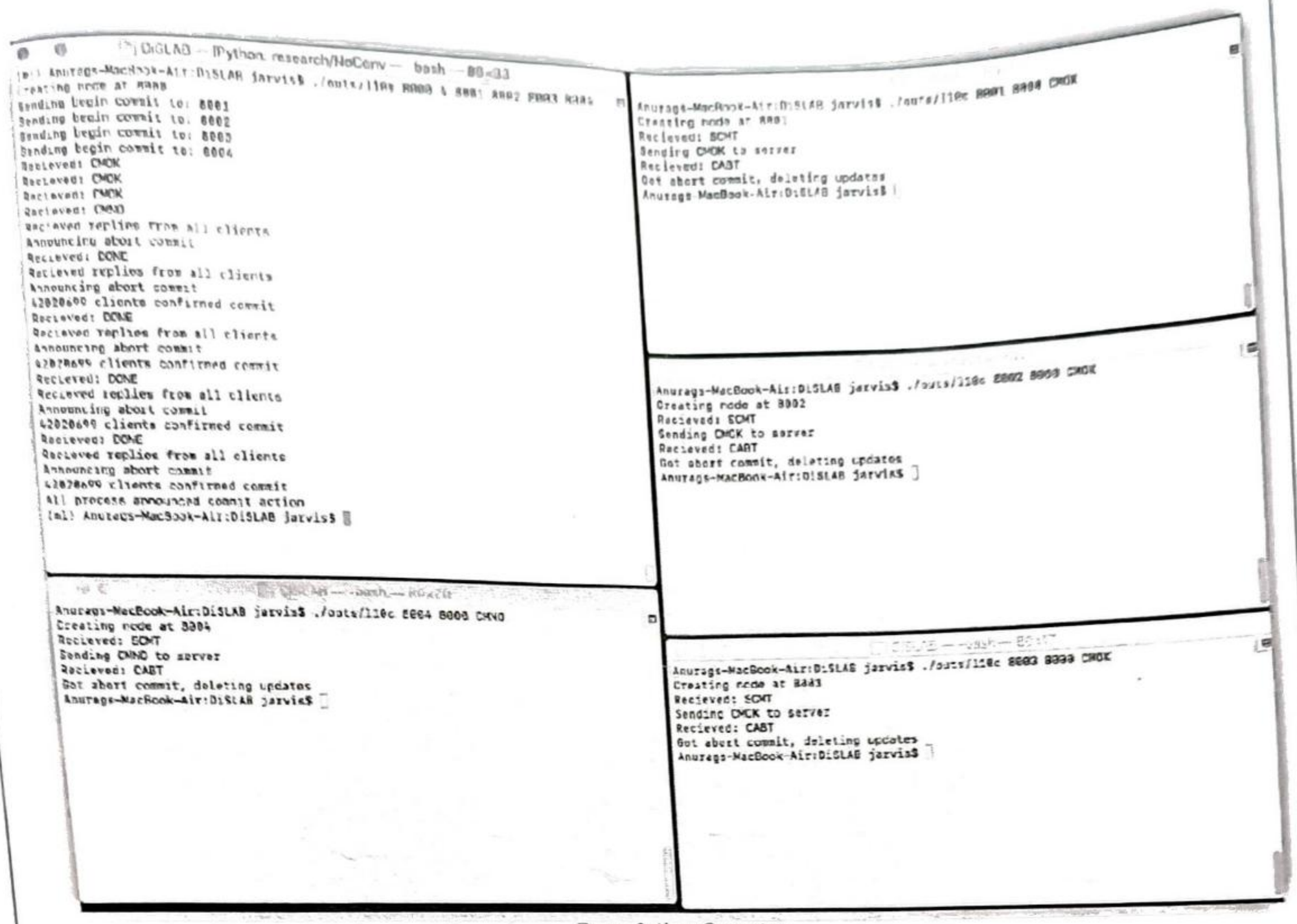


Figure 2 Abort Operation

Findings and Learnings:

1. We successfully implemented 2-phase commit.