Term Project Final Report

Title of the project

Light-Weight and Privacy-Preserving Authentication Protocol for Mobile Payments in the Context of IoT.

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Abstract

In the current world IoT is getting widespread over a wide range of scenarios. From Smart Home to smart cards etc, IoT is becoming the new norm. One of the major characteristics IoT is being lightweight in terms of size, power consumption, performance, storage, etc. The protocol mentioned here provides security while still making sure that the performance and storage are within the capabilities of a IoT system. The protocol provides privacy and authentication for mobile payments in context of IoT. There are a various number of use cases from payments from smart devices like smart electric meters, smart cars, smart watches, monitoring systems, etc. The protocol uses at unidirectional certificateless proxy re-signature scheme, which is of independent interest. Based on this signature scheme, the protocol achieves anonymity, unforgeability and low performance overhead. In this protocol the computational overhead is placed on the Pay Platform. To increase the efficiency of the protocol, a batch-verification mechanism is provided for the Pay Platform and Merchant Server. The security of the protocol is based on the CDH (Computational Diffie-Hellman) Problem.

Protocol Summary

When a payment protocol in any IOT enabled smart device is implemented, the involved computation and storage space should be low for the limited resourced devices. However, in traditional transaction protocols, a public key infrastructure is introduced to issue certificates for public key of the user. This validity of the public key can be verified based on the certificates issued by a certificate authority. It is easy to see that PKI caused a lot of communication and storage costs when the revocation, storage, and distribution of certificates are done.

To solve the above challenge, we propose a new mobile payment scheme that achieves anonymity, unforgeability and low resource consumption simultaneously. All In all, this protocol accomplishes 3 things :

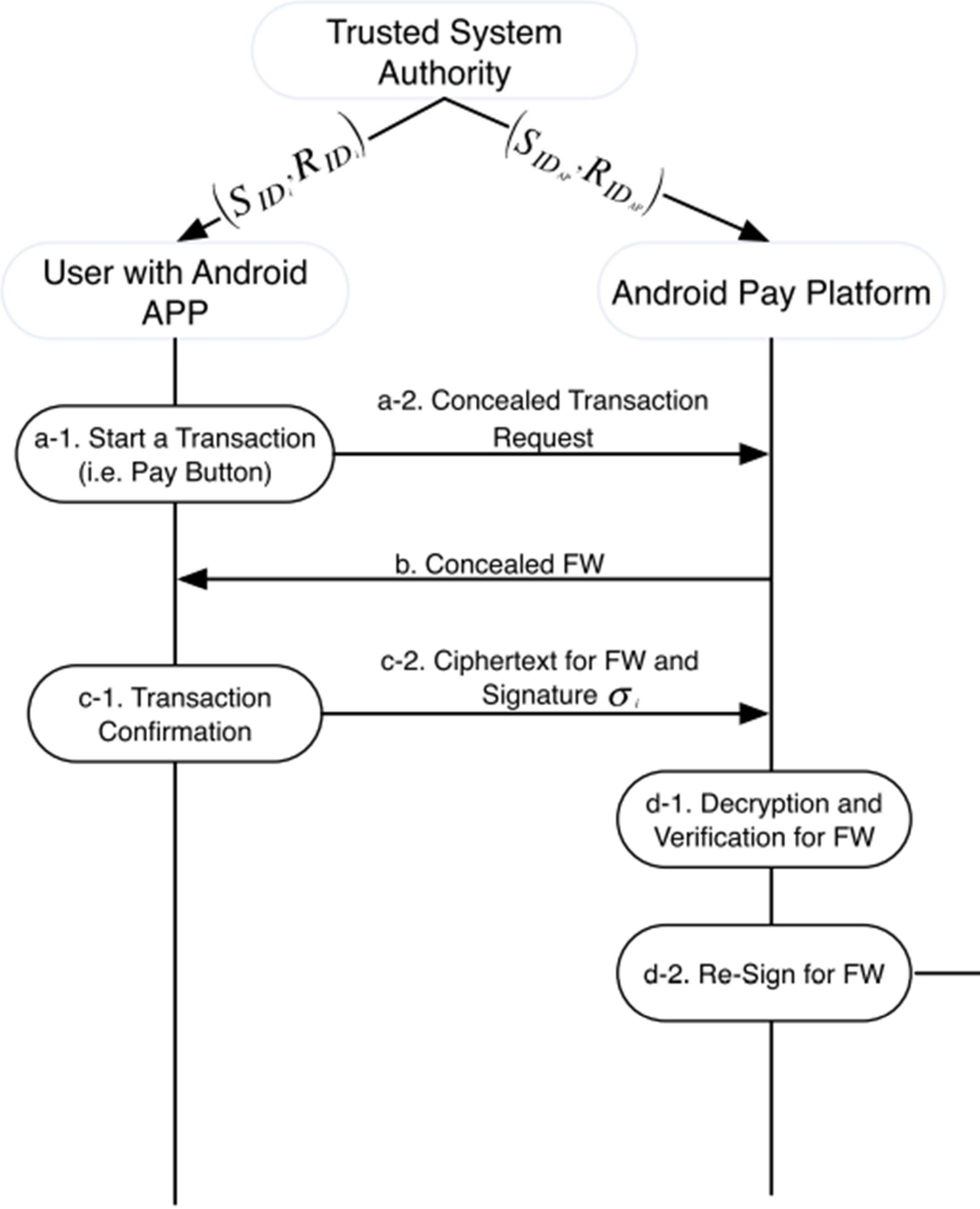
1. We propose the first unidirectional certificate-less proxy re-signature scheme which is of independent interest.
2. A mobile payment protocol with user anonymity is presented based on our proposed scheme.
3. Using Batch-verification to accelerate the signature verification process such that multiple signatures from different users on distinct messages can be verified quickly. Moreover, the signatures from the same user can be further batched to achieve higher efficiency

