Extension and Integration of an Abstract Interface to Cryptography Providers

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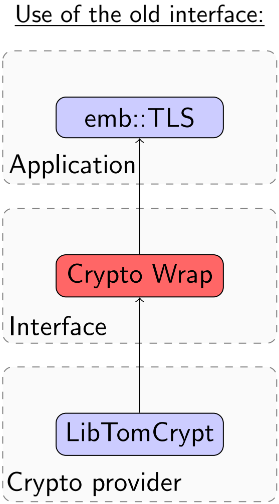
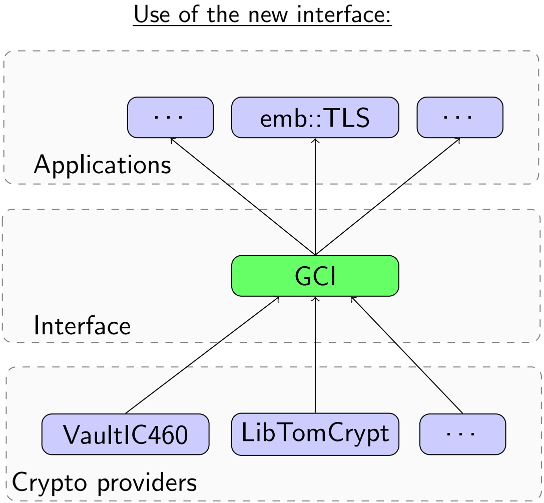
Table of contents

1. Goal of the project
2. Interface
3. Implementation
4. Results
5. Conclusion

Goal of the project





Requirements

Old cryptographic interface:

- Cannot be use in other application without changing some functions
- No other library can be use without rewriting the interface
- To old regarding the evolution of the cryptograhy

New cryptographc interface GCI:

- Possibility to use other cryptographic libraries
- Possibility to use it in hardware-coded-based cryptographic modules
- Possibility to easily add new cryptographic algorithms

Scheduling of the project

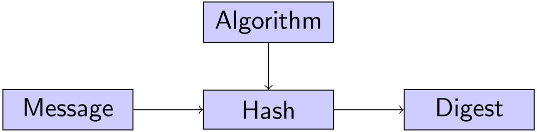
1. Acquisition of the basic cryptographic algorithms
2. Acquisition of TLS's princip and the implementation emb::TLS
3. Understanding the design of old cryptographic interface (Crypto Wrap)
4. Analysis of the cryptographic requirements imposed by TLS
5. Integration of the new interface in the application emb::TLS
6. Implementation of the provider LibTomCrypt

Interface

Interface in 5 main cryptography parts:

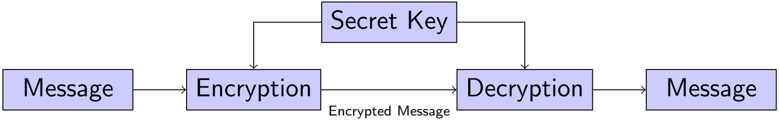
- Hash
- Symmetric cipher
- Asymmetric cipher
- Signature
- Diffie-Hellman

Interface - Hash



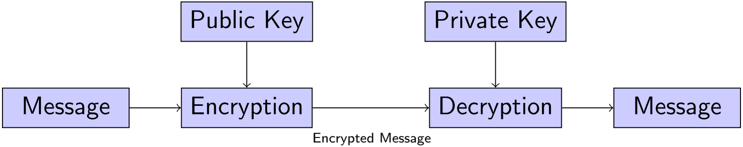
- quick to compute for any message
- infeasible to modify a message without changing the hash
- infeasible to find two different message with the same hash

Interface - Sym. Cipher



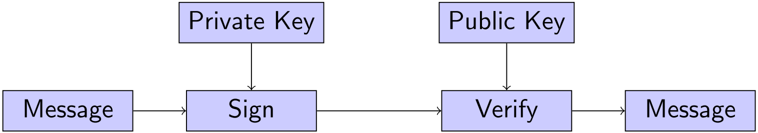
- Same key uses for Encryption and Decryption
- Allows privacy of data (nobody can understand the encrypted message only he has the secret key for decrypting it)

