Experiment 10

AIM: Write a program to implement entry eventual consistency between processes which mutually exclusively update replicated data stores.

THEORY:

Some cases like a worldwide naming system such as DNS can be viewed as cases of large-scale distributed and replicated databases that tolerate a relatively high degree of inconsistency. They have in common that if no updates take place for a long time, all replicas will gradually become consistent. This form of consistency is called eventual consistency.

Data stores that are eventually consistent thus have the property that in the absence of updates, all replicas converge toward identical copies of each other. Eventual consistency essentially requires only that updates are guaranteed to propagate to all replicas. Write-write conflicts are often relatively easy to solve when assuming that only a small group of processes can perform updates.

SOURCE CODE:

Server

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>
#include <string.h>
#include <sys/types.h>
#include <time.h>
#include <string.h>
#define TRUE 1
#define FALSE 0
#define ML 1024
#define MPROC 32

typedef struct Resource
{
   int a,b,c,d,e;
} Resource;
void serealize(Resource S, char output[ML])
{
   sprintf(output, "MCON %d\t%d\t%d\t%d\t%d\t", S.a, S.b, S.c, S.d, S.e);
}
Resource unserealize(char input[ML])
{
   char temp[ML];
   int ix = 0, itr = 5;
   Resource S;
   for(itr; input[itr] != '\t'; itr +=1)
      temp[ix++] = input[itr];
   temp[ix] = '\0';
   S.a = atoi(temp);
   ix = 0;

   for(itr = itr + 1; input[itr] != '\t'; itr +=1)
      temp[ix++] = input[itr];
   temp[ix] = '\0';
   S.b = atoi(temp);
   ix = 0;
   for(itr = itr + 1; input[itr] != '\t'; itr +=1)
      temp[ix++] = input[itr];
   temp[ix] = '\0';
   S.c = atoi(temp);
   ix = 0;
   for(itr = itr + 1; input[itr] != '\t'; itr +=1)
      temp[ix++] = input[itr];
   temp[ix] = '\0';
   S.d = atoi(temp);
   ix = 0;
   for(itr = itr + 1; input[itr] != '\t'; itr +=1)
      temp[ix++] = input[itr];
   temp[ix] = '\0';
   S.e = atoi(temp);
   ix = 0;
   return S;
}
int connect_to_port(int connect_to)
```

```
{
   int sock_id;
   int opt = 1;
   struct sockaddr_in server;
   if ((sock_id = socket(AF_INET, SOCK_DGRAM, 0)) < 0)
   {
      perror("unable to create a socket");
      exit(EXIT_FAILURE);
   }
   setsockopt(sock_id, SOL_SOCKET, SO_REUSEADDR, (const void *)&opt, sizeof(int));
   memset(&server, 0, sizeof(server));
   server.sin_family = AF_INET;
   server.sin_addr.s_addr = INADDR_ANY;
   server.sin_port = htons(connect_to);
   if (bind(sock_id, (const struct sockaddr *)&server, sizeof(server)) < 0)
   {
      perror("unable to bind to port");
      exit(EXIT_FAILURE);
   }
   return sock_id;
}
void send_to_id(int to, int from, char message[ML])
{
   struct sockaddr_in cl;
   memset(&cl, 0, sizeof(cl));

   cl.sin_family = AF_INET;
   cl.sin_addr.s_addr = INADDR_ANY;
   cl.sin_port = htons(to);
   sendto(from, (const char *)message,strlen(message),  MSG_CONFIRM, (const struct
sockaddr *)&cl, sizeof(cl));
}
void make_consistent(int from, int procs[], int n_procs, Resource S)
{
   char message[ML];
   int i;
   serealize(S, message);
   for (i = 0; i < n_procs; i++)
      send_to_id(procs[i], from, message);
```

