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PROJECT REPORT

Advanced Data Structures

Banking System using Blockchain in C

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1. Introduction

The banking sector plays a pivotal role in the global economy, serving as a cornerstone for financial transactions, investments, and wealth management. With the advent of digital technologies, there has been a growing demand for secure, efficient, and transparent banking systems that can adapt to the evolving needs of customers while ensuring data integrity and confidentiality.

Blockchain technology has emerged as a disruptive force in the financial industry, offering a decentralized and immutable ledger system that can revolutionize traditional banking practices. By leveraging cryptographic techniques and distributed consensus mechanisms, blockchain enables transparent and tamper-proof recording of transactions, thereby enhancing security and trust in financial transactions.

The objective of this project is to develop a banking system using blockchain technology implemented in the C programming language. The project aims to address the shortcomings of traditional banking systems by providing a secure, transparent, and efficient platform for managing financial transactions.

Key Features

- Secure Transaction Management: Implementing blockchain data structures and algorithms to securely record and verify transactions.
- User Account Management: Facilitating account creation, authentication, and management functionalities for users.
- Transaction Processing: Enabling functionalities for deposit, withdrawal, and fund transfer operations, ensuring seamless transaction processing.
- Data Integrity and Confidentiality: Utilizing cryptographic techniques to ensure the integrity and confidentiality of user data and transaction records.

2. Problem Statement

The project aims to develop a banking system using blockchain technology in C. The system will address challenges in traditional banking, including security vulnerabilities, inefficiencies, and lack of transparency. Key objectives include implementing robust security measures, streamlining transaction processing, ensuring transparency through blockchain's decentralization, and providing a user-friendly interface. The system will integrate with existing banking infrastructure, comply with regulations, and ensure data integrity through cryptographic techniques.

3. Features

- Account Management
- Transaction Processing
- Blockchain Integration
- Security Measures
- User Authentication
- Data Integrity
- Scalability
- Compliance
- User-Friendly Interface
- Error Handling
- Backup and Recovery

4. Concepts Used

- Blockchain Technology
- Data Structures (e.g., Linked Lists, Binary Search Trees)
- File Handling (Input/Output operations)
- Dynamic Memory Allocation (malloc, free)
- String Manipulation (strcpy, strcat, sprintf)
- Time Handling (time, time_t)
- Error Handling and Error Messages (perror)
- Memory Management and Resource Optimization
- Algorithm Design and Implementation (e.g., hashing)
- Input Validation and Sanitization
- Interfacing with External Libraries (e.g., stdio.h, stdlib.h)
- Implementation of Banking Operations (e.g., account creation, deposit, withdrawal, transfer)
- Cryptography and Hashing Algorithms (e.g., computeHash function)

- File I/O Operations (e.g., saving/loading user data and transactions to/from CSV files)
- User Authentication and Authorization

5. Program Code

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

#define TABLE_SIZE 10  // Define the size of the hash table for simplicity

typedef struct Block {
int index;
char transactionID[65];
char previousHash[65];
time_t timestamp;
char data[1024];
char hash[65];
struct Block *next;
} Block;

typedef struct BSTNode {
char transactionID[65];
struct BSTNode *left, *right;
} BSTNode;

typedef struct {
Block *head;
int length;
BSTNode *root;  // Root node for BST of transactions
} Blockchain;

typedef struct User {
char accountNumber[20];
char name[100];
char mobile[20];
char password[100];
float balance;
```

```
struct User *next;
} User;

typedef struct {
User *users;
int nextAccountNumber;
User *hashTable[TABLE_SIZE];  // Hash table for users
} BankDatabase;

Blockchain blockchain;

int hashFunction(char *str) {
unsigned long hash = 5381;
int c;
while ((c = *str++))

hash = hash * 33 + c;

return hash % TABLE_SIZE;
}

void computeHash(char *str, char *hash) {
unsigned long hashValue = 5381;
int c;
while ((c = *str++))
hashValue = hashValue * 33 + c;
sprintf(hash, "%lu", hashValue);
}

BSTNode* insertBST(BSTNode *node, char *transactionID) {
if (node == NULL) {
BSTNode *temp = malloc(sizeof(BSTNode));
strcpy(temp->transactionID, transactionID);
temp->left = temp->right = NULL;
return temp;
}
if (strcmp(transactionID, node->transactionID) < 0)
node->left = insertBST(node->left, transactionID);
else
node->right = insertBST(node->right, transactionID);
return node;
```

