21IT077

IMPLEMENTATION OF RSA, DIFFIE HELLMAN AND MAN-IN-THE-MIDDLE ATTACK

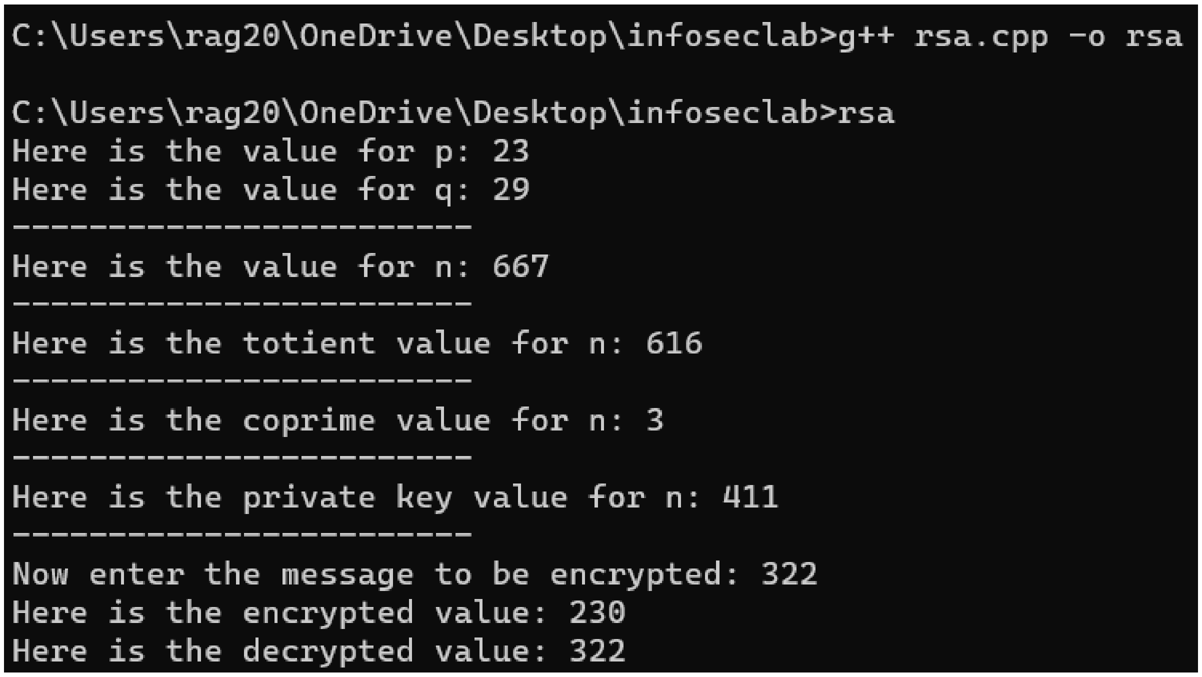
AIM: To implement RSA public-key cryptosystem, Diffie Hellman Key technique and the Man-in-the-middle attack.

CODE:

RSA (Rivest, Shamir, and Adleman) Cryptosystem

```
#include <iostream>
#include <cstdlib>
#include <cmath>
#include <math.h>
#include <set>
using namespace std;

bool isPrime(int num) {
    if (num <= 1)
        return false;
    for (int i = 2; i <= sqrt(num); i++) {
        if (num % i == 0) {
            return false;
        }
    }
    return true;
}

int generatePrime() {
    int num;
    while (true) {
        num=rand()%415+1;
        if (isPrime(num)) {
            return num;
        }
    }
}

int gcd(int a, int b) {
    if (b == 0)
        return a;
    return gcd(b, a % b);
}

int coprime(int n){
    int flag=0;
    for(int i=3;i<n;i++){
        if(gcd(n,i)==1){
            return i;
            break;
        }
    }
    return 0;
}

int privateKey(int copr, int tot){
    //e x d === 1 mod tot value
    for(int i=2;i<=1000000;i++){
        int val=(copr*i)%tot;
        if(val==1){
            return i;
            break;
        }
        else continue;
    }
    return 0;
}

int modExp(int base, int exponent, int modulus) {
    int result = 1;
    base = base % modulus;
    while (exponent > 0) {
        if (exponent % 2 == 1) {
            result = (result * base) % modulus;
        }
        exponent = exponent >> 1;
        base = (base * base) % modulus;
    }
    return result;
}

int main(){

    int p=generatePrime();
    p=23;
    int q=generatePrime();
    q=29;
    cout << "Here is the value for p: " << p << endl;
    cout << "Here is the value for q: " << q << endl;
    cout << "------------------------" << endl;
    int n=p*q;
    cout << "Here is the value for n: " << n << endl;
    cout << "------------------------" << endl;
    int tot=(p-1)*(q-1);
    cout << "Here is the totient value for n: " << tot << endl;
    cout << "------------------------" << endl;
    int copr=coprime(n);
    cout << "Here is the coprime value for n: " << copr << endl;
    cout << "------------------------" << endl;
    int privKey=privateKey(copr,tot);
    cout << "Here is the private key value for n: " << privKey << endl;
    cout << "------------------------" << endl;
    cout << "Now enter the message to be encrypted: "; int m;
    cin >> m;
    int encryption=modExp(m,copr,n);
    int decryption=modExp(encryption,privKey,n);
    cout << "Here is the encrypted value: " << encryption << endl;
    cout << "Here is the decrypted value: " << decryption << endl;
}
```

