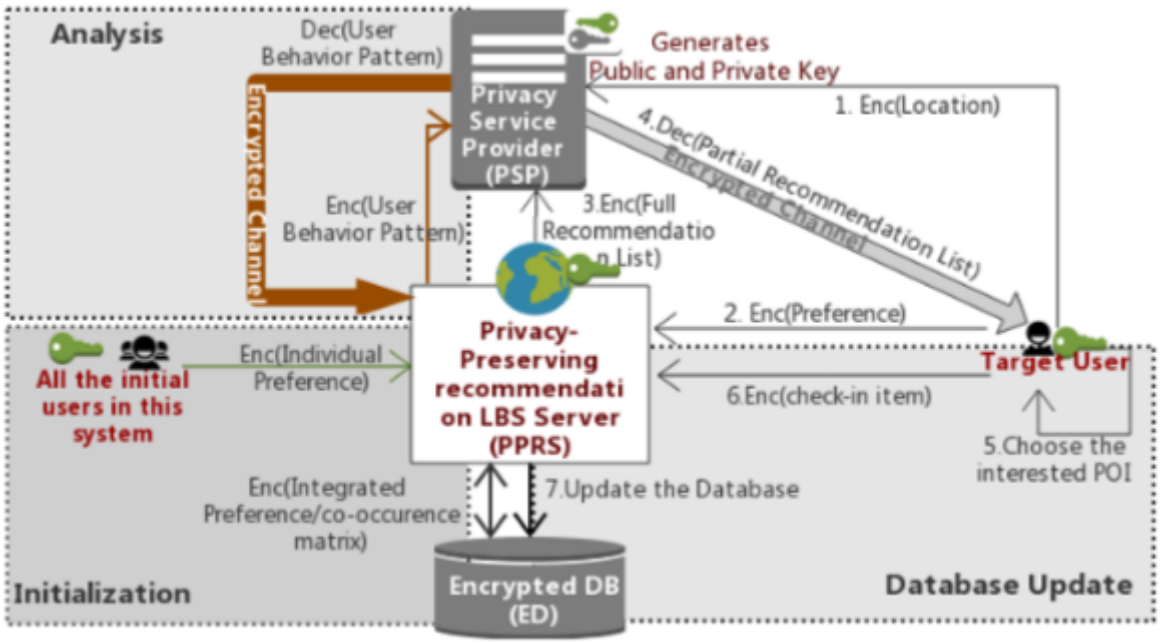
Privacy-Preserving Recommendation for Location-Based Services with Fully Homomorphic Encryption

Implementation of the protocol with the functions:

1. Compute aggregate information concerning user behavior patterns homomorphically while maintaining the privacy of individual users.
2. Encrypted database update.



Prerequisites

- CentOS 7.3
- Linux Kernel 3.10.0
- glibc 2.17
- g++ 4.8.5
- cmake >=2.8
- HElib
- doxygen (If you generate a document)

Building

1. Build HElib, then you copy the HELib top directory to `/usr/local/src/HElib`.
2. Run following command to build the library.

```
$ mkdir build && cd build
$ cmake ..
$ make
```

- Generated files

File	Content
lbsr/lbsr_psp/liblbsr_psp.so	PSP library

File	Content
lbsr/lbsr_pprs/liblbsr_pprs.so	PPRS library
lbsr/lbsr_client/liblbsr_client.so	Client(Target User) library
stdsc/stdsc/libstdsc.so	stdsc library
demo/psp/psp	PSP demo app
demo/pprs/pprs	PPRS demo app
demo/client/client	Client(Target User) demo app

API Reference

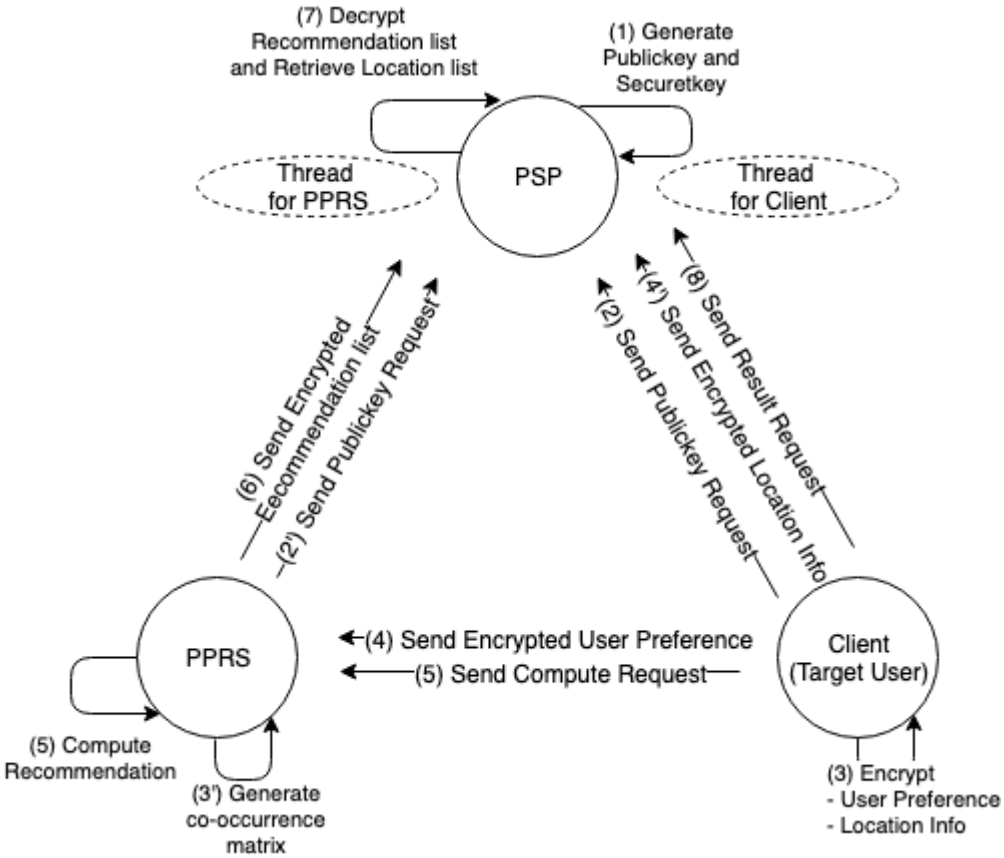
- Run following command to build the documentation.

```
$ cd doc && doxygen
```