Interface - Asym. Cipher



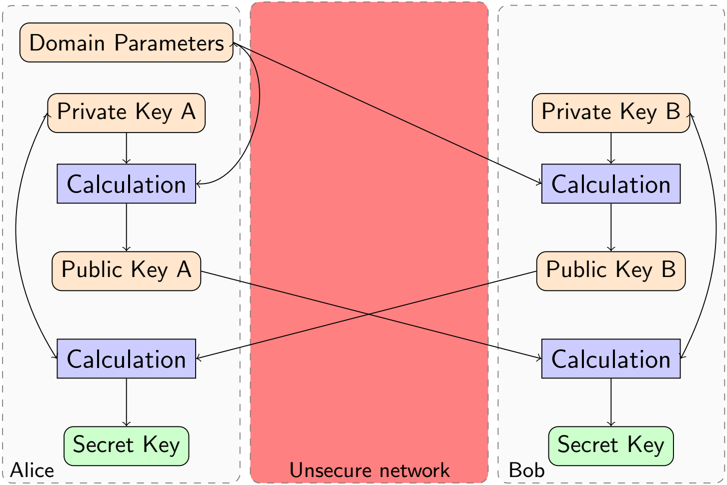
- Public and private key created by one person
- Public key sended to everyone who wants to get a communication
- Private key stay by who has created the key pair
- Public key allows the Encryption of the message
- Private key only can decrypt the message
- Allows privacy (only this one who has the private key can decypt the messages)
- Integraty (Sure that nobody can decrypt the messages)

Interface - Signature



- Private key uses to sign the message
- Public to verify the signature
- Allows no-repudiation (means that we are sure who sended this message)

Interface - Diffie-Hellman



Interface - Diffie-Hellman

- Domain parameters created by one person (Alice)
- Private key created by each one and not sended
- Public key computed with the domain parameters and the private key
- Secret key compute with the own private key and the public key of the other person
- Same secret key in each side

- Start with asymmetric keys
- Finish with symmetric key

Interface - Contexts

Princip

Old cryptographic interface (Crypto Wrap):

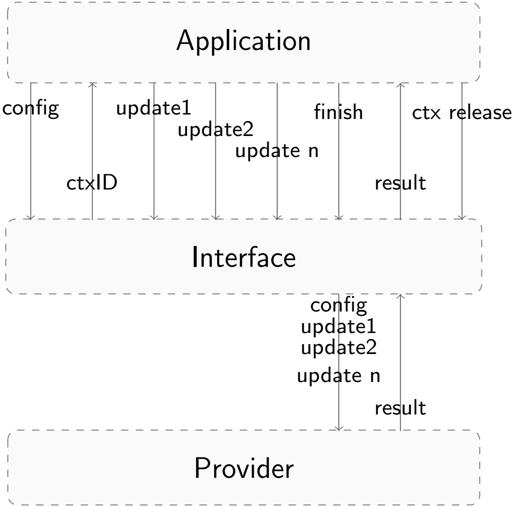
- Several functions with only one parameter of difference
- Several times the same parameters added for doing the same thing

New cryptographic interface (GCI):

- Use of context to save one time the parameters
- Give an identifiant (ID) back with where are the parameters saved
- Use of the ID to update the datas and get the result
- Release the context (the parameters in the same time) to free memory

Interface - Contexts

Example of use:



Princip

Old cryptographic interface (Crypto Wrap):