OUTPUT:

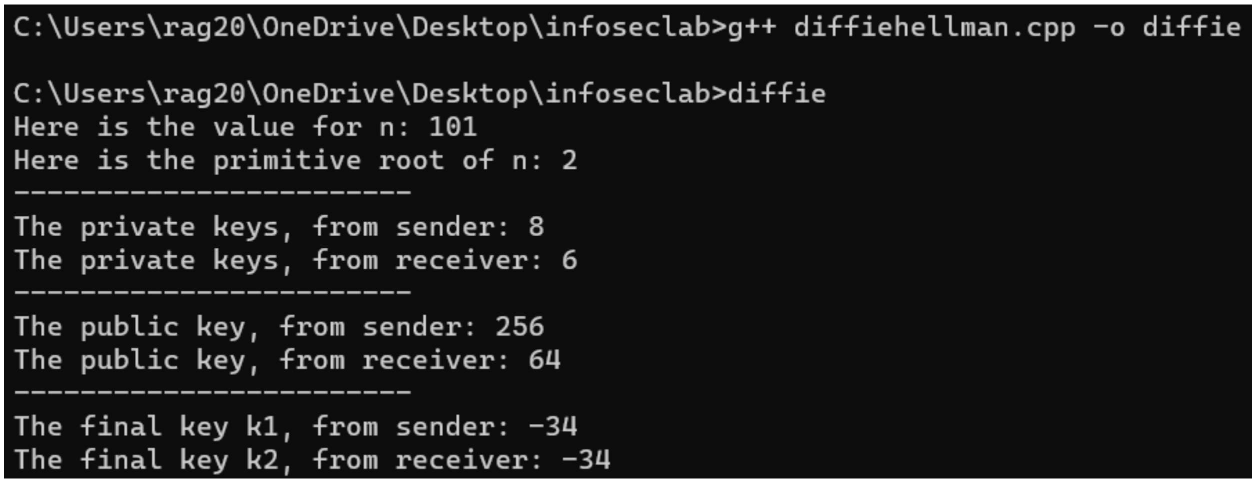


```
C:\Users\rag20\OneDrive\Desktop\infoseclab>g++ rsa.cpp -o rsa

C:\Users\rag20\OneDrive\Desktop\infoseclab>rsa
Here is the value for p: 23
Here is the value for q: 29
------------------------
Here is the value for n: 667
------------------------
Here is the totient value for n: 616
------------------------
Here is the coprime value for n: 3
------------------------
Here is the private key value for n: 411
------------------------
Now enter the message to be encrypted: 322
Here is the encrypted value: 230
Here is the decrypted value: 322
```