- see `doc/html/index.html`

Demo

Demo app consists of three processes: PSP, PPRS and Client(Target User). These processes communicate as shown in the following figure.



PSP demo app

- Behavior
  - If the `-g` option is specified, PSP generates a Public Key file with the file name specified by `pubkey_filename` and a Secret Key file with file name specified by `seckey_filename`. (Fig: (1))

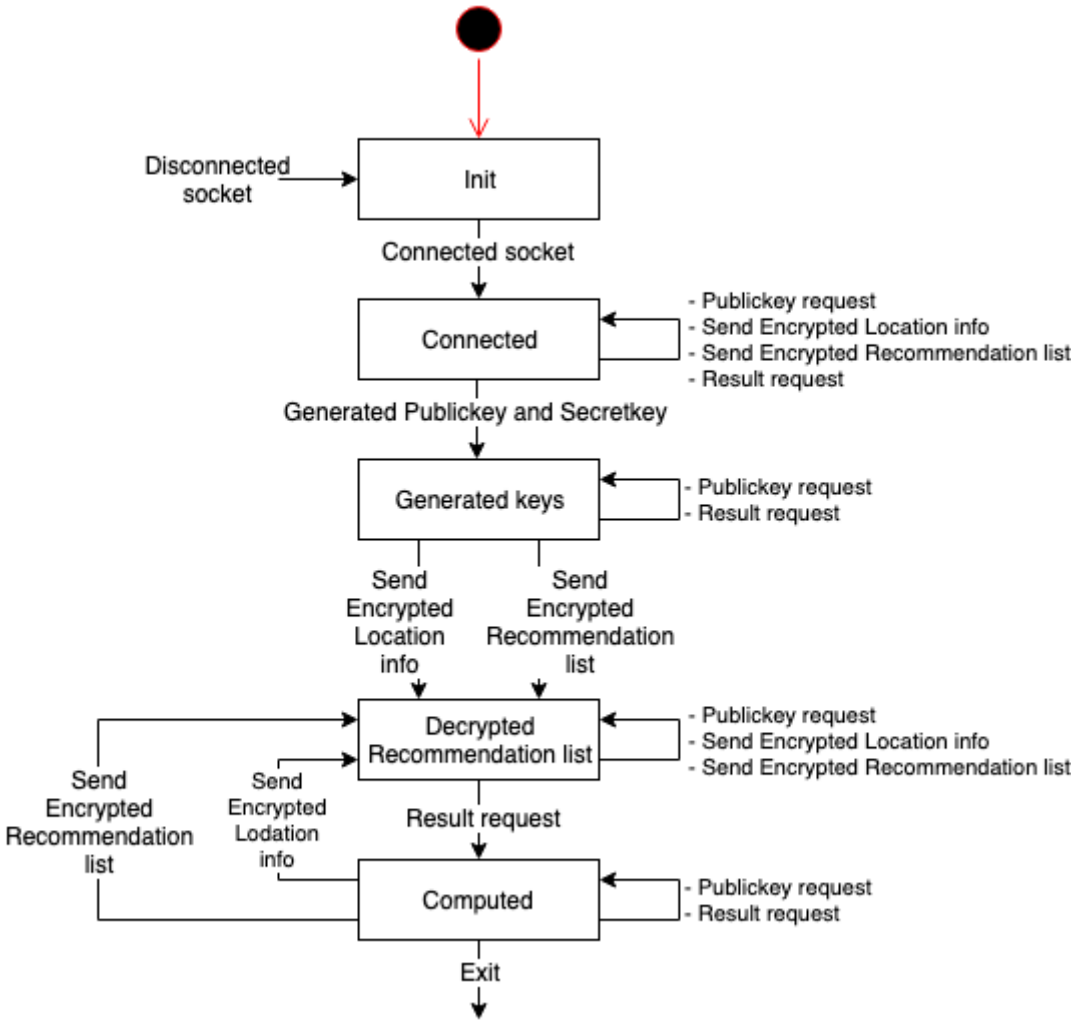
- PSP receives public key request from Client, then return the public key to Client. (Fig: (2))
- PSP receives encryped location info from Client. (Fig: (4'))
- PSP receives result request from Client, then decrypt recommendation list and retrieve location info and return the result to Clinet. (Fig: (8))