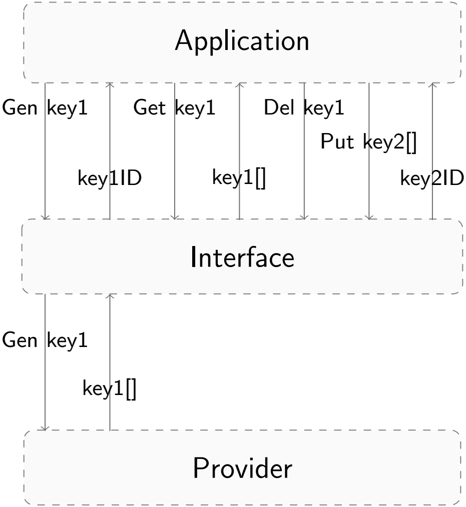
- Do not use memory to save several times the same key

New cryptographic interface (GCI):

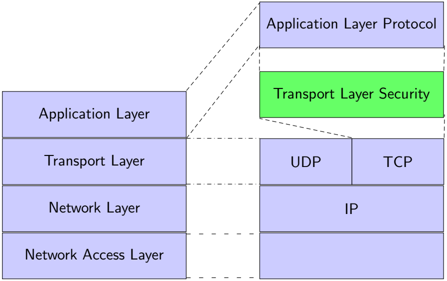
- Use of key management to save keys and become an identifiant (ID) of where they are saved
- Key could be get by passing the ID
- Release the key saved to free memory

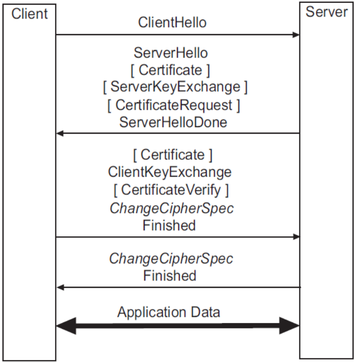
Interface - Key Management

Example of use:



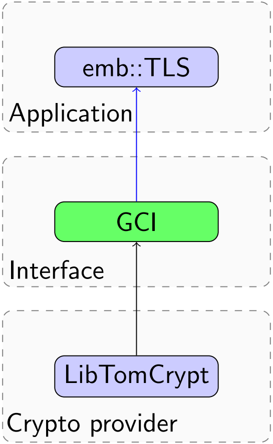
emb::TLS

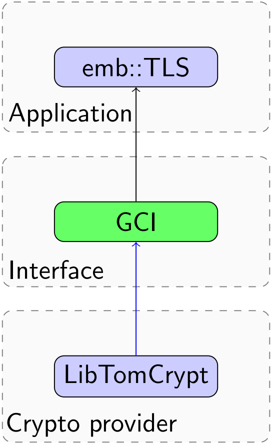




- emb::TLS as client with OpenSSL as server
- emb::TLS as server with Curve as client