DIFFIE-HELLMAN KEY TECHNIQUE

```
#include <iostream>
#include <cstdlib>
#include <cmath>
#include <math.h>
#include <set>
#include <iostream>
#include <fstream>
using namespace std;

//To generate a prime number, i.e., n
bool isPrime(int num) {
    if (num <= 1)
        return false;
    for (int i = 2; i <= sqrt(num); i++) {
        if (num % i == 0) {
            return false;
        }
    }
    return true;
}

int generatePrime() {
    int num;
    while (true) {
        num=rand()%40+100;
        if (isPrime(num)) {
            return num;
        }
    }
}

// To find the primitive root, i.e., p
int gcd(int a, int b) {
    if (b == 0)
        return a;
    return gcd(b, a % b);
}

int findPrimitiveRoot(int n) {
    if (n <= 2)
        return -1; // No primitive root exists for n<=2

    int totient = n - 1;
    std::set<int> factors;

    // Find all prime factors of totient
    int temp = totient;
    for (int i = 2; i <= sqrt(temp); i++) {
        while (temp % i == 0) {
            factors.insert(i);
            temp /= i;
        }
    }
    if (temp > 1)
        factors.insert(temp);

    // Check potential primitive roots
    for (int i = 2; i <= n; i++) {
        bool isPrimitiveRoot = true;
        for (auto factor : factors) {
            if (gcd(i, totient / factor) == 1) {
                isPrimitiveRoot = false;
                break;
            }
        }
        if (isPrimitiveRoot)
            return i;
    }

    return -1; // No primitive root found
}

int main() {

    //Create an output stream object
    std::ofstream outputfile;
    outputfile.open("actuallog.txt");

    // Generate a prime number
    int n = generatePrime();
    cout << "Here is the value for n: " << n << endl;

    // Generate the primitive root of n
    int p = findPrimitiveRoot(n);
    cout << "Here is the primitive root of n: " << p << endl;
    cout << "------------------------" << endl;

    //Now to generate two keys, one for the sender and another for the receiver
    int X=rand()%21;
    int Y=rand()%56;
    cout << "The private keys, from sender: " << X << endl;
    cout << "The private keys, from receiver: " << Y << endl;
    cout << "------------------------" << endl;

    //Public key generation, i.e., A and B
    int A=(int)pow(p,(X%n));
    int B=(int)pow(p,(Y%n));
    cout << "The public key, from sender: " << A << endl;
    outputfile << A << std::endl;
    cout << "The public key, from receiver: " << B << endl;
    outputfile << B << std::endl;
    cout << "------------------------" << endl;

    //Final key generation, k1 and k2
    int k_A=((int)(pow(B,X))%n);
    int k_B=((int)(pow(A,Y))%n);
    cout << "The final key k1, from sender: " << k_A << endl;
    cout << "The final key k2, from receiver: " << k_B << endl;
    cout << "------------------------" << endl;

    outputfile.close();
}
```

OUTPUT:

