Proof of Location for Blockchain

General Description

Location information, particularly about people, is extremely useful to modern industry. Businesses use it to analyze trends and make strategy. Individuals use it to navigate using Waze, find stores via local search, or have packages tracked automatically. Our smartphones and other personal devices (such as iOT, fitness sensors, smart watches) report our location better than any government spy agency in history.

Yet individuals need the right to conceal information about their position - sometimes called “spatial” or “locational privacy” – since location information is easily abused for example to rob your home when you are away, limit employee freedom, charge higher prices via targeted ads, and so on. Services that use location data have a similar right to privacy protection: a company should be able to either track its activities in an area, or subscribe to information about locations, without competitors knowing.

Protecting privacy is even more challenging in blockchain technologies than in web services, since transaction details are stored forever in a permanent, indelible, distributed ledger. Bitcoin and Ethereum have caused a revolution in cryptocurrency and distributed processing of contracts. However, location information has been difficult to transact on public blockchain ledgers, due to privacy issues. This project seeks to propose solutions to those issues.

Project Details

We explore a cryptocurrency “Platin” that pays a reward if a user can claim to be in a location. In the basic use case a “sender” offers to pay an individual price “P” of the cryptocurrency Platin (PTN) to a “receiver” when that receiver proves they are at a specified location. This basic scenario can be abstracted to cover many other use cases in future, from supply chain to iOT.

We start with a completely transparent scenario. Each side sends the information so that it can be inspected by anyone. Sending data in this way, while simple, has no privacy at all. We then improve this by implementing privacy using cryptographic protocols.
Goals

- Learn about sending and receiving cryptocurrency e.g. bitcoin
- Learn about location data and privacy
- Learn and compare various zero knowledge cryptographic protocols

Project Steps

The following steps are proposed. The scenario is described in more detail below.

MAP SERVICE

- Select or create a map service.
- Can store and display locations L. Look at Google Places API, Apple Core location, Mozilla Geolocation. Make sure that the location is expressed in a standardized way: see schema.org, ISO 6709.
- Can communicate with other parties to facilitate map/location activities

SENDER & RECEIVER APPLICATIONS

- Create applications to send and receive cryptocurrency, based on location requirements. This app may be part of an existing cryptocurrency wallet.
- SENDER stores a location L and a general margin of error M(L) that contains L. Can communicate with the other parties to list the location on the MAP SERVICE, and if a RECEIVER claims to be in M(L), make a payment
- RECEIVER stores a location L’. Can do the proper communications so that, if L’ is in a location where a sender is sending money, the RECEIVER can make a claim and collect the money
- Both apps implement cryptography to avoid revealing private information

EVALUATOR SERVICE

- Create a software application to act as an intermediary in order to protect privacy.
- The EVALUATOR can be considered like a smart contract processor, or a trusted third party. It stores cryptocurrency offers and can evaluate claims to take currency (based on location data). It also can perform zero knowledge protocols to evaluate contracts without being aware of private details.

Scenario Flow Details

Transparent Scenario

In this beginning scenario, sender and receiver each have full knowledge of what the other is doing.
The following describes flow shown in Diagram A:

1. A sender signs a simple contract: “I will pay PTN amount P if a receiver can prove to me that he is at location L within margin of error M(L).” M(L) could for example be a circle of radius R around location L, so any point within one meter of L is contained in M(L).
2. The sender contacts a public map service.
3. The map service verifies that the sender does in fact own PTN amount P.
4. The map agrees to accept the notification and display the PTN on the location. It also offers the node address of the publisher (the sender) for anyone to contact the sender.
5. The public map displays that area M(L) has PTN P available, from the sender.
6. Receiver accesses the map service. Receiver sees PTN amount P on the public map.
7. The receiver sees that he is in or near M(L) and is a candidate to claim the PTN amount.
8. The receiver states to the sender that he is at location L’ (L’ being inside M(L)).
9. The sender validates that the receiver is in fact inside M(L). (L’ is inside M(L)).
10. Sender agrees as originally committed, to pay / release the PTN to the receiver, since the receiver has satisfied the contract.
11. Sender transfers PTN P from to the receiver’s address —> this transfer is committed to the public ledger (blockchain).
12. The public map is made aware of this transaction and clears PTN amount from L.

**Diagram A**

**Transparent Scenario DRAFT**

**Homeomorphic Hiding Scenario**

The above transparent scenario violates the location privacy of both parties. To begin to protect the privacy of both sender and receiver, a new service is added, called an evaluator. The evaluator protects each user—sender and receiver—from having any direct knowledge of the other, by harnessing cryptographic zero knowledge protocols.

The method of this hiding is called “homeomorphic hiding (HH), a general umbrella term that does
not refer to any specific algorithm.

The following describes flow shown in Diagram B:

1. A sender signs a simple contract: “I will pay PTN amount P if a receiver can prove to me that he is at location L within margin of error M(L).” M(L) could for example be a circle of radius R around location L, so any point within one meter of L is contained in M(L).
2. The sender publishes this contract to the evaluator. Any details considered private are hidden using homeomorphic hiding (HH).
3. The sender pays the evaluator amount PTN P. This functions as an escrow deposit; the evaluator will pay this P to a valid receiver when such receiver offers a valid claim. In other words, The evaluator knows that the sender’s node S will pay HH(P) if a receiver node R can prove that they’re at location HH(M(L)).
4. The evaluator returns to the sender a token expressing that the claim is registered and valid.
5. The sender publishes to the map his announcement that he will pay PTN P to anyone in area M(L) and supplies the token from the evaluator.
6. The map validates the token, and publishes the information on its public map.
7. Receiver sees PTN amount P on the public map.
8. The receiver also sees that he is in or near M(L).
9. The receiver sends to the evaluator a claim that he is at HH(L’).
10. The evaluator now applies relevant methods (aka, zero knowledge) to compare the HH(M(L)) to HH(L’).
11. The evaluator finds that they match.
12. The evaluator transfers PTN P to the receiver’s address R.
13. The evaluator sends an updated token to the public map. By matching the token to the previous token, the public map can update its information and show that P at M(L) is no longer available.

Diagram B

Homeomorphic Hiding Scenario DRAFT
Mentors

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