- Usage

```
Usage: ./psp [-p pubkey_filename] [-s seckey_filename] [-g]
```

  - -p pubkey_filename : file path of public key file (REQUIRED)
  - -s seckey_filename : file path of secret key file (REQUIRED)
  - -g : if this option is specified, it generates a public Key file and a secret Key file. (OPTINAL)

- State Transition Diagram



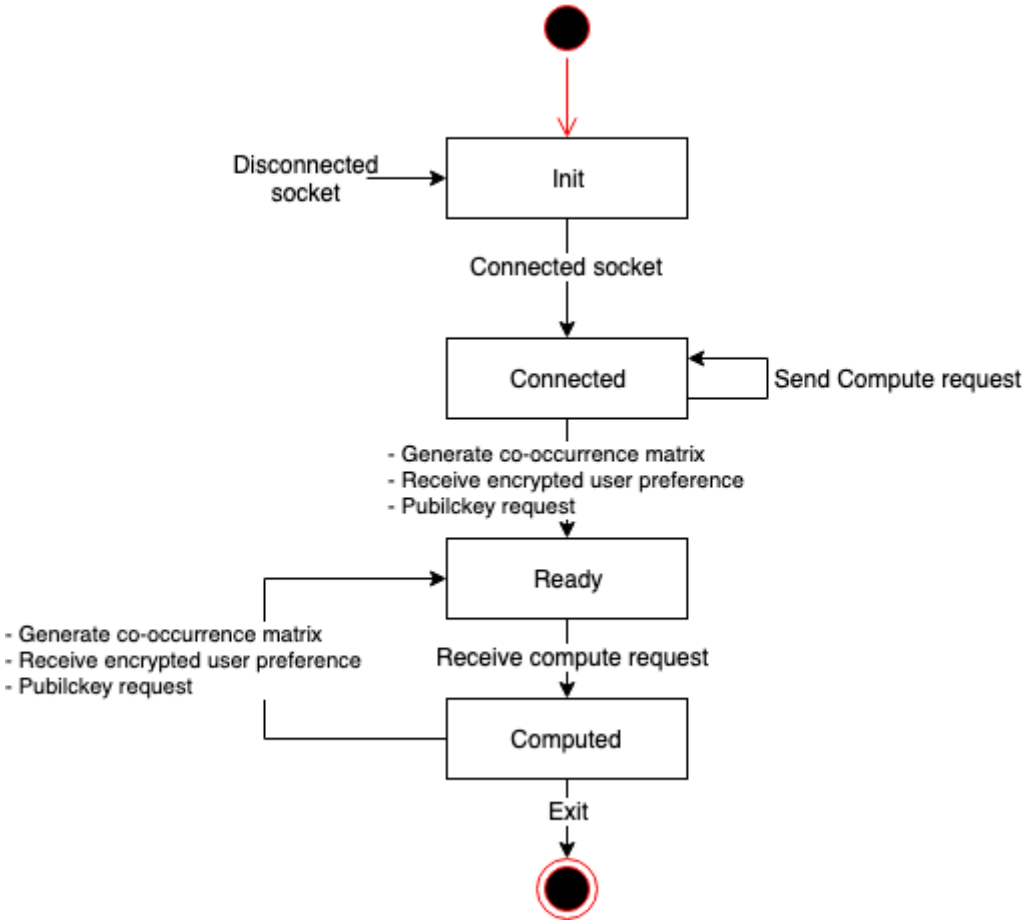
PPRS demo app

- Behavior
  - PPRS sends public key request to PSP, then receives the public key from PSP and save it named `pubkey.txt`. (Fig: (2'))
  - PPRS generates a co-occurrence matrix file named `enc_cooccurrence.txt`. (Fig: (3'))
  - PPRS receives encryped user preference from Client and save it named 'enc_preference.txt`. (Fig: (4))
  - PPRS receives compute request from Client, then compute recommendation and send the result to PSP. (Fig: (5)(6))
- Usage

```
Usage: ./pprs [-i input_filename]
```

- -i input_filename : file path of input data (REQUIRED)

- State Transition Diagram



Client demo app

- Behavior
  - Client sends public key request to PSP, then receives the public key from PSP and save it named `pubkey.txt`. (Fig: (2))
  - Client encrypts the user preference specified by `input_filename`, then Client sends encrypted data to PPRS. (Fig: (3)(4))
  - Client sends encrypted location info to PSP. (Fig: (4'))
  - Client sends result request to PSP, then receives the result from PSP and write it to stdout. (Fig: (8))
- Usage

```
Usage: ./querier [-i input_filename]
```

  - -i input_filename : file path of input data (REQUIRED)

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