```
}

void addBlock(char *data) {
Block *newBlock = (Block *)malloc(sizeof(Block));
newBlock->index = blockchain.length++;
time(&newBlock->timestamp);
strcpy(newBlock->data, data);
sprintf(newBlock->transactionID, "%s-%d", "TRX", newBlock->index);
computeHash(data, newBlock->hash);
newBlock->next = NULL;

if (blockchain.head == NULL) {
strcpy(newBlock->previousHash, "0");
blockchain.head = newBlock;
} else {
Block *current = blockchain.head;
while (current->next != NULL) {
current = current->next;
}
strcpy(newBlock->previousHash, current->hash);
current->next = newBlock;
}
blockchain.root = insertBST(blockchain.root, newBlock->transactionID);  // Insert
into BST
}

void initBankDatabase(BankDatabase *db) {
db->users = NULL;
db->nextAccountNumber = 1;
for (int i = 0; i < TABLE_SIZE; i++) {
db->hashTable[i] = NULL;
}
}

User *createUser(BankDatabase *db, const char *name, const char *mobile, const
char *password, float initialDeposit) {
User *newUser = (User *)malloc(sizeof(User)); // Allocate memory for the new user
if (!newUser) {
// Handle memory allocation failure
return NULL;
}
```

```
sprintf(newUser->accountNumber, "CSAGRP6A%03d", db->nextAccountNumber++); //
Generate an account number
strcpy(newUser->name, name); // Copy name to user struct
strcpy(newUser->mobile, mobile); // Copy mobile number to user struct
strcpy(newUser->password, password); // Copy password to user struct
newUser->balance = initialDeposit; // Set initial deposit as user balance
newUser->next = NULL; // Set the next pointer of the new user to NULL

// If the list is empty, make the new user the head
if (db->users == NULL) {
db->users = newUser;
} else {
// Traverse the list to find the last user
User *current = db->users;
while (current->next != NULL) {
current = current->next;
}
// Append the new user at the end of the list
current->next = newUser;
}

// Calculate the index for the hash table and add the user to the appropriate
bucket
int index = hashFunction(newUser->accountNumber);
newUser->next = db->hashTable[index];
db->hashTable[index] = newUser;

return newUser; // Return a pointer to the newly created user
}



User* findUser(BankDatabase *db, const char* accountNumber) {
int index = hashFunction(accountNumber);
User *current = db->hashTable[index];
while (current) {
if (strcmp(current->accountNumber, accountNumber) == 0) {
return current;
}
current = current->next;
}
```

```
return NULL;
}

void saveUsersToCSV(BankDatabase *db, const char *filename) {
FILE *file = fopen(filename, "w");
if (!file) {
perror("Failed to open file");
return;
}
fprintf(file, "AccountNumber,Name,Mobile,Password,Balance\n");
User *current = db->users;
while (current != NULL) {
fprintf(file, "%s,%s,%s,%s,%.2f\n", current->accountNumber, current->name,
current->mobile, current->password, current->balance);
current = current->next;
}
fclose(file);
}

void loadUsersFromCSV(BankDatabase *db, char *filename) {
FILE *file = fopen(filename, "r");
if (!file) {
file = fopen(filename, "w");
if (!file) {
perror("Failed to create file");
return;
}
fprintf(file, "AccountNumber,Name,Mobile,Password,Balance\n");
fclose(file);
printf("New file created: %s\n", filename);
return;
}

char line[256];
fgets(line, sizeof(line), file); // Skip header
while (fgets(line, sizeof(line), file) != NULL) {
char accountNumber[20], name[100], mobile[20], password[100];
float balance;
sscanf(line, "%[^,],%[^,],%[^,],%[^,],%f", accountNumber, name, mobile, password,
&balance);
User *user = createUser(db, name, mobile, password, balance);
```

```
if (user) {
strcpy(user->accountNumber, accountNumber); // Restore account number directly
}
}
fclose(file);
}

void saveTransactionsToCSV(const char *filename) {
FILE *file = fopen(filename, "w");
if (!file) {
perror("Failed to open file");
return;
}
fprintf(file, "Index,TransactionID,PreviousHash,Timestamp,Data,Hash\n");
Block *current = blockchain.head;
while (current != NULL) {
fprintf(file, "%d,%s,%s,%ld,%s,%s\n", current->index, current->transactionID,
current->previousHash, current->timestamp, current->data, current->hash);
current = current->next;
}
fclose(file);
}

void loadTransactionsFromCSV(const char *filename) {
FILE *file = fopen(filename, "r");
if (!file) {
file = fopen(filename, "w");
if (!file) {
perror("Failed to create file");
return;
}
fprintf(file, "Index,TransactionID,PreviousHash,Timestamp,Data,Hash\n");
fclose(file);
printf("New transactions file created: %s\n", filename);
return;
}

char line[2048];
fgets(line, sizeof(line), file); // Skip header
while (fgets(line, sizeof(line), file) != NULL) {
int index;
```