```
}
int main(int argc, char* argv[])
{
    int self = atoi(argv[1]);
    int n_procs = atoi(argv[2]);
    int itr, ix = 0;
    int procs[MPROC];
    int key_avail = 1;
    int dest;
    int sock_id, len, n;
    char buffer[ML], msg[ML];
    char flag[256], p_id[256];
    struct sockaddr_in from;
    Resource S = {0, 0, 0, 0, 0};
    for(itr = 0; itr < n_procs; itr ++)
        procs[itr] = atoi(argv[3 + itr]);
    printf("Creating node at %d\n", self);
    sock_id = connect_to_port(self);

    while(TRUE)
    {
        memset(&from, 0, sizeof(from));
        n = recvfrom(sock_id, (char *)buffer, ML, MSG_WAITALL, (struct sockaddr *)&from,
&len);
        buffer[n] = '\0';
        printf("Recieved: %s\n", buffer);

        for(itr = 0; itr < 4; itr ++)
            flag[itr] = buffer[itr];
        flag[itr] = '\0';
        printf("Extracted flag %s\n", flag);
      if (strcmp(flag, "KEYR") == 0)
        {
            ix = 0;
            for (itr = 5; itr < 9; itr++)
                p_id[ix++] = buffer[itr];
            p_id[ix] = '\0';
            dest = atoi(p_id);
            printf("Extracted dest %d\n", dest);
            if (key_avail)
            {
                send_to_id(dest, sock_id, "PASS");
                key_avail = 0;
            }
            else
            {
                send_to_id(dest, sock_id, "WAIT");
            }
        }
        else if (strcmp(flag, "DONE") == 0)
        {
            printf("Key released\n");
            S = unserealize(buffer);
            key_avail = 1;
        }
        // process calls for consistency
        else if (strcmp(flag, "MCON") == 0)
        {
            printf("Forcing consistency \n");
            make_consistent(sock_id, procs, n_procs, S);
            for (itr = 5; itr < 9; itr++)
                p_id[5-itr] = buffer[itr];
            p_id[5-itr] = '\0';
            dest = atoi(p_id);
            send_to_id(dest, sock_id, "CNOK");
        }
    }

}
```

Client

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>
```

```
#include <string.h>
#include <sys/types.h>
#include <time.h>
#include <string.h>
#define TRUE 1
#define FALSE 0
#define ML 1024
#define MPROC 32
 typedef struct Resource
{
   int a, b,c,d,e;
} Resource;
void serealize(Resource S, char output[ML])
{
   sprintf(output, "DONE %d\t%d\t%d\t%d\t%d\t", S.a, S.b, S.c, S.d, S.e);
}
Resource unserealize(char input[ML])
{
   char temp[ML];
   int ix = 0, itr = 5;
   Resource S;
   for(itr; input[itr] != '\t'; itr +=1)
   {
      printf("%d %c\n", itr, input[itr]);
      temp[ix++] = input[itr];
   }
   temp[ix] = '\0';
   S.a = atoi(temp);
   ix = 0;
   printf("here\n");
   for(itr = itr + 1; input[itr] != '\t'; itr +=1)
      temp[ix++] = input[itr];
   temp[ix] = '\0';
   S.b = atoi(temp);
   ix = 0;
   for(itr = itr + 1; input[itr] != '\t'; itr +=1)
      temp[ix++] = input[itr];
   temp[ix] = '\0';
   S.c = atoi(temp);
```