Implementation



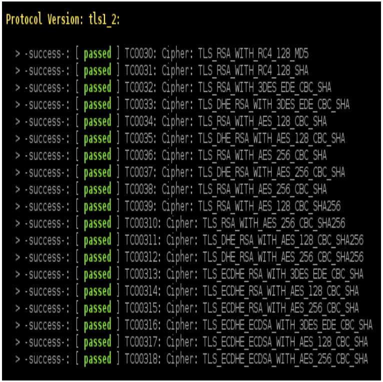


- Function from Cryto Wrap changed with this of GCI

- Implementation of the provider LibTomCrypt

Results - emb::TLS Client

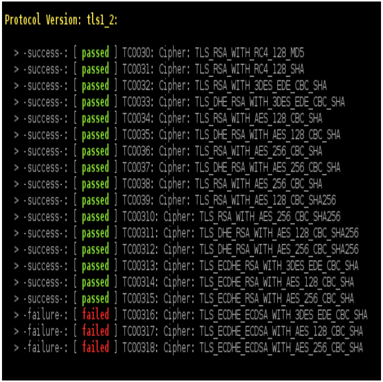
with old interface (Crypto Wrap):



```
Protocol Version: tls1_2:

 > -success-: [ passed ] TC0030: Cipher: TLS_RSA_WITH_RC4_128_MD5
 > -success-: [ passed ] TC0031: Cipher: TLS_RSA_WITH_RC4_128_SHA
 > -success-: [ passed ] TC0032: Cipher: TLS_RSA_WITH_3DES_EDE_CBC_SHA
 > -success-: [ passed ] TC0033: Cipher: TLS_DHE_RSA_WITH_3DES_EDE_CBC_SHA
 > -success-: [ passed ] TC0034: Cipher: TLS_RSA_WITH_AES_128_CBC_SHA
 > -success-: [ passed ] TC0035: Cipher: TLS_DHE_RSA_WITH_AES_128_CBC_SHA
 > -success-: [ passed ] TC0036: Cipher: TLS_RSA_WITH_AES_256_CBC_SHA
 > -success-: [ passed ] TC0037: Cipher: TLS_DHE_RSA_WITH_AES_256_CBC_SHA
 > -success-: [ passed ] TC0038: Cipher: TLS_RSA_WITH_AES_256_CBC_SHA
 > -success-: [ passed ] TC0039: Cipher: TLS_RSA_WITH_AES_128_CBC_SHA256
 > -success-: [ passed ] TC00310: Cipher: TLS_RSA_WITH_AES_256_CBC_SHA256
 > -success-: [ passed ] TC00311: Cipher: TLS_DHE_RSA_WITH_AES_128_CBC_SHA256
 > -success-: [ passed ] TC00312: Cipher: TLS_DHE_RSA_WITH_AES_256_CBC_SHA256
 > -success-: [ passed ] TC00313: Cipher: TLS_ECDHE_RSA_WITH_3DES_EDE_CBC_SHA
 > -success-: [ passed ] TC00314: Cipher: TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA
 > -success-: [ passed ] TC00315: Cipher: TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA
 > -success-: [ passed ] TC00316: Cipher: TLS_ECDHE_ECDSA_WITH_3DES_EDE_CBC_SHA
 > -success-: [ passed ] TC00317: Cipher: TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA
 > -success-: [ passed ] TC00318: Cipher: TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA
```

with new interface (GCI):



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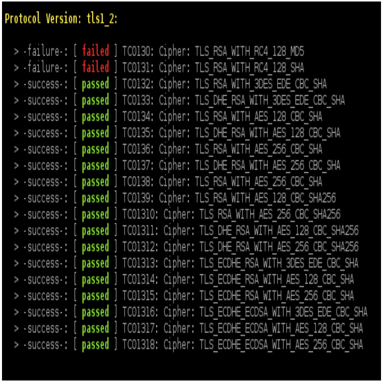
 > -success-: [ passed ] TC0033: Cipher: TLS_DHE_RSA_WITH_3DES_EDE_CBC_SHA
 > -success-: [ passed ] TC0034: Cipher: TLS_RSA_WITH_AES_128_CBC_SHA
 > -success-: [ passed ] TC0035: Cipher: TLS_DHE_RSA_WITH_AES_128_CBC_SHA
 > -success-: [ passed ] TC0036: Cipher: TLS_RSA_WITH_AES_256_CBC_SHA
 > -success-: [ passed ] TC0037: Cipher: TLS_DHE_RSA_WITH_AES_256_CBC_SHA
 > -success-: [ passed ] TC0038: Cipher: TLS_RSA_WITH_AES_256_CBC_SHA
 > -success-: [ passed ] TC0039: Cipher: TLS_RSA_WITH_AES_128_CBC_SHA256
 > -success-: [ passed ] TC00310: Cipher: TLS_RSA_WITH_AES_256_CBC_SHA256
 > -success-: [ passed ] TC00311: Cipher: TLS_DHE_RSA_WITH_AES_128_CBC_SHA256
 > -success-: [ passed ] TC00312: Cipher: TLS_DHE_RSA_WITH_AES_256_CBC_SHA256
 > -success-: [ passed ] TC00313: Cipher: TLS_ECDHE_RSA_WITH_3DES_EDE_CBC_SHA
 > -success-: [ passed ] TC00314: Cipher: TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA
 > -success-: [ passed ] TC00315: Cipher: TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA
 > -failure-: [ failed ] TC00316: Cipher: TLS_ECDHE_ECDSA_WITH_3DES_EDE_CBC_SHA
 > -failure-: [ failed ] TC00317: Cipher: TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA
 > -failure-: [ failed ] TC00318: Cipher: TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA
```

- All cipher suites work
- Only ECDSA which isn't implemented doesn't work yet

Results - emb::TLS Server

with old interface (Crypto Wrap):