```
char transactionID[65], previousHash[65], data[1024], hash[65];
long timestamp;
sscanf(line, "%d,%64[^,],%64[^,],%ld,%1023[^,],%64s", &index, transactionID,
previousHash, &timestamp, data, hash);
Block *newBlock = (Block *)malloc(sizeof(Block));
newBlock->index = index;
strcpy(newBlock->transactionID, transactionID);
strcpy(newBlock->previousHash, previousHash);
newBlock->timestamp = timestamp;
strcpy(newBlock->data, data);
strcpy(newBlock->hash, hash);
newBlock->next = blockchain.head;
blockchain.head = newBlock; // prepend to maintain order on reload
}
fclose(file);
}

void printUsers(BankDatabase *db) {
User *current = db->users;

printf("List of Users:\n");
while (current != NULL) {
printf("Account #%s: %s, Mobile: %s, Balance: Rs.%.2f\n", current->accountNumber,
current->name, current->mobile, current->balance);
current = current->next;
}

}

int authenticateUser(BankDatabase *db, const char* accountNumber, const char*
password) {
User *user = findUser(db, accountNumber);
if (user && strcmp(user->password, password) == 0) {
return 1; // Authentication successful
}
return 0; // Authentication failed
}

void transaction(BankDatabase *db, const char* accountNumber, float amount, int
type) {
char password[100];
```

```
printf("Enter password for account %s: ", accountNumber);
scanf("%s", password); // Use scanf("%99s", password) to prevent buffer overflow

if (!authenticateUser(db, accountNumber, password)) {
printf("Authentication failed. Transaction aborted.\n");
return;
}

User *user = findUser(db, accountNumber);
if (user == NULL) {
printf("Account number %s not found.\n", accountNumber);
return;
}

char data[1024];
if (type == 1) { // Deposit
user->balance += amount;
sprintf(data, "Deposited Rs.%.2f to %s. New Balance: Rs.%.2f", amount, user-
>accountNumber, user->balance);
printf("Rs.%.2f deposited to Account #%s. New Balance: Rs.%.2f\n", amount, user-
>accountNumber, user->balance);
} else if (type == 2) { // Withdrawal
if (user->balance >= amount) {
user->balance -= amount;
sprintf(data, "Withdrawn Rs.%.2f from %s. New Balance: Rs.%.2f", amount, user-
>accountNumber, user->balance);
printf("Rs.%.2f withdrawn from Account #%s. New Balance: Rs.%.2f\n", amount,
user->accountNumber, user->balance);
} else {
printf("Insufficient funds for withdrawal.\n");
return;
}
}
addBlock(data);
}

void transfer(BankDatabase *db, char* fromAccount, char* toAccount, float amount)
{
char password[100];
printf("Enter password for account %s: ", fromAccount);
scanf("%s", password); // Use scanf("%99s", password) to prevent buffer overflow
```

```
if (!authenticateUser(db, fromAccount, password)) {
printf("Authentication failed. Transfer aborted.\n");
return;
}

User *fromUser = findUser(db, fromAccount);
User *toUser = findUser(db, toAccount);

if (fromUser == NULL || toUser == NULL) {
printf("One or both account numbers not found.\n");
return;
}

if (fromUser->balance >= amount) {
fromUser->balance -= amount;
toUser->balance += amount;
char data[1024];
sprintf(data, "Transferred Rs.%.2f from %s to %s", amount, fromUser-
>accountNumber, toUser->accountNumber);
printf("Rs.%.2f transferred from Account #%s to Account #%s\n", amount,
fromAccount, toAccount);
addBlock(data);
} else {
printf("Insufficient funds in source account.\n");
}
}

void menu() {
BankDatabase db;
initBankDatabase(&db);
loadUsersFromCSV(&db, "D:\\YASH\\COLLEGE\\ADS\\CP\\Banking System using
Blockchain\\users.csv");
loadTransactionsFromCSV("D:\\YASH\\COLLEGE\\ADS\\CP\\Banking System using
Blockchain\\transactions.csv");

int choice;
char accountNumber[20];
float amount;
char name[100];
char mobile[20];
```