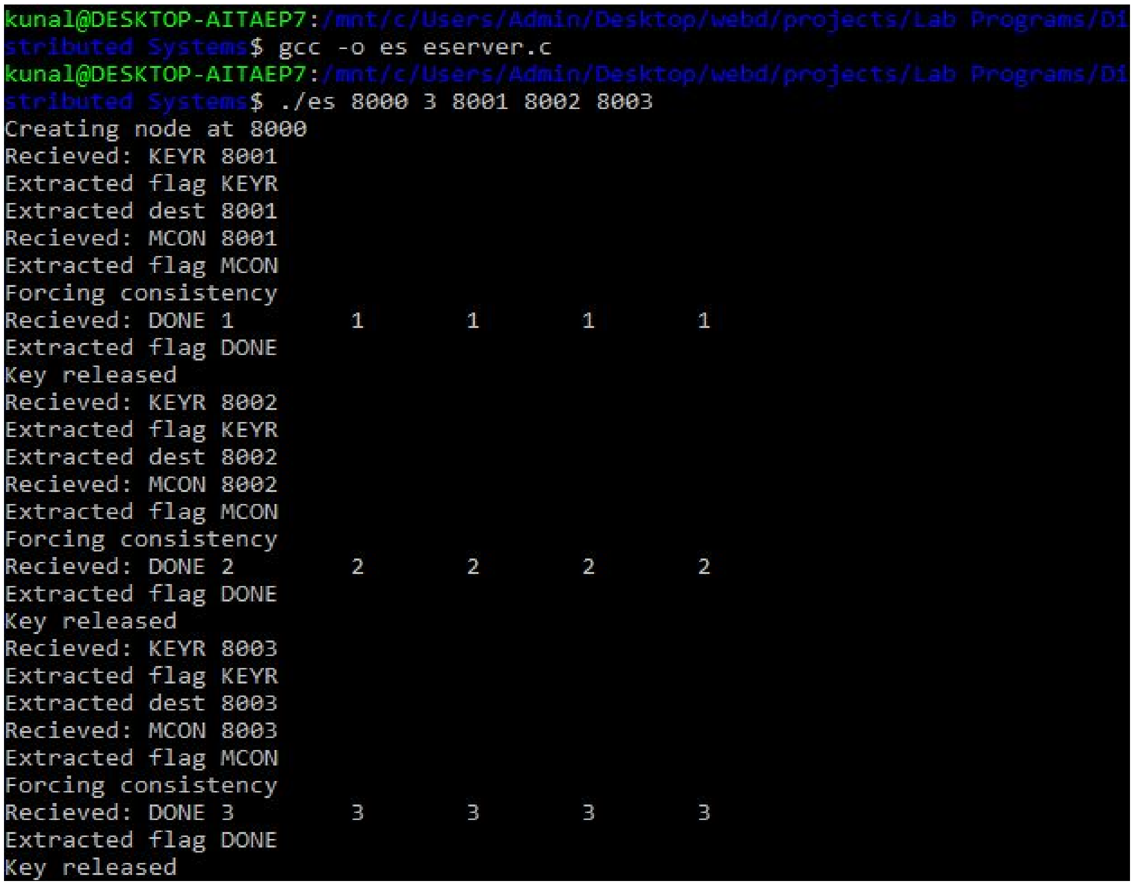
```
    ix = 0;
    for(itr = itr + 1; input[itr] != '\t'; itr +=1)
        temp[ix++] = input[itr];
    temp[ix] = '\0';
    S.d = atoi(temp);
    ix = 0;
    for(itr = itr + 1; input[itr] != '\t'; itr +=1)
        temp[ix++] = input[itr];
    temp[ix] = '\0';
    S.e = atoi(temp);
    ix = 0;
    return S;
}
int connect_to_port(int connect_to)
{
    int sock_id;
    int opt = 1;
    struct sockaddr_in server;
    if ((sock_id = socket(AF_INET, SOCK_DGRAM, 0)) < 0)
    {
        perror("unable to create a socket");
        exit(EXIT_FAILURE);
    }
    setsockopt(sock_id, SOL_SOCKET, SO_REUSEADDR, (const void *)&opt, sizeof(int));
    memset(&server, 0, sizeof(server));
    server.sin_family = AF_INET;
    server.sin_addr.s_addr = INADDR_ANY;
    server.sin_port = htons(connect_to);
    if (bind(sock_id, (const struct sockaddr *)&server, sizeof(server)) < 0)
    { perror("unable to bind to port");
        exit(EXIT_FAILURE);
    }
    return sock_id;
}
void send_to_id(int to, int from, char message[ML])
{
    struct sockaddr_in cl;
    memset(&cl, 0, sizeof(cl));
    cl.sin_family = AF_INET;
    cl.sin_addr.s_addr = INADDR_ANY;
    cl.sin_port = htons(to);
    sendto(from, (const char *)message,  strlen(message), MSG_CONFIRM, (const struct
sockaddr *)&cl, sizeof(cl));
}
void request_key(int server, int sock_id, int a)
{
    char msg[256];
    sprintf(msg, "KEYR %d", a);
    send_to_id(server, sock_id, msg);
}
int main(int argc, char* argv[])
{
    int self = atoi(argv[1]);
    int server = atoi(argv[2]);
    int start = atoi(argv[3]);
    int udelay = atoi(argv[4]);
    int itr;
    int dest;
    int key = 0;
    int sock_id, len, n;
    char buffer[ML], msg[ML];
    char flag[256], p_id[256];
    struct sockaddr_in from;
    Resource S = {0, 0, 0, 0, 0};
    printf("Creating node at %d\n", self);
    sock_id = connect_to_port(self);

    if (start)
    {
        request_key(server, sock_id, self);
    }
    else
    {
        sleep(udelay);
        request_key(server, sock_id, self);
    }
    while(TRUE)
    {       memset(&from, 0, sizeof(from));
```

```
        n = recvfrom(sock_id, (char *)buffer, ML, MSG_WAITALL, (struct sockaddr *)&from,
&len);
        buffer[n] = '\0';
        printf("Recieved: %s\n", buffer);
        for(itr = 0; itr < 4; itr ++)
            flag[itr] = buffer[itr];
        flag[itr] = '\0';
        printf("Extracted flag %s\n", flag);
    if (strcmp(flag, "WAIT") == 0)
        {
            sleep(udelay);
            request_key(server, sock_id, self);
        }
        else if (strcmp(flag, "PASS") == 0)
        {
            printf("Key recieved\n");
            key = 1;
            sprintf(msg, "MCON %d", self);
            send_to_id(server, sock_id, msg);
        }
        else if (strcmp(flag, "MCON") == 0)
        {
            printf("Pulling data from server before update\n");
            S = unserealize(buffer);
            printf("Pulled file\n %5d, %5d %5d %5d %5d\n", S.a, S.b, S.c, S.d, S.e);
        }
        else if (strcmp(flag, "CNOK") == 0 && key)
        {   printf("Entering critical Seaction\n");
            S.a++;    S.b++;
            S.c++; S.d++; S.e++;
            printf("Exiting critical Seaction\n");
            printf("Current file\n %5d, %5d %5d %5d %5d\n", S.a, S.b, S.c, S.d, S.e);
            serealize(S, msg);
            send_to_id(server, sock_id, msg);
            exit(EXIT_SUCCESS);
        }
    }
    return 0;
}
```

