Abstract

This Request For Comment (RFC) is a proposal for a new protocol to use Money Over the Internet protocol (MOI). Features like a distributed architecture, a published cryptographic algorithm, a minimal authority responsibility, the absence of fees will make this protocol a perfect tool for citizens in today’s digital World.

An implementation has validated the main principles and we entering now a testing phase (v0.1). Depending of the results, a released date for the 1.0 revision will to decided to allow anybody to send or to receive money to/from anyone, in any currency, with a regular and personal smart-phone. A distributed hash table (DHT) is used to store all transactions, public keys and certificates redundantly on several nodes. The all system may replace coins, banknotes and classical checks in the future. We also argue that the Bitcoin technology does not satisfy the requirements for a digital mean of payment. This proposal is expected to be reviewed and commented by the Internet Engineering Task Force.

1 Introduction

There always has been two ways money can be used between citizens of the same community. In the first and classical way, an authority is in charge of forging tangible coins and paper banknotes to facilitate trading, exchange of goods and services. That authority is usually unique to have such privilege.

The other way is to chose a unique trusted accountant who should record on a big blackboard or a big book all transactions between citizens and should allow a limited fare credit for each one. Nothing can be deleted on the board. Anyone can see all transactions to compute the balance of anybody.

If the second solution have been avoided in History for obvious reasons, making it impracticable for a large community, things has now to be reconsidered with three major innovations:

- Internet as the Net of all nets connects every one on Earth.
- Cryptography advance techniques, and elliptic curves cryptography (ecc) for highly secure transactions, authentication, certificates.
- Peer2Peer protocols making distributed/redundant shared data possible and not deletable.

We would like to show with the following RFC proposal that "MOI" is not only possible, but also simple, efficient and compliant to the main democratic requirements for the money function.

Our main goal is to provide a free of charge payment system (not like Visa/Mastercard/PayPal !) at digital age, just like the usage of coins and paper banknotes has been free of charge before the Internet.

MOI is not a cryptocurrency in a sens that new money has never created from nothing. Every MOI account has to reference the same amount of money from an official banking account (€, $, ..) and is using the same currency unit. However, it is based on advanced open-source cryptographic primitive to manage transactions securely and with a full transparency on Internet. This is more a crypto-payment system.

2 Digital check

A pillar of the proposed system is the notion of digital check. What is a check in the physical World? It is a piece of paper with the following fields:

\footnote{CEO Pluggle SAS - Toulouse - France. CUPFOUNDATION is a non-profit association for promoting the [] currency.

\footnote{we may use the acronym ‘MOI’ for our proposal system. It means ‘me’ in French, to enforce the concern of individuals for money.}
1. the current date,
2. the name/symbol of the currency used,
3. the amount of money to be exchanged,
4. the sender’s name,
5. the recipient’s name,
6. optionally a reference of an invoice
7. ...and the handwritten signature of the sender.

In the digital World, many types of digital signatures exists nowadays. Let us select one of the shortest; EC-DSA with a specific curve called P-521 from the NIST\cite{1}. Such a signature is always 132 long binary array for any message to be signed. In fact a hash of the message is used, so the signature itself does not have to worry about the length of the original message. What is important here is that any bit modification, for instance the amount of money, or the recipient id, will make the signature verification fail. Also, the message and the signature are never encrypted, they are plain readable text (if extended from binary) and anyone can verify whether the signature is valid or not on a given message.

Our proposal for the format of a transaction is the following:

1. 1 byte: protocol version + reference field length (see bellow),
2. 3 bytes: the amount of money (cents for $ or €) so the maximum transaction is around 167,000 units!
3. 4 bytes: currency + date of the transaction
4. 8 bytes: the ID of the sender,
5. 8 bytes: the ID of the recipient,
6. 0 to 64 bytes: the optional reference (free signed text),
7. 132 bytes: the signature of the previous 24 bytes (88 bytes maximum) message by the sender.

This first four bits of the first byte have the following value:

- 0x0: moi protocol vα (test only)
- 0x1: moi protocol v0.1 (test only)
- 0x2: moi protocol v0.2 (test only)
- 0x3: moi protocol v0.3 (test only)
- 0x4: moi protocol v1.0 (validated for trading)
- 0x5: moi protocol v1.1 (validated for trading)
- 0x6 - 0xF Spare for moi protocol v1.X

The last four bites of the first byte indicates the length (in 4 bytes words) of an additional reference field. Value zero means “no field” and the maximum value 16 (0xF) means 64 bytes added for a free text. Be aware that the reference field is included in the signed message, so it can not be changed. This is useful to give a reference of the exchanged good, of an invoice or any short message.