```
char password[100];
char confirmPassword[100];

do {
printf("\n--- Bank Menu ---\n");
printf("1. Create Account\n");
printf("2. Deposit Money\n");
printf("3. Withdraw Money\n");
printf("4. Transfer Money\n");
printf("5. View Accounts\n");
printf("6. Exit\n");
printf("Choose an option: ");
scanf("%d", &choice);

switch (choice) {
case 1:
printf("Enter name: ");
scanf("%s", name); // Use scanf("%99s", name) to prevent buffer overflow
printf("Enter mobile number: ");
scanf("%s", mobile); // Use scanf("%19s", mobile) to prevent buffer overflow
if (strlen(mobile) != 10) {
printf("Error: Mobile number must be exactly 10 digits long.\n");
break; // Break out of the switch-case
}
printf("Create password: ");
scanf("%s", password); // Use scanf("%99s", password) to prevent buffer overflow
printf("Confirm password: ");
scanf("%s", confirmPassword); // Use scanf("%99s", confirmPassword) to prevent
buffer overflow
if (strcmp(password, confirmPassword) != 0) {
printf("Passwords do not match. Account creation failed.\n");
break;
}
printf("Initial deposit: ");
scanf("%f", &amount);

User *user = createUser(&db, name, mobile, password, amount);
if (user) {
printf("Account created successfully. Account Number: %s\n", user-
>accountNumber);
char data[1024];
```

```
sprintf(data, "Created account for %s with initial deposit of Rs.%.2f. Account
Number: %s", name, amount, user->accountNumber);
addBlock(data);
saveUsersToCSV(&db, "D:\\YASH\\COLLEGE\\ADS\\CP\\Banking System using
Blockchain\\users.csv");
saveTransactionsToCSV("D:\\YASH\\COLLEGE\\ADS\\CP\\Banking System using
Blockchain\\transactions.csv");

}
break;
case 2:
printf("Enter account number: ");
scanf("%s", accountNumber);
printf("Enter amount to deposit: ");
scanf("%f", &amount);
transaction(&db, accountNumber, amount, 1);
break;
case 3:
printf("Enter account number: ");
scanf("%s", accountNumber);
printf("Enter amount to withdraw: ");
scanf("%f", &amount);
transaction(&db, accountNumber, amount, 2);
break;
case 4:
{
char toAccount[20];
printf("Enter from account number: ");
scanf("%s", accountNumber);
printf("Enter to account number: ");
scanf("%s", toAccount);
printf("Enter amount to transfer: ");
scanf("%f", &amount);
transfer(&db, accountNumber, toAccount, amount);
saveUsersToCSV(&db, "D:\\YASH\\COLLEGE\\ADS\\CP\\Banking System using
Blockchain\\users.csv");
saveTransactionsToCSV("D:\\YASH\\COLLEGE\\ADS\\CP\\Banking System using
Blockchain\\transactions.csv");
}
break;
case 5:
```

```
printUsers(&db);
break;
case 6:
printf("Exiting and saving data...\n");
saveUsersToCSV(&db, "D:\\YASH\\COLLEGE\\ADS\\CP\\Banking System using
Blockchain\\users.csv");
saveTransactionsToCSV("D:\\YASH\\COLLEGE\\ADS\\CP\\Banking System using
Blockchain\\transactions.csv");
printf("Data saved. Exiting program.\n");
break;
default:
printf("Invalid option.\n");
}
} while (choice != 6);
}