```
Protocol Version: tls1_2:

 > -failure-: [ failed ] TC0130: Cipher: TLS_RSA_WITH_RC4_128_MD5
 > -failure-: [ failed ] TC0131: Cipher: TLS_RSA_WITH_RC4_128_SHA
 > -success-: [ passed ] TC0132: Cipher: TLS_RSA_WITH_3DES_EDE_CBC_SHA
 > -success-: [ passed ] TC0133: Cipher: TLS_DHE_RSA_WITH_3DES_EDE_CBC_SHA
 > -success-: [ passed ] TC0134: Cipher: TLS_RSA_WITH_AES_128_CBC_SHA
 > -success-: [ passed ] TC0135: Cipher: TLS_DHE_RSA_WITH_AES_128_CBC_SHA
 > -success-: [ passed ] TC0136: Cipher: TLS_RSA_WITH_AES_256_CBC_SHA
 > -success-: [ passed ] TC0137: Cipher: TLS_DHE_RSA_WITH_AES_256_CBC_SHA
 > -success-: [ passed ] TC0138: Cipher: TLS_RSA_WITH_AES_256_CBC_SHA
 > -success-: [ passed ] TC0139: Cipher: TLS_RSA_WITH_AES_128_CBC_SHA256
 > -success-: [ passed ] TC01310: Cipher: TLS_RSA_WITH_AES_256_CBC_SHA256
 > -success-: [ passed ] TC01311: Cipher: TLS_DHE_RSA_WITH_AES_128_CBC_SHA256
 > -success-: [ passed ] TC01312: Cipher: TLS_DHE_RSA_WITH_AES_256_CBC_SHA256
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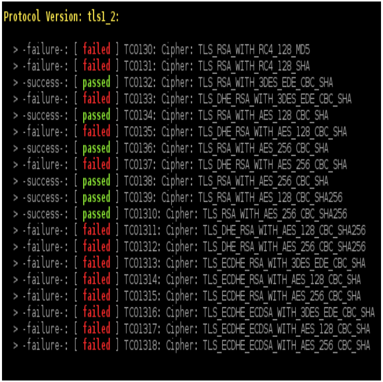
```

with new interface (GCI):



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 > -success-: [ passed ] TC0136: Cipher: TLS_RSA_WITH_AES_256_CBC_SHA
 > -failure-: [ failed ] TC0137: Cipher: TLS_DHE_RSA_WITH_AES_256_CBC_SHA
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 > -failure-: [ failed ] TC01317: Cipher: TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA
 > -failure-: [ failed ] TC01318: Cipher: TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA
```

- Diffie-Hellman doesn't work yet (problem of implementation in emb::TLS)
- Elliptic Curve Diffie-Hellman doesn't work too
- ECDSA isn't implemented yet

Conclusion

What work:

- The new interface is in emb::TLS implemented
- The provider is in the interface implemented
- Client cipher suites work

What doesn't still work:

- Diffie-Hellman and Elliptic Curve Diffie-Hellman doesn't work in the server case
- ECDSA isn't implemented

Conclusion

TODOs:

1. Implementation of the rest of the server part
2. Add ECDSA in server and client
3. Write the documentation of the interface

Thanks for your attention

Questions?