2.1 Date format

The date shall have a specific format to prevent abusive check publishing; a transaction with a date in the future won’t be accepted. Dates shall start the first January 2016 with a resolution of one minute. We could have second or less as resolution but this low frequency is to prevent high frequency financial transactions and more generally robot money spending. For any human-being, buying something every minute is far enough. Date shall be coded on 26 bits so it ends in year 2143!
2.2 Currency format

The currency is coded in 6 bits, allowing 64 different currencies. Her some reserved values

- 0x00: "none" (test only)
- 0x01: $ [USD]
- 0x02: € [EUR]
- 0x03: £ [GBP]
- 0x04: ¥ [CNY]
- 0x05: ¥ [JPY]
- 0x3F: ⊥ [6]

So a transaction is 156 bytes (220 bytes maximum) long in binary format and 195 characters (275 characters maximum) long with a BASE85 readable encoding. Other representations can be used in ASN1, XML, JSON, but it is important to keep the transaction format as simple and as small as possible.

Thus, a transaction can be sent by e-mail, socket, HTTP request or with two SMS:

- one SMS including the message and a transaction-reference-id
- the other SMS with the signature only and the same transaction-reference-id to recompose the full transaction

The transaction-reference-id can be 8 bytes long to fit in a 140 bytes SMS.

No-one can deny having written a valid digital check. As soon as a digital check is published on the Net and is valid, the transaction is considered executed.

For convenient, User ID are just the 8 ending bytes of the public key (132 bytes long), assuming we are using an asymmetrical cryptographic scheme for signature (DSA).

To start using the money over the Net, any user must have a mobile device, usually a smart-phone. At initialisation, it is recommended to disconnect the device from the Net. The user is invited to launch a random generator that produces several public-key/private-key couples. She has to select one couple exactly as a young person chose a hand-written signature for all her life. No authority, no Secret Agency can be present to see/force someone to chose that couple and not that one. The private key is left private inside the phone and only on this device. We will see later the recovering process when a phone is stolen/lost/broken. As one may expect, the public-key is published on the Web, as for any upcoming transaction.

The recipient of a check have to verify the signature validity but also that the public-key of the sender has been previously published and lastly that the account of the sender will have a positive balance if the transaction is accepted.

But how are balances values computed over the Net?

3 Get balances

As a master rule, all accounts start with a null balance, and anytime after, the sum of all balances are always null, by design.

This mean that a few accounts are allowed to have negatives balances, and we shall call them i-BANKS. The other accounts are not allowed to have negative balances. Those are just regular accounts, for citizens.

An i-BANKS account has some additional features so that nobody can decide by its own to become an i-BANK. In fact, i-BANK accounts are certified, unlike regular accounts. What does is mean exactly?

In our system, it shall exist a master authority (MA), represented by a set of individuals so any decisions of that authority needs the signature of all the members. The master authority gives to a trust-able institution the right to have during a given period (one year default), a negative balance of a bounded value (may be 1B€ for instance). The so called i-BANK receives a digital certificate, that is mainly her identity message signed by the master authority.

The master authority public key and all i-BANKS public-key are all published on the Net, like regular accounts. Also all certificates are published. Thus anyone on Earth, connected to the Net can verify any transaction/certificate signatures but also that all transactions issued by i-BANKS results balances that are compliant to the contract given by the certificate.

An i-BANK is usually a well known institution that will always write a negative transaction on its Internet account by doing the symmetrical operation on the private banking account of its customer. For the end user, it's just like transferring some money from the bank to its Internet account.
Now, to compute a balance of a given account, it is straightforward. Just sum all the transactions, positive and negative, where the user acts as a sender or as a recipient. Anyone can compute the current balance of anyone.