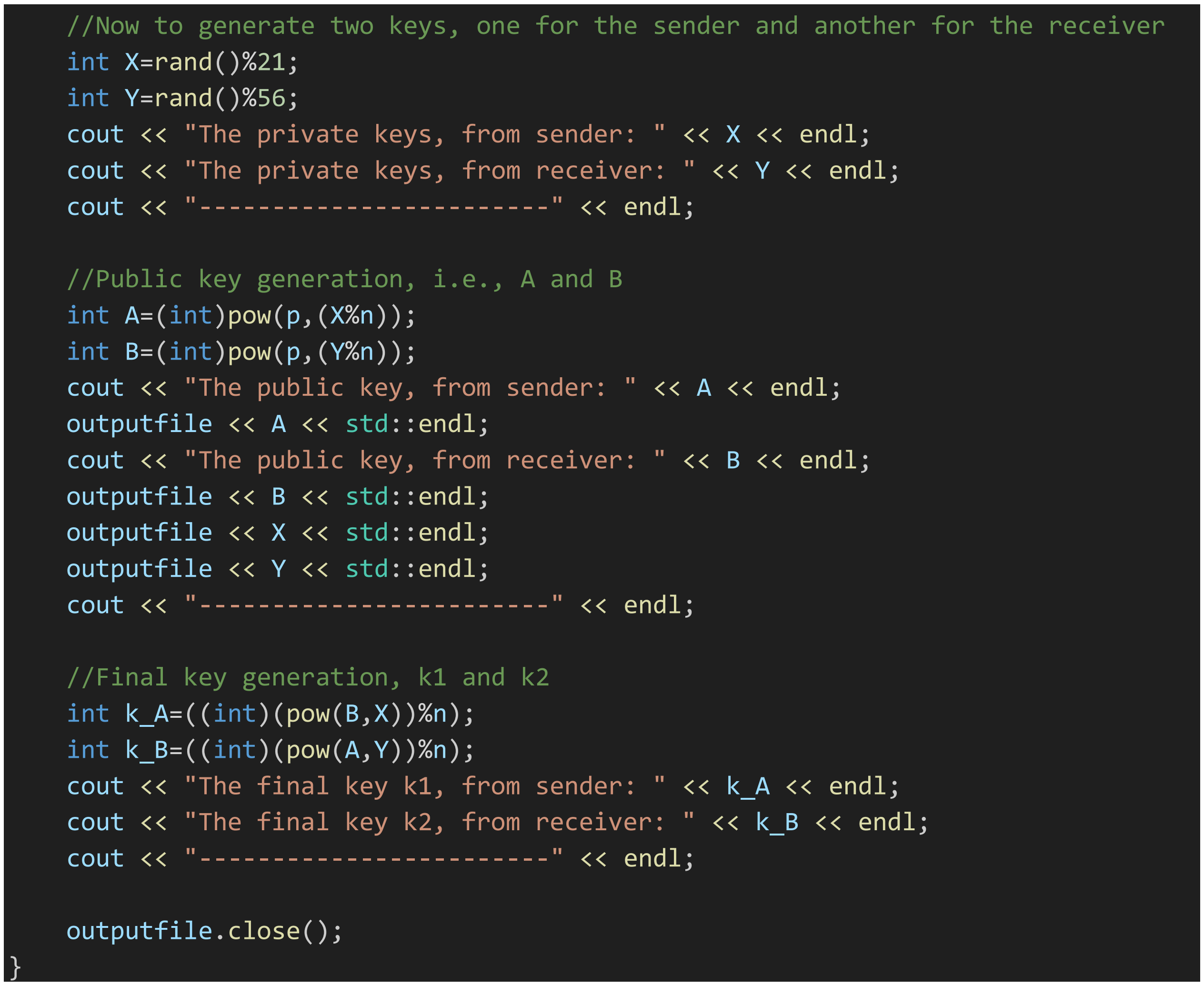


```
C:\Users\rag20\OneDrive\Desktop\infoseclab>g++ diffiehellman.cpp -o diffie

C:\Users\rag20\OneDrive\Desktop\infoseclab>diffie
Here is the value for n: 101
Here is the primitive root of n: 2
------------------------
The private keys, from sender: 8
The private keys, from receiver: 6
------------------------
The public key, from sender: 256
The public key, from receiver: 64
------------------------
The final key k1, from sender: -34
The final key k2, from receiver: -34
```

MAN-IN-THE-MIDDLE ATTACK (ON DIFFIE HELLMAN)