int main() {
blockchain.head = NULL;
blockchain.length = 0;
menu();
return 0;
}
```

6. Output

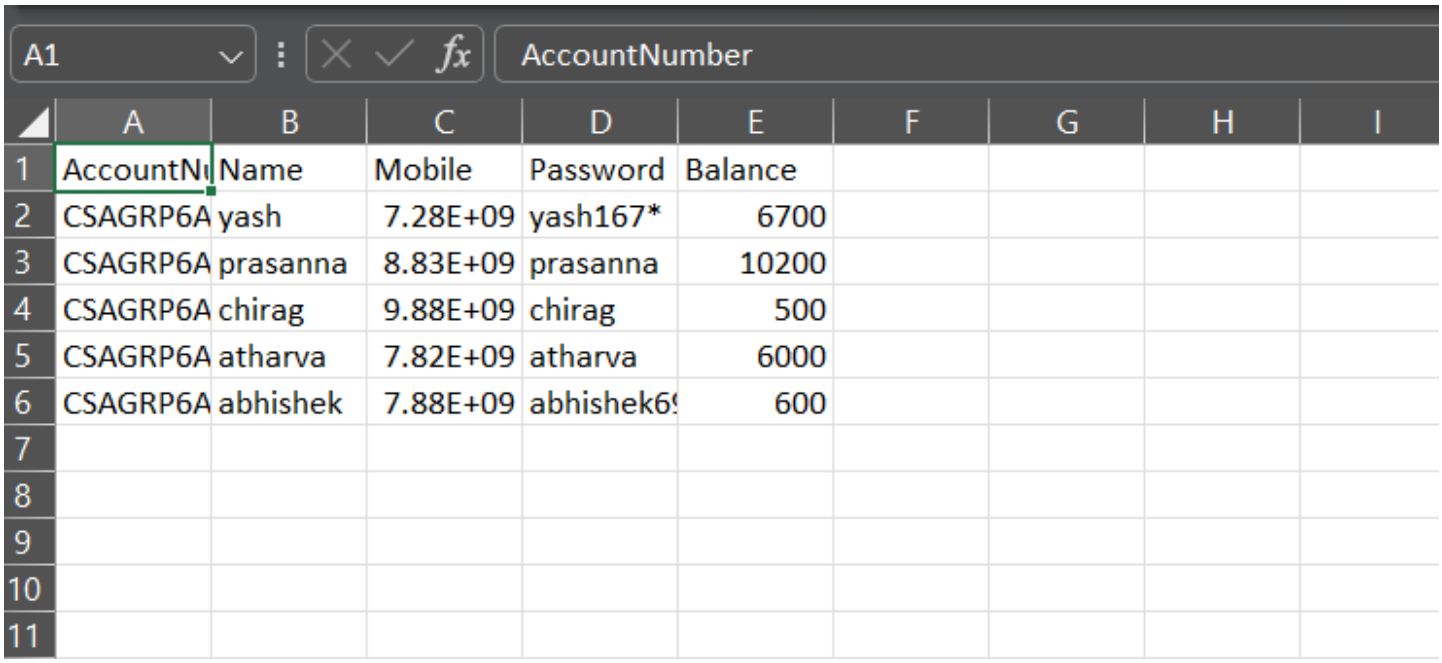
```
--- Bank Menu ---
1. Create Account
2. Deposit Money
3. Withdraw Money
4. Transfer Money
5. View Accounts
6. Exit
Choose an option: 1
Enter name: abhishek
Enter mobile number: 7875590104
Create password: abhishek6919
Confirm password: abhishek6919
Initial deposit: 500
Account created successfully. Account Number: CSAGRP6A005
```

```
--- Bank Menu ---
1. Create Account
2. Deposit Money
3. Withdraw Money
4. Transfer Money
5. View Accounts
6. Exit
Choose an option: 4
Enter from account number: CSAGRP6A001
Enter to account number: CSAGRP6A005
Enter amount to transfer: 100
Enter password for account CSAGRP6A001: yash167*
Rs.100.00 transferred from Account #CSAGRP6A001 to Account #CSAGRP6A005
```

