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## **Project Sigma**

**Developing Decentralized Cellular Technology using a Blockchain and Onion Routing**

Ty Sands  
Primary Inventor

**Abstract:** We propose a new protocol for cellular communication based on peer-to-peer communication and micropayments. Onion routing provides privacy for transmissions, while GPS coordinates dictate the control frequency used for establishing connections with nearby devices. Nodes and participants can earn money by forwarding data between users, while a scanning method is used to eliminate congestion across the frequency spectrum.

## Background

- **Radio and Cellular Technology:** In the early 20th century, radio technology provided ships and the military the ability to communicate over the airwaves. Later, the first commercial radio broadcasts targeted consumers as the technology became more mainstream.

As these devices became more compact and power-efficient, walkie-talkies were created to allow people to communicate over long distances. While these devices are completely peer-to-peer, they have come to be largely replaced by cellular technologies.

Cellular networks operate by dividing regions into hexagonal regions known as "cells". These regions are generally between 1 and 3 kilometers in size, with a tower in the center of each cell. Each cell is assigned a control frequency such that no two adjacent cells have the same control frequency. Thus, only seven control frequencies are needed across the whole network.

Devices scan each control frequency for activity, contacting the tower with the strongest signal. The device and tower coordinate and establish communication on another frequency so the control frequency doesn't get jammed.

- **Currencies and Blockchain Technology:** In pre-recorded history, animals and humans didn't participate in trade. The earliest currencies were seashells and beads. Later, gold was used because it was shiny and attractive. The first banks held gold in vaults, issuing deposit slips and holding it in reserve. However, it wasn't long before banks figured out that they could hold only a fraction of deposits in reserve, since most people wouldn't ever redeem their deposit slips for the gold. In modern times, banks have managed to eliminate the gold from the equation entirely.

Blockchain allows for value to be transmitted in a trust-less way from one person to another, without the use of a bank. Bitcoin, the initial blockchain, was devised in 2008 as a solution to the long-standing "double spending problem". These blockchain-based assets form the foundation of the micropayment incentives model described in this paper.

## Prior work

- **Onion Routing:** Onion routing is a method by which communication can be secured.
- **TerraNet AB:** TerraNet AB is a project which attempts to link cell phones together. They have no economic model.
- **JoyStream 1.x:** JoyStream is a protocol for trading a cryptocurrency for bandwidth on a network.

## **Connecting to Peers**

We propose a solution for deterministically and independently deriving the control frequency used for peer discovery on a cellular network by the use of GPS coordinates, a hash function and some rules for dealing with edge cases.

## **Transferring Data**

We propose a solution for the incentivization of data relay by the use of a "micropayment-per-kilobyte" system. The sender asks a peer to relay data using a given peer in exchange for a certain amount of a utility token.

## **Finding a Route**

It is a well-known fact that decentralized routing across a large network of peers without central coordination is an unsolved problem. We propose a solution that would avoid this problem by storing the peer IDs of bridge nodes (nodes that connect directly to the internet) on nodes that connect to such nodes directly. Thus, the bridges become well-known and routes can be established.

## **Bridging and Internetwork Communication**

Since all nodes can earn money for relaying data across the network, nodes that are able to bridge between the internet and the decentralized network will receive a large amount of traffic. Competition will emerge as the number of bridges in a given area increase.

## **Data Stream Teleportation**

A problem emerges when two devices in geographically distinct locations attempt to communicate; such communication will be prohibitively expensive and will be subject to extremely high latency. For connections with particularly high hop counts, finding a path may also be difficult.

A solution is to connect all internet bridge nodes on an internet-based peer-to-peer network. This allows for each device to simply connect to a bridge, and for the connection to be routed across the internet.

## **Privacy**

Once a path has been found, the sender of a message can employ onion routing to encrypt their data across all stages of transmission.

## **Incentives**

For consumers, the network will generally reduce the cost of cellular service. This is because while they still need to pay their peers for routing data, the devices can earn back some of the money when the device forwards the data of others.

For service providers and network operators, a profit can be earned by relaying the data of others. Larger operators will be able to operate at lower cost, but the network will not become reliant on those large entities. They will be unable to impose censorship, and if they fail smaller bridges and towers will keep the network running.

## **Adoption**

Applications for existing handsets can be developed which modify the modem firmware and add compatibility with the network in addition to existing cell networks. Phones can be purchased and modified to use the technology, then resold.

Raspberry Pi computers and other devices can be sold as bridges between a home Wi-Fi network and the decentralized network, as a way to earn passive income.

## **Ramifications and Social Implications**

Building a decentralized, private and largely censorship-resistant network for communication will have a significant and notable impact.

## **Conclusion**

The widespread deployment of a purely peer-to-peer cell network would have widespread implications for society. This paper should be viewed as a foundation rather than a description of a fully-developed idea. Past attempts to build such a network have proven unsuccessful due to lack of an economic incentive.