Transactions do not have to be chained like for *Bitcoin*. Nodes can sort them by date and compute a small check-sum for each user. It’s then easy for each node to compare check-sums with other nodes and to know if it needs updating. However, the synchronization mechanism between nodes may produce the situation where two nodes have accepted two different transactions that leave positives balances at time of publishing, but when added all transactions, the balance become negative for the last transaction. Then the account is someway blocked until it receives a credit to be back positive. As a date is included in the transaction message, nodes may use a tempo function of the check age to valid the transaction, so the risk that two transactions validated on two nodes at the very same time is very improbable.

Because there may be thousands of transactions, balances are always computed and verified in a background process and the result is intermediated stored until a modification occurs. This is just a trick to get balance result in real time, but the principle is always to sum transactions values from the beginning.

Servers that store data (public keys, transactions, certificates) are distributed and redundant, so they always compete each other to detect if another server has accepted a not fully valid transaction, in order to black list it. Not all servers should have a copy of world-wide transactions. A clever cache mechanism makes possible for a server to have only a small subset of users/i-banks accounts just because there are only transactions inside such subset.

Server are distributed likes nodes of the *BitTorrent* protocol. However, a user is sharing a part of her CPU and disk space for *Money Over IP* protocol, but she has no control on the transactions. Her computer might store their own transactions and also transactions from other ones, not especially friends.

Consider a classical high definition movie of 4GBytes stored on a basic PC hard disk. The same size can store about twenty five millions of transactions! There is not rule or imposed technology to make persistent all the data. However we recommend to use a *key-value* database to be able to find instantly a transaction, a public key or a certificate.

The proposed format for certificate is the following:

- 1 byte: currency + protocol version (no reference field),
- 3 bytes: the authorized **debt** in the given currency in kilo (cross 1000); maximum 16 B€ for instance,
- 4 bytes: the deadline of the certificate validity,
- 8 bytes: the ID of the i-bank account,
- 132 bytes: the signature of previous message by the *master authority*. This signature is the resultant of several individual signatures.

A certificate is then 148 bytes long.

The **MA** id and its public key is hardly written in the protocol. For v0.1 testing protocol the **MA** is defined by:

- **MA ID** (base85): `Lfeeeb)XsP` or `0x42DB8CD275A019E9`
- **MA Public-key** (base85):

```
0o;@Dnke406Kas)ZJ}hg>"1A1ceYz@3V5;\u{w}LYCcPrxRm7OjOR%(-P6avd@#8U)#;=iUp}S{"|GrA-4bk
```

- **MA Public-key** (base64):

```
AdyT8Joo3rMTbJQqaFktux03sB31tuCniyHbE6kENqPkuWuJT1GowGYSvTEtHBss-ThF_bzeuKBak4_yIxzCG3
```

4 Clearing house

As soon as it exists more than one i-banks, a clearing house shall be needed both for both the legal currency an for the MOI accounts. This is obviously a full automated task on the Internet. The **MA** shall delegate an organization to work as a world-wide global clearing house. Each recorded transaction shall have a bit to remind if the transaction is cleared or not.
5 Recovering process

Using asymmetrical keys for signing gives us the power to define our own digital identity. But that identity must be keep safe by its owner. That’s why we recommend a three criteria authentication before any usage of the private key for signing.

- a mobile device you own and you can carry out anywhere,
- some secret you know like a pass-phrase and you never share it,
- some feature on you like your fingerprint (TouchID iPhone),

But what append if you forget your pass-phrase or if your phone is stolen/broken or lost ? Well, it is always possible to buy another phone and reset the process, but what about the money on the last account ?

If you loose a phone without fingerprint authentication and with the pass-phrase hand written on top of it, it will be hard for any system to insure your money back...this is like dropping a banknote on the street.

There is however a simple way to protect the money on an Internet account. Just prepare (after initialisation) and sign one or several digital checks for an amount higher than your regular balance and select as recipient someone you trust in, a parent or friend, but do not publish the check over the Net. Keep it on a saved ush-key or print it (200 characters) and save it just like a bank-note under your bed.

If for instance you have lost your phone with a 976€ balance (you can read the exact balance value on any computer over the net, with your id that is part of your public key), and you had signed and recovered a check of 1000€ somewhere. Put some money on your new account, send a check of exactly 24€ to the stolen account and just after, publish the recovery check of 1000€ from the old account to your friend. Then, if the thief has not been as responsive as you are, the old account balance is now null and you just have to call your friend and ask her to refund the 1000€ to your new account. If you did not prepare a recovery check and if the account is not broken, then nobody, even the NSA nor any i-BANKS will be able to get the money from this account.