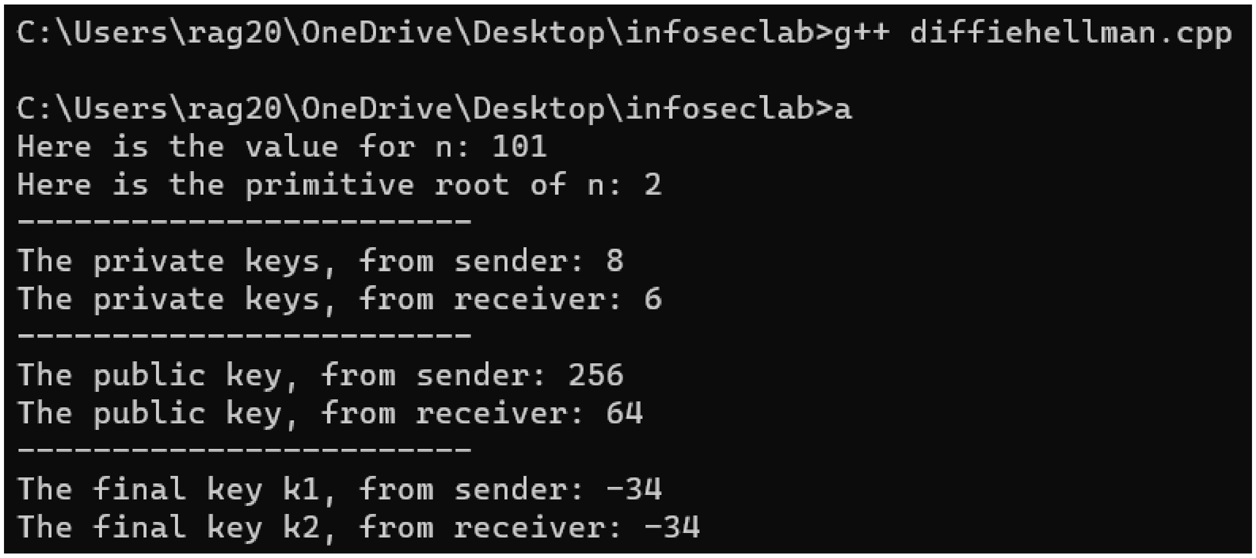
(authentic encryption process)

```cpp
#include <iostream>
#include <cstdlib>
#include <cmath>
#include <math.h>
#include <set>
#include <iostream>
#include <fstream>
using namespace std;

//To generate a prime number, i.e., n
bool isPrime(int num) {
    if (num <= 1)
        return false;
    for (int i = 2; i <= sqrt(num); i++) {
        if (num % i == 0) {
            return false;
        }
    }
    return true;
}

int generatePrime() {
    int num;
    while (true) {
        num=rand()%40+100;
        if (isPrime(num)) {
            return num;
        }
    }
}

// To find the primitive root, i.e., p
int gcd(int a, int b) {
    if (b == 0)
        return a;
    return gcd(b, a % b);
}

int findPrimitiveRoot(int n) {
    if (n <= 2)
        return -1; // No primitive root exists for n<=2
    int totient = n - 1;
    std::set<int> factors;

    // Find all prime factors of totient
    int temp = totient;
    for (int i = 2; i <= sqrt(temp); i++) {
        while (temp % i == 0) {
            factors.insert(i);
            temp /= i;
        }
    }
    if (temp > 1)
        factors.insert(temp);

    // Check potential primitive roots
    for (int i = 2; i <= n; i++) {
        bool isPrimitiveRoot = true;
        for (auto factor : factors) {
            if (gcd(i, totient / factor) == 1) {
                isPrimitiveRoot = false;
                break;
            }
        }
        if (isPrimitiveRoot)
            return i;
    }

    return -1; // No primitive root found
}

int main() {

    //Create an output stream object
    std::ofstream outputfile;
    outputfile.open("actuallog.txt");

    // Generate a prime number
    int n = generatePrime();
    cout << "Here is the value for n: " << n << endl;

    // Generate the primitive root of n
    int p = findPrimitiveRoot(n);
    cout << "Here is the primitive root of n: " << p << endl;
    cout << "-------------------------" << endl;
```



```
    //Now to generate two keys, one for the sender and another for the receiver
    int X=rand()%21;
    int Y=rand()%56;
    cout << "The private keys, from sender: " << X << endl;
    cout << "The private keys, from receiver: " << Y << endl;
    cout << "------------------------" << endl;

    //Public key generation, i.e., A and B
    int A=(int)pow(p,(X%n));
    int B=(int)pow(p,(Y%n));
    cout << "The public key, from sender: " << A << endl;
    outputfile << A << std::endl;
    cout << "The public key, from receiver: " << B << endl;
    outputfile << B << std::endl;
    outputfile << X << std::endl;
    outputfile << Y << std::endl;
    cout << "------------------------" << endl;

    //Final key generation, k1 and k2
    int k_A=((int)(pow(B,X))%n);
    int k_B=((int)(pow(A,Y))%n);
    cout << "The final key k1, from sender: " << k_A << endl;
    cout << "The final key k2, from receiver: " << k_B << endl;
    cout << "------------------------" << endl;

    outputfile.close();
}
```

OUTPUT:



```
C:\Users\rag20\OneDrive\Desktop\infoseclab>g++ diffiehellman.cpp

C:\Users\rag20\OneDrive\Desktop\infoseclab>a
Here is the value for n: 101
Here is the primitive root of n: 2
------------------------
The private keys, from sender: 8
The private keys, from receiver: 6
------------------------
The public key, from sender: 256
The public key, from receiver: 64
------------------------
The final key k1, from sender: -34
The final key k2, from receiver: -34
```

