DAT 510: Assignment 2

Submission Deadline 23:59, Tuesday, 13th October, 2020

Implement Secure Communications

In this project, you will implement a secure communication scenario, which utilizes crypto-graphic primitives in a similar but rather simplified way as the real-world applications.

Part1: After learned the subject of cryptography, Alice and Bob decide to secure their communications with three types of cryptographic primitives: symmetric ciphers, pseudo-random generators and public-key cryptography (PKC)-based key exchange protocol. Below is their step-by-step procedure for realizing secure communications:

Step 1. Alice and Bob agree on the global parameters for DH-like key exchange: the cyclic group G = <g> they will use. E.g. a cyclic group Z_p with generator g = 2 (choose prime as p = 2q + 1 from a prime), or a cyclic group generated from an elliptic curve E. (refer to the textbook)

Step 2. Following Diffie-Hellman's key exchange scheme, Alice and Bob generate their own key pairs (PR_a , PU_a) and (PR_b; PU_b) separately

Step 3. Alice sends her public key PU_a to Bob, and Bob sends his public key PU_b to Alice;

Step 4. Alice generates a shared key K_{ab}, so does Bob;

Step 5. Alice and Bob are concerned about the strength of the shared key K_{ab}, so they agreed to use a same cryptographically strong pseudo-random number generator (CSPRNG), which takes K_{ab} as the seed, to generate a secret key K for subsequent encryption/decryption.

Step 6. Alice chooses a symmetric cipher to encrypt her file with the key K, and sends the encrypted file over public channel (e.g., Internet) to Bob;

Step 7. Upon receiving the encrypted file from Alice, Bob use the same key K and symmetric cipher to decrypt it and obtain Alice's file in the clear plain form;

Step 8. Both Alice and Bob are happy with their achievement: keep their communications confidential from adversaries in the middle.

The above process is illustrated in Figure 1. In this assignment, you are asked to implement this process for Alice and Bob with the cryptographic primitives you have learned. Generally speaking, your program will be composed of three main components:

1. **Key Exchange**: such as DH's scheme, elliptic curve-based DH's scheme
2. **CSPRNG**: such as BBS generator, RC4 and block-cipher based PRNG
3. **Symmetric Cipher**: such as DES, 3DES, AES and SDES, TripleSDES in Previous Assignment

You are free to choose your favourite ones or design them by yourself.