6 Deployment

Because security is the most important thing when dealing with money, it is not safe to use a pre-released protocol for real valued exchanges. So the protocol version v0.1 is intended for testing only. People should use it, play with it as many times they want but they should not exchange goods or services against this virtual money. Anyone interested in playing the role of an i-Bank for testing (v0.1) can contact us. i-BANK candidates may be accepted for testing but not for real life.

If the testing phase works well, i-BANKS will receive a certificate for a period to be define to send transaction with the version 1.0 protocol, meaning this is real money.

Other modifications of the protocol in the testing phase may append; v0.2, v0.3 is necessary, before releasing the v1.0.

7 Possible attacks

A node receiving a transaction that will make the balance of a regular account negative shall not accept the transaction and shall not store it.

Also any transaction with a null amount value is rejected. A transaction with the sender equal to the recipient is also deleted.

Anyone can play "ping-pong" between two accounts of its own. For instance, having account A and B, one send 1€ from A to B and 1€ from B to A and repeat the cycle million times. The result is that the cache system response may be slower for those account A and B, but not for other accounts.

Any created account left more than a period of time (months) unused, with no transactions is deleted from the nodes.

8 Selected configuration

The selected hashing algorithm is sha256 for all signed message.

The selected elliptic curve is NIST P-521[1], which is stronger than the one used for Bitcoin[4].

Messages+signatures can be sent as binary code when possible and for readable transaction, please use as possible the ASCII BASE65[2] encoding with zero padding.

Saving 8 bytes for users IDs may be considered a little large, but we must minimize the risk of collision of the same ID with different public-keys. If unfortunately that case occurs, the second user is proposed to select another couple of keys.
End user can run locally a key-generator and select the key with a base85 encoded ID she likes the most, for instance without specific characters. However hopefully, it is not possible to chose first an ID and second run in a finite time a program that will return a public-key for that ID.

9 Anonymity

All transactions, public-keys and certificates are public, so anyone connected to the Net can see that a given ID has bought for such amount of money to another ID (the date of the check is never a significant proof). As long as he cannot link the ID to a physical person, transaction stay anonymous. This is the same level of anonymity than for Bitcoin. We recommend to use several accounts, some are public (published on a web page) and some are privates (not linked to a person). Then, someone reading a transaction, does not know if this is between two different physical persons or between two accounts of the same person.

10 Uniqueness

It may be interesting for a citizen to select a unique digital ID and have the ability to prove to anyone that such ID is unique. In some countries, it is currently discussed the opportunity to send the same amount of money to every one every month, without any conditions, just for the fact to be in life. We can imagine how hard it is with a classical tool to check that a malicious citizen is not trying to register on two different places to get twice incomes. This is where we need to introduce for a selected account the notion of primary account, meaning that anybody has only one primary account at a time.

Just as for i-banks, the master authority can deliver new certificates with a zero debt field, meaning that those institutions are not able to give money to anyone, but just able to register ID and check citizenship. Each country shall select an identification number system where a strictly unique number is given to each baby all her life. The local administration asks each citizen to see him physically with identification papers and a proof of the right national number. It is then checked on a big shared hash table on Internet that such number is not already registered. If all tests pass, the administration will sign the id number and will associate to the account ID selected by the user. Then an unique primary account is registered.

Primary keys (public/private) are also pre-requirements for a possible future democratic voting system over the Internet. However, considering the current research results, not all requirements are satisfied to rely on Internet Voting.

11 About Bitcoin

One may think about the Bitcoin technology when dealing with digital money and Internet. Indeed, Bitcoin is a very interesting algorithm and curiosity for computer science. It shows how to build a digital and secure Ponzi-like pyramid. Bitcoin wants to address the difficult problem of money creation in a pure decentralised way. First, the consequence is that the early adopters, who started in 2009, are really advantaged compared to people trying to forge coins now. This is not clearly a fare situation. Second, because it is not allowed to create money for a standard currency, say American dollar, Bitcoin is exchanged on a free market that fix a rate for the currency, and is open to strong speculation. But what is sold here? A bitcoin is just a particular big integer with properties proving that it has been added to a block-chain started in 2009 with the random string "The Times 03/Jan/2009 Chancellor on brink of second bailout for banks"!