Plan of Implementation

SYSTEM MODEL OF OUR TRANSACTION PROTOCOL

The considered system consists of four types of entities: the trusted system authority (TSA), the user app, the merchant server, and the Pay Platform [9].

1. **Trusted System Authority**: **TSA** is a trusted third party organization that provides registration services for User’s App and Pay Platform. TSA also distributes system params and partial private keys for registered users to ensure the whole scheme successfully works.
2. **User’s App**: Any software that requires a payment function is called User’s App, such as Apple pay, etc. This application needs to be registered with the TSA to obtain the corresponding system params and partial private key. It also generates its own user secret value and public key. Then User’s App completes the signature using its full private key, which consists of partial private key.
3. **Pay Platform**: Pay Platform is an application offered by a trusted party, of course, it also needs to register with the TSA to obtain system params and private key. Simultaneously, in order to protect the user’s information of the transaction, Pay Platform will provide re-sign service, that is, the Pay Platform transforms signature of User’s App into signature of Pay Platform.
4. **Merchant Server**: Merchant Server is utilized by a merchant, it verifies the correctness of the transaction information to check the product is given to the right user.



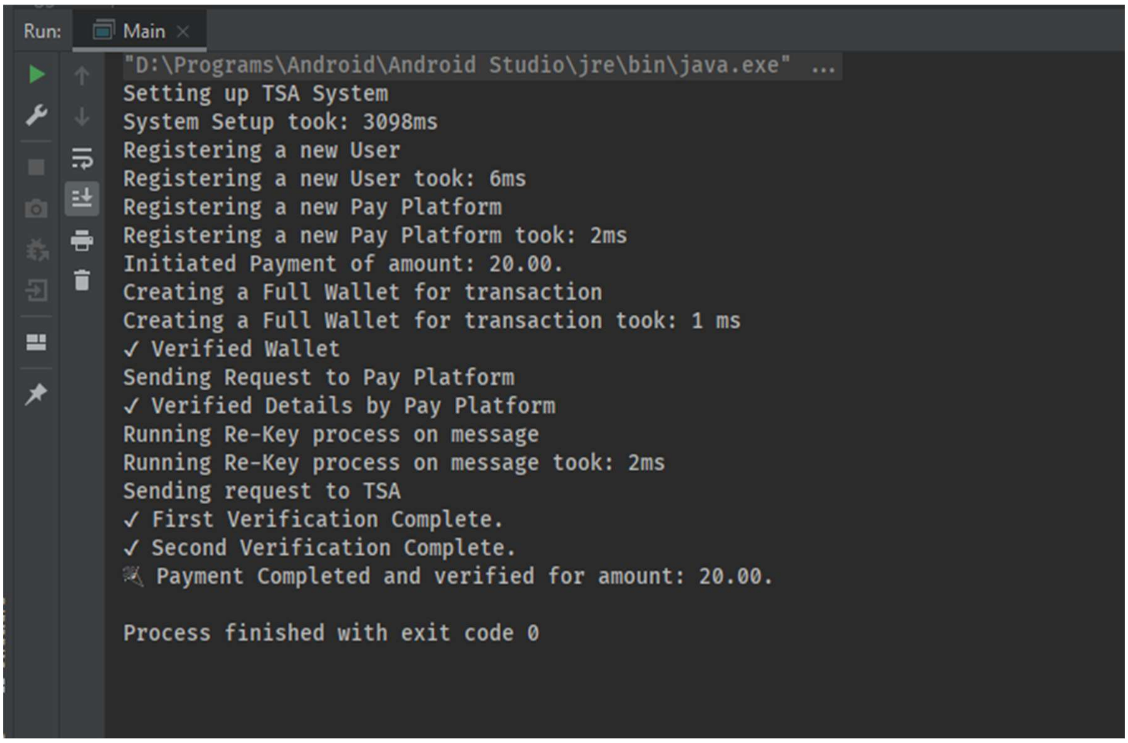
Trusted System Authority
(S_{ID_i}, R_{ID_i})
$(S_{ID_{AP}}, R_{ID_{AP}})$
User with Android APP
Android Pay Platform
a-1. Start a Transaction (i.e. Pay Button)
a-2. Concealed Transaction Request
b. Concealed FW
c-1. Transaction Confirmation
c-2. Ciphertext for FW and Signature σ_i
d-1. Decryption and Verification for FW
d-2. Re-Sign for FW