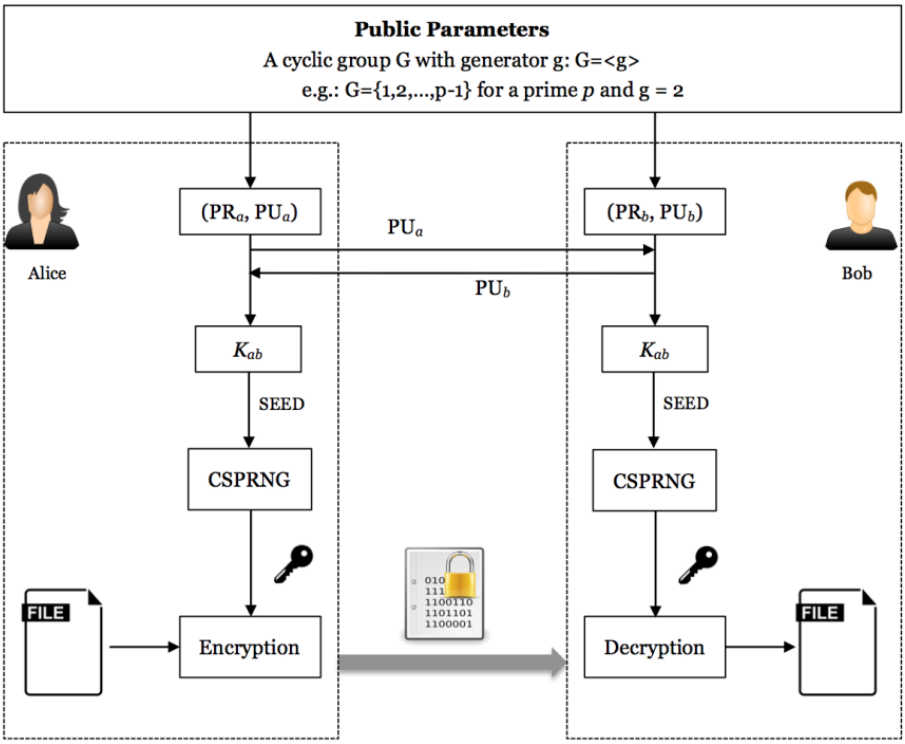


Figure 1: Secure Communications for Alice and Bob

Your program should:

- display the following information:

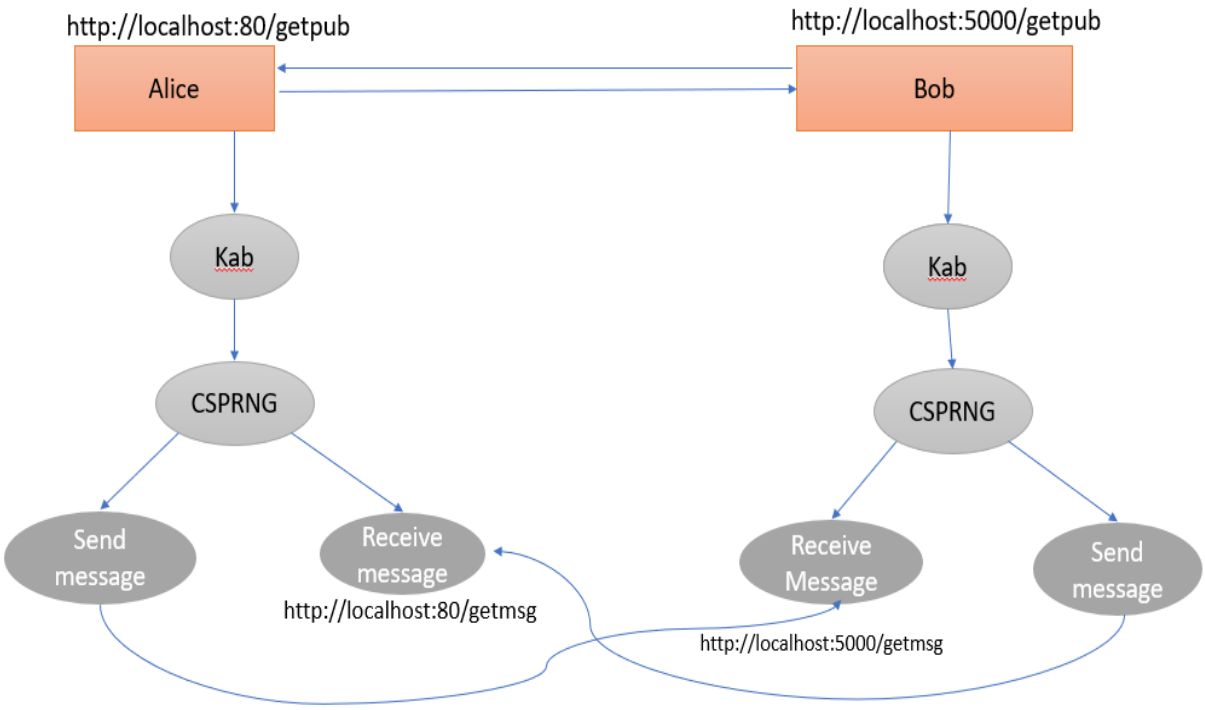
  - the cyclic group and public parameters you use in the logs :
  - the public keys of Alice and Bob;
  - the key K_{ab} shared by Alice and Bob;
  - the secret key K that will be used for encryption and decryption;

- the parameters and keys should be in the form of either decimal or hexadecimal;
- take input from Alice for encryption, the format for encryption can be binary/character string, files, etc.
- take input from Bob for decryption, the format for decryption can be binary/text file; show Bob can decrypt Alice's encrypted file as expected. namely, show