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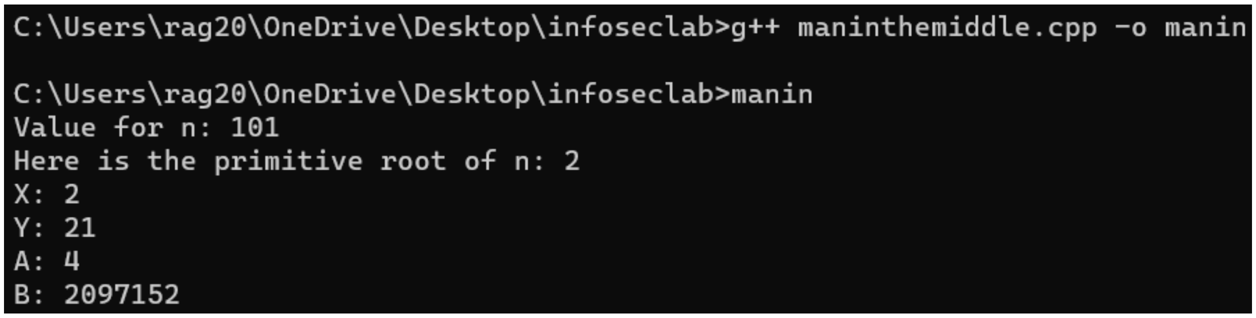
(attacker)

```
#include <iostream>
#include <cstdlib>
#include <cmath>
#include <math.h>
#include <set>
#include <iostream>
#include <fstream>
using namespace std;

bool isPrime(int num); // Function prototype

int generatePrime() {
    int num;
    while (true) {
        num = rand()%40 + 100;
        if (isPrime(num)) {
            return num;
        }
    }
}

bool isPrime(int num) {
    if (num <= 1)
        return false;
    for (int i = 2; i <= sqrt(num); i++) {
        if (num % i == 0) {
            return false;
        }
    }
    return true;
}

int gcd(int a, int b) {
    if (b == 0)
        return a;
    return gcd(b, a % b);
}

int findPrimitiveRoot(int n) {
    if (n <= 2)
        return -1; // No primitive root exists for n<=2

    int totient = n - 1;
```

```cpp
    std::set<int> factors;

    // Find all prime factors of totient
    int temp = totient;
    for (int i = 2; i <= sqrt(temp); i++) {
        while (temp % i == 0) {
            factors.insert(i);
            temp /= i;
        }
    }
    if (temp > 1)
        factors.insert(temp);

    // Check potential primitive roots
    for (int i = 2; i <= n; i++) {
        bool isPrimitiveRoot = true;
        for (auto factor : factors) {
            if (gcd(i, totient / factor) == 1) {
                isPrimitiveRoot = false;
                break;
            }
        }
        if (isPrimitiveRoot)
            return i;
    }

    return -1; // No primitive root found
}

int main() {
    int n = generatePrime();
    cout << "Value for n: " << n << endl;
    int p = findPrimitiveRoot(n);
    cout << "Here is the primitive root of n: " << p << endl;
    int X=rand()%15;
    int Y=rand()%59;
    cout << "X: " << X << endl;
    cout << "Y: " << Y << endl;
    int A=(int)pow(p,(X%n));
    int B=(int)pow(p,(Y%n));
    cout << "A: " << A << endl;
    cout << "B: " << B << endl;
    cout << "------------------------" << endl;

    //Public Keys A and B need to be inserted in another txt file
    std::ofstream outputfile("attackerlog.txt");
    outputfile << A << endl << B <<endl;
    outputfile << X << endl << Y <<endl;

    //Man-in-the-middle attack demonstrated now
    //Both public keys are available to the attacker
    //From the log.txt file

    std::ifstream inputfile("actuallog.txt");
    int value1,value2,cmpr1,cmpr2;
    inputfile >> value1;
    inputfile >> value2;

    //Successfully retrieved the public keys (A and B of the other side)

}
```

OUTPUT:



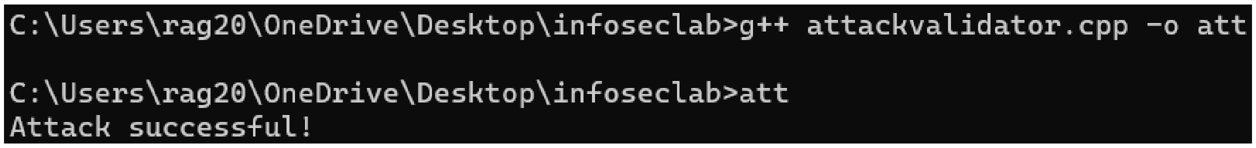
```
C:\Users\rag20\OneDrive\Desktop\infoseclab>g++ maninthemiddle.cpp -o manin

C:\Users\rag20\OneDrive\Desktop\infoseclab>manin
Value for n: 101
Here is the primitive root of n: 2
X: 2
Y: 21
A: 4
B: 2097152
```

(attackvalidator – attacker side program)

```
#include <iostream>
#include <cstdlib>
#include <cmath>
#include <math.h>
#include <iostream>
#include <fstream>
using namespace std;

int AfromActual,BfromActual,XfromActual,YfromActual;
int AfromAttacker,BfromAttacker,XfromAttacker,YfromAttacker;

void func1(){
std::ifstream inputfile("actuallog.txt");
```

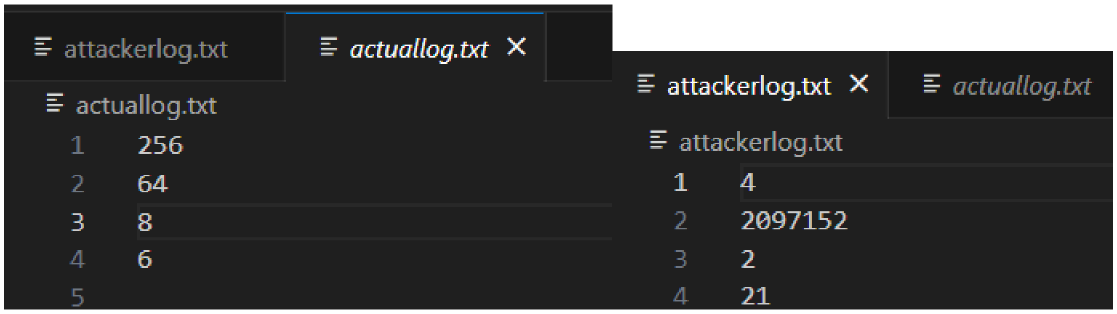
```
    inputfile >> AfromActual;
    inputfile >> BfromActual;
    inputfile >> XfromActual;
    inputfile >> YfromActual;
    inputfile.close();
}
void func2(){
std::ifstream inputfile2("attackerlog.txt");
    inputfile2 >> AfromAttacker;
    inputfile2 >> BfromAttacker;
    inputfile2 >> XfromAttacker;
    inputfile2 >> YfromAttacker;
    inputfile2.close();
}

int main(){
    //Set the values to the global variables defined above
    func1();
    func2();
    //Now to calculate the keys
    int keyOneofActual=((int)(pow(BfromAttacker,XfromActual))%101);
    int keyTwoofAttacker=((int)(pow(AfromActual,YfromAttacker))%101);
    bool flag=false; //Attack set unsuccessful
    if(keyOneofActual == keyTwoofAttacker){
        flag=true;
    }
    int keyOneofAttacker=((int)(pow(BfromActual,XfromAttacker))%101);
    int keyTwoofActual=((int)(pow(AfromAttacker,YfromActual))%101);
    if(keyOneofAttacker!=keyTwoofActual){
        flag=false;
    }
    if(flag){
        cout << "Attack successful!";
    }
    else{
        cout << "Keys not matched. Attack unsuccessful.";
    }
}
```

OUTPUT:



```
C:\Users\rag20\OneDrive\Desktop\infoseclab>g++ attackvalidator.cpp -o att

C:\Users\rag20\OneDrive\Desktop\infoseclab>att
Attack successful!
```

(log files)



actuallog.txt
```
256
64
8
6

```

attackerlog.txt
```
4
2097152
2
21
```

RESULT:

Thus, RSA public-key cryptosystem, Diffie Hellman Key technique and the Man-in-the-middle attack have been implemented accordingly.