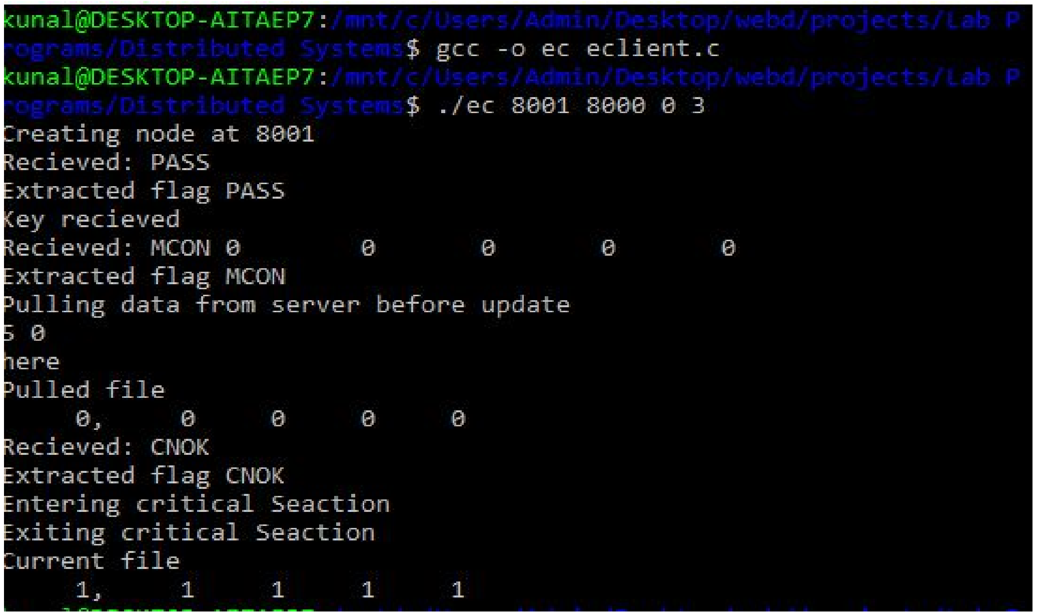
OUTPUT:

Server

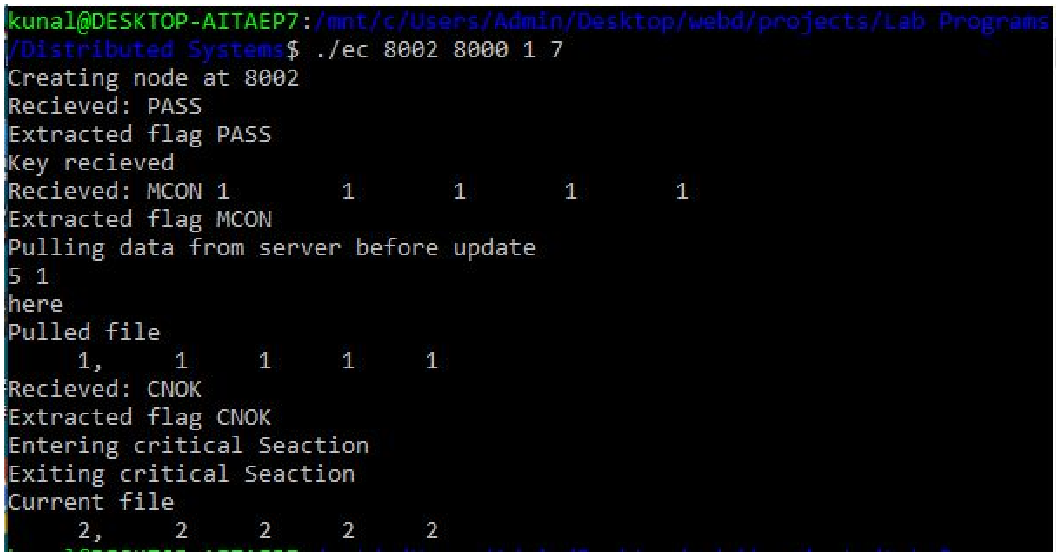


```
kunal@DESKTOP-AITAEP7:/mnt/c/Users/Admin/Desktop/webd/projects/Lab Programs/Di
stributed Systems$ gcc -o es eserver.c
kunal@DESKTOP-AITAEP7:/mnt/c/Users/Admin/Desktop/webd/projects/Lab Programs/Di
stributed Systems$ ./es 8000 3 8001 8002 8003
Creating node at 8000
Recieved: KEYR 8001
Extracted flag KEYR
Extracted dest 8001
Recieved: MCON 8001
Extracted flag MCON
Forcing consistency
Recieved: DONE 1        1       1       1       1
Extracted flag DONE
Key released
Recieved: KEYR 8002
Extracted flag KEYR
Extracted dest 8002
Recieved: MCON 8002
Extracted flag MCON
Forcing consistency
Recieved: DONE 2        2       2       2       2
Extracted flag DONE
Key released
Recieved: KEYR 8003
Extracted flag KEYR
Extracted dest 8003
Recieved: MCON 8003
Extracted flag MCON
Forcing consistency
Recieved: DONE 3        3       3       3       3
Extracted flag DONE
Key released
```