  $Dec(Enc(IN_a, K), K) = IN_A$, where IN_A represents Alice's input file;

- You are allowed to use existing libraries of Symmetric Ciphers (such as SDES, TripleSDES which you have implemented in Assignment 1, or 3DES, AES in built-in libraries)
- not allowed to use libraries for CSPRNG and DH Key Exchange (you have to implement them by yourself);

Part2: You have implemented a simple web server in Assignment1 which receives ciphers and decrypts it based on the previously saved keys. However, in most real-world applications it is common for the key to be decided by both parties at the time of connection using the Key exchange methods. In this part you will use the Program You made in Part1 to expand your web server to exchange keys before connecting and send data using the acquired key. Alice and Bob would each run an instance of the program and try to exchange keys at first. Later on, they will start to send and receive data using the key. Here is a guide about how your final application can look and how the nodes can connect.



You are free to choose your design for the program as long as it meets the following results :

- Alice and Bob trying to find other party and share the public key generated by them.
- Both parties send and receive data (you can send strings, files, photos …) and show the result in the other side.
- Each side can be allocated sample demo data so that whenever they connect they can send it to the other side using the key generated and agreed by both of them.

Assignment Submission

Deadline: 23:5**9, Tuesday ,** Oct**.** 13**,** 2020 **(**submit your assignment through can**v**as**)** Final submission:

1. Source Code

   Source code submitted for the assignment should be your own code. If you have usesources from the internet everything should be added to the references. If you used someone's code without reference, that will also be treated as plagarism.

   Source code should be single, compressed directory in .tar.gz or .zip format.

   Directory should contain a le called **README** that describes the contents of the directory and any special instructions needed to run your programs (i.e. if it requires and packages, commands to install the package. describe any command-line arguments with the required parameters).

   You may use any reasonable programming language for the assignment. Reasonable languages include: Java, C, C++, Python, Javascript, R, Go and others with permission from Sohrab Chalishhafshejani (s.chalishhafshejani@stud.uis.no) or Dhanya Therese Jose (Email: dhanya.t.jose@uis.no)

You should NOT use available libraries/packages/classes for implementing the core functionality of the assignment.

2. A separate report with PDF format

   Texts in the report should be readable by human, and recognizable by machine; Other formats will NOT be opened, read, and will be considered missing;

   Report should follow the formal report style guide in next page.

   Each student should write an individual report. Each report will be checked for plagiarism. If it is copied from somewhere else, you will fail the assignment.

3. A presentation on the PowerPoint including your voiceover describing the steps and challenges during implementation of each part. This should not be more than 10 minutes and you can include parts of your code and explain what you have done. (**DO NOT** upload videos directly to canvas. Please upload in platforms like OneDrive , Google Drive , . . . and present the link to the video when submitting)

NOTE: If you encounter problem with upload archive le (e.g. *.zip, *.tar) to the website https://uis.instructure.com/, you should be able to upload after you add extention .txt to your achieve le (e.g., *.tar) *.tar.txt).

Note: The assignment is individual and can NOT be solved in groups.

Project Title

Abstract

A one-paragraph summary of the entire assignment - your choices of cryptographic primitives and their parameters, procedure, test results, and analysis.

Introduction

A description of the scientific background for your project, including previous work that your project builds on. (Remember to cite your sources!) The final sentence (analogous to the thesis statement in a term paper) is the objective of your experiment.

Design and Implementation

A detailed description (in paragraph format) of the design, procedure, and implementation of your project. This should be the main part of the report.

Test Results

Results of testing the software, as you observed/recorded them. Note that this section is only for observations you make during testing. Your analysis belongs in the Discussion section.

Discussion

Your analysis of what your testing results mean, and your analysis.

Conclusion

A short paragraph that restates the objective from your introduction and relates it to your results and discussion, and describes any future improvements that you would recommend. Works Cited A bibliography of all of the sources you got information from in your report.