Imagine that we are creating a new rcoin currency with friends. A new coin is forged each time some computer find a new decimal of $\pi$. Like Bitcoin, it is more and more difficult to create new coins, but can someone say that it owns the $n^{th}$ decimal of $\pi$ and could sell that number to someone else? The answer is 'no' because any integer is a mathematical object belonging to everyone, means no-one. It’s hopefully forbidden to claim owning a particular number, whatever are the properties of that number. The $\pi$ number at a given decimal is a much more remarkable number that a bitcoin block, but none of them should be sold as some intangible good. For not expert in cryptography, a big integer representing a digital signature remains a little magic, with some probably intrinsic value, and many people would be ready to pay to own one of them. But it’s a pure game where each player try to convince other less experts or other gamers to enter the game in order to gain real money on behalf them.

The scarcity of Bitcoin does not make it valuable as it has always been for gold. The name "forging" has been used to make believe it is as exhausting to extract bitcoins than extracting gold. But it is false; the object value is not the price of a human miner hard working because for Bitcoin, only machines are really "working", more exactly they are consuming some electricity to find big integers that will not help at all research in Mathematics. So Bitcoin is a nice trickery just for people who like to gamble. The economics requirement for every day trading
is not a game, banks are not lotteries. So we can no rely on a the *Bitcoin* family system as a payment mean for every citizen.

The following table summarize differences between *Bitcoin*, *MOI* and the traditional banking system:

|                      | *Bitcoin*     | *MOI*        | Banks                  |
|----------------------|---------------|--------------|------------------------|
| Money type           | *value money* | *debt money* | both value&debt         |
| Money creation issue | yes           | no           | yes                    |
| Centralization       | none          | minimal      | full                   |
| Money mass           | finite        | infinite     | rules                  |
| Transactions history | chain required| set required | private network        |
| Architecture         | P2P           | P2P          | private servers        |
| Rate with $          | free (speculative) | fixed as identical | official               |
| ECC curve            | P-384         | P-521        | none                   |
| Power consumption    | very high     | very small   | manual tasks           |
| Main purpose $       | currencies exchange | goods&services trading | traditional banking |

Our proposal has some common feature with *Bitcoin* as both are using Elliptic Curves Cryptography (ECC). Because we aim to offer a digital payment system for legal currencies, we do not address the problem of money creation. Thus, we did not succeed in making the all system fully decentralized. At least one t-BANK should exist and its debt bounded by a master authority. However, no entity is in charge of the big issue to create money from scratch, as the ECB or the FED in the classical system. For a really democratic and fare distribution of money to all living humans on Earth, it would be mandatory to use a primary account, insuring uniqueness, but the decision to create money such a new way would be the responsibility of governments. The MOI protocol does not require any change to be MONEY OVER THE INTERNET.

## 12 First Application

The MOI protocol will be used for paying electricity consummation for electric vehicle in public areas, using the pluggle system. For the end user, the same mobile phone application enable to lock/unlock chargers and to pay the owner of the charger. The application may move to a full digital generic person2person payment system after experimentation phase.

## 13 Conclusion

This paper shows how it is simple to use Internet as a universal payment system, without *Bitcoin* drawbacks. This system can be called MONEY OVER IP (MOI). We proposed a pre-released version of the protocol for debate and testing. As money remains a matter of concern of any-one, not just for computer scientists, we hope that our proposal will raise discussions and new ideas with the same goal of offering to any citizen on Earth a universal, open, free and easy to use payment system. Please, do not hesitate to join us for this MOI project.

## References

[1] NIST *Recommended elliptic curves for federal government use*. 1999.

[2] P. Hintjens *ZerOMQ Base-85 Encoding*. 2011.

[3] L. Fournier *Economics for Intangible Goods*. arXiv.org 2012.

[4] S. Nakamoto *Bitcoin: A Peer-to-Peer Electronic Cash System*. 2009.

[5] L. Fournier *Merchant Sharing Theory*. HAL 2013.

[6] L. Fournier *Merchant Sharing. Toward a zero marginal cost economy*. ArXiv.org 2014.

[7] Wikipedia *Foreign exchange market*. 2013.

[8] RFC-2026 *The Internet Standards Process*. 1996.