```
--- Bank Menu ---
1. Create Account
2. Deposit Money
3. Withdraw Money
4. Transfer Money
5. View Accounts
6. Exit
Choose an option: 5
List of Users:
Account #CSAGRP6A001: yash, Mobile: 7276480578, Balance: Rs.6700.00
Account #CSAGRP6A002: prasanna, Mobile: 8830198902, Balance: Rs.10200.00
Account #CSAGRP6A003: chirag, Mobile: 9875564231, Balance: Rs.500.00
Account #CSAGRP6A004: atharva, Mobile: 7823495355, Balance: Rs.6000.00
Account #CSAGRP6A005: abhishek, Mobile: 7875590104, Balance: Rs.600.00
```

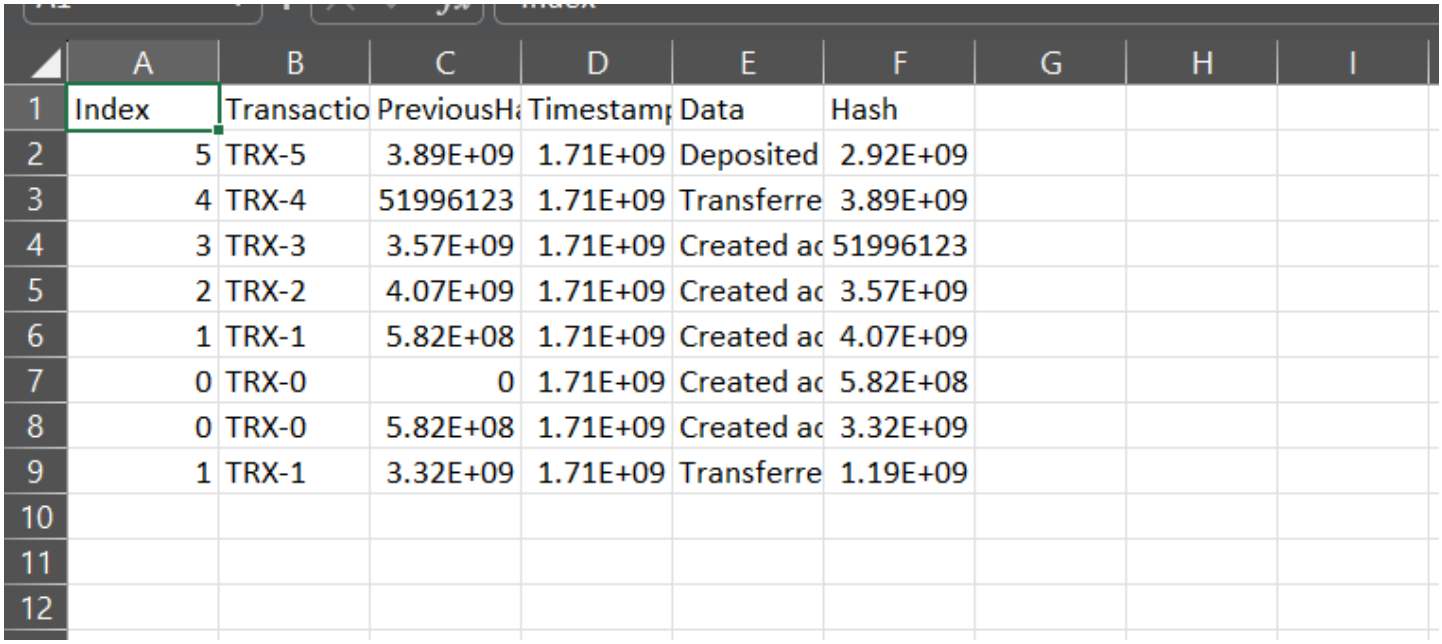
```
--- Bank Menu ---
1. Create Account
2. Deposit Money
3. Withdraw Money
4. Transfer Money
5. View Accounts
6. Exit
Choose an option: 6
Exiting and saving data...
Data saved. Exiting program.

Process returned 0 (0x0)   execution time : 68.079 s
Press any key to continue.
```



A1 | AccountNumber

	A	B	C	D	E	F	G	H	I
1	AccountNu	Name	Mobile	Password	Balance				
2	CSAGRP6A	yash	7.28E+09	yash167*	6700				
3	CSAGRP6A	prasanna	8.83E+09	prasanna	10200				
4	CSAGRP6A	chirag	9.88E+09	chirag	500				
5	CSAGRP6A	atharva	7.82E+09	atharva	6000				
6	CSAGRP6A	abhishek	7.88E+09	abhishek6	600				
7									
8									
9									
10									
11									



	A	B	C	D	E	F	G	H	I
1	Index	Transactio	PreviousHa	Timestamp	Data	Hash			
2	5	TRX-5	3.89E+09	1.71E+09	Deposited	2.92E+09			
3	4	TRX-4	51996123	1.71E+09	Transferre	3.89E+09			
4	3	TRX-3	3.57E+09	1.71E+09	Created ac	51996123			
5	2	TRX-2	4.07E+09	1.71E+09	Created ac	3.57E+09			
6	1	TRX-1	5.82E+08	1.71E+09	Created ac	4.07E+09			
7	0	TRX-0	0	1.71E+09	Created ac	5.82E+08			
8	0	TRX-0	5.82E+08	1.71E+09	Created ac	3.32E+09			
9	1	TRX-1	3.32E+09	1.71E+09	Transferre	1.19E+09			
10									
11									
12									

7. Future Scope

- **Smart Contract Integration**
- **Multi-Currency Support**
- **Enhanced Security Measures**
- **Integration with External Services**
- **Blockchain Interoperability**
- **Enhanced User Experience**
- **Regulatory Compliance Enhancements**
- **Data Analytics and Reporting**