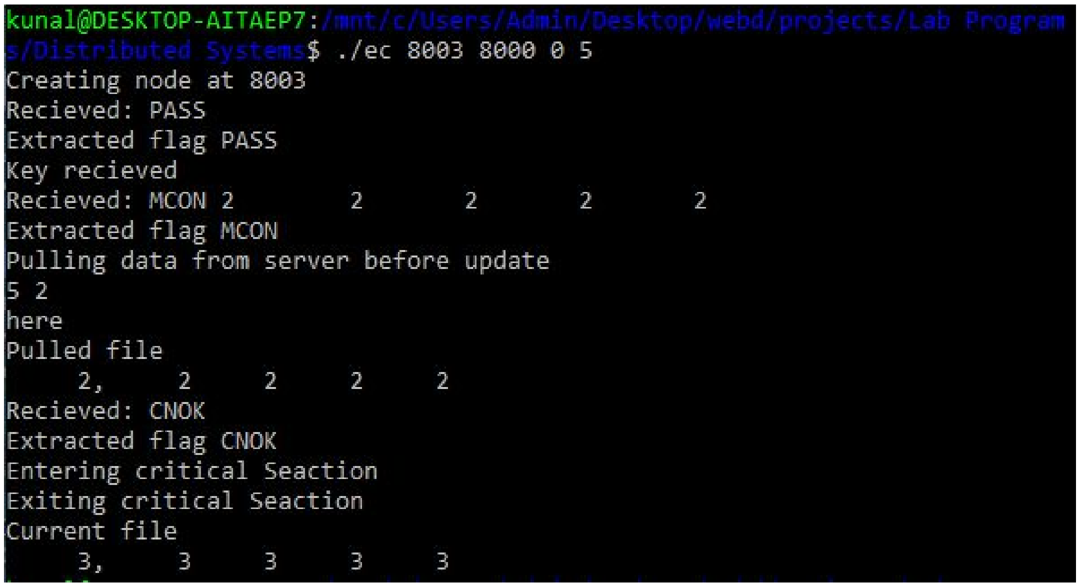
Clients



```
kunal@DESKTOP-AITAEP7:/mnt/c/Users/Admin/Desktop/webd/projects/Lab P
rograms/Distributed Systems$ gcc -o ec eclient.c
kunal@DESKTOP-AITAEP7:/mnt/c/Users/Admin/Desktop/webd/projects/Lab P
rograms/Distributed Systems$ ./ec 8001 8000 0 3
Creating node at 8001
Recieved: PASS
Extracted flag PASS
Key recieved
Recieved: MCON 0        0       0       0       0
Extracted flag MCON
Pulling data from server before update
5 0
here
Pulled file
    0,     0     0     0     0
Recieved: CNOK
Extracted flag CNOK
Entering critical Seaction
Exiting critical Seaction
Current file
    1,     1     1     1     1
```



```
kunal@DESKTOP-AITAEP7:/mnt/c/Users/Admin/Desktop/webd/projects/Lab Programs
/Distributed Systems$ ./ec 8002 8000 1 7
Creating node at 8002
Recieved: PASS
Extracted flag PASS
Key recieved
Recieved: MCON 1        1       1       1       1
Extracted flag MCON
Pulling data from server before update
5 1
here
Pulled file
     1,     1     1     1     1
Recieved: CNOK
Extracted flag CNOK
Entering critical Seaction
Exiting critical Seaction
Current file
     2,     2     2     2     2
```



```
kunal@DESKTOP-AITAEP7:/mnt/c/Users/Admin/Desktop/webd/projects/Lab Program
s/Distributed Systems$ ./ec 8003 8000 0 5
Creating node at 8003
Recieved: PASS
Extracted flag PASS
Key recieved
Recieved: MCON 2        2       2       2       2
Extracted flag MCON
Pulling data from server before update
5 2
here
Pulled file
     2,     2     2     2     2
Recieved: CNOK
Extracted flag CNOK
Entering critical Seaction
Exiting critical Seaction
Current file
     3,     3     3     3     3
```

LEARNING OUTCOMES:

We successfully implemented eventual consistency between processes . Eventual consistency is therefore often cheap to implement. Eventual consistent data stores work tine as long as clients always access the same replica. However, problems arise when different replicas are accessed over a short period of time.