Code and Experimental Results

We implemented the protocol in Java using the JPBC Library. We followed an OOP approach with interfaces to keep the code modular and mocked Message Passing between the various entities. We Initialized the Secret Parameters and the ECC Pairing generation followed by the process of User Registration and Pay Platform Registration. And finally making a payment.

We used Type A elliptical curve with G1 and G2 size 512 and 1024 bits respectively.

Single Run Results:



Results (Average Time (100)):

- System Setup: 4.1 seconds
- Registration: 10 ms
- Transaction: 1~2 ms

Observations and Conclusion

Performance Analysis:

Our local machine on which we run code was more powerful than the one mentioned in Paper but to due to lack of available hardware we ran the code and found really good performance.

Scope of Improvement:

We used JBPC which relies on Java VM runtime and can cause an overhead, using a native machine code implementation such as (PBC) for C++ will provide more improvement in performance.

Configuration for User's App (Original)

- **CPU**: PXA270 processor 624MHz
- **RAM**: 1GB memory

Configuration for Payment Platform (Original)

- **CPU**: Intel i3-380M processor 2.53GHz
- **RAM**: 8GB memory

Hash Function: SHA-3

G_1, Z_q -> 64 Byte

G_2 -> 128 Byte

ECC -> $y^2 = x^3 + x$

Paper's Usage

- VC++ 6.0
- PBC library

Our Usage

- GNU G++
- PBC library

Summary of the results

The Protocol is really secure and also works really fast and is also very low on computation and storage resources and hence is a good pick for IOT mobile payments. In our implementation we found that the User side computation took very few time hence improving the user experience with IOT based payments as well providing the same level of security as 2048 bit RSA.

References

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