Hypothetical Problems concerning the Theory of Relativity on Cryptographic Currency Implementations

Abrahim Ladha
Computer Security
Armstrong State University
abrahimladha@protonmail.ch

***Abstract*—this is my abstract section**

I. What is bitcoin?

History Bitcoin was invented by someone using the psuedonym Satoshi Nakamoto. In his original whitepaper titled ”Bitcoin: A Peer-to-Peer Electronic Cash System”, he introduces the concept of a decentralized and crytpographically secured monetary system. He also covers topics on proof-of-work, transactions, mining, privacy, and attacks on the network. [1] It was implemented as free software and released in January 2009. Unlike gold, bitcoin has no attachment to any sort of industry, so the price day to day price fluctuation is really based on nothing but speculation. It has been as high as 1000 USD per bitcoin. [2]

Units There can only ever exist a maximum of 21 million bitcoins. Each bitcoin can be broken up into a hundred million pieces, much like a single US Dollar can be broken up into one hundred pennies. The smallest unit of bitcoin is called a satoshi, which is 10^{-8}th of one bitcoin

Ownership Since bitcoin has no central authority, transactions are made user to user. A user can only send bitcoins to another user if they can digitally sign the transaction with their private key. Without the private key, a malicious user cannot sign the transaction and the coins cannot be spent.

Transactions A transaction is a data structure with a source of funds for the input and a destination, or the output. A bitcoin transaction is just 300 to 400 bytes of data. Once a bitcoin transaction is sent, it will be validated by that node. If valid it will propogate through the nodes to which it is connected sending a confirmation to the sender. The propogation grows exponentially across the network until everyone has received the message. To prevent spamming and denial of service attacks, each node independently validates each transaction before propogating it further. A bitcoin transaction has what is called *unspent transaction output*, or UTXO. These are indivisble units of bitcoin with an associated owner. These are recognized as currency units by the rest of the network and recorded into the blockchain. an owners bitcoin amount would be scattered UTXO from many transactions and many blocks.

mining Verifying transactions take computation power which takes time, money and electricity. Mining is the incentive. Mining is the process in which new blocks are added to the money supply. Miners are the ones to validate transactions and record them on the ledger. A new block containing the transactions since the last block is mined 10 minutes on average adding those transactions to the blockchain and considered confirmed. After coins are confirmed, this allows the new owners of those bitcoins to engage in transactions. This is how the problem of double-spending coins is prevented.

II. The Theory of Relativity

history In physics up to this point in history, there had been a major inconsistency with the laws of physics between mechanics and electromagnetism. In 1905, Albert Einstein published a series of papers showing that just with two simple postulates, classical physics was simply an approximation that got more inaccurate at very large values. Relativity was the puzzle piece to fix these inconsistencies. Conseguences of Relativity are even proved to this day, with the recent discovery of gravitational waves.

Postulates Einstein's Theory of Relativity is based upon two postulates:

1) The Laws of Physics are the same for all observers in all inertial reference frames. No one frame is preferred over the other.
2) The speed of light in a vacuum has the same value c in all directions and in all inertial reference frames.

Galileo's postulates stated that the laws of *mechanics* were the same in all inertial frames. Einstein extended this to all laws of physics, to include optics, and electromagnetism. The first postulate does not say that all quantities are measured the same for all inert observers, but the laws, the relationship between quantities, is the same.

The second postulate is more defining. Previously we had thought that there was no speed limit to anything, and you simply required enough energy to reach that speed then it was attainable. We now realize that no information can travel faster than light. We denote the speed of light as the constant $c = 299792458$m/s. No particle with mass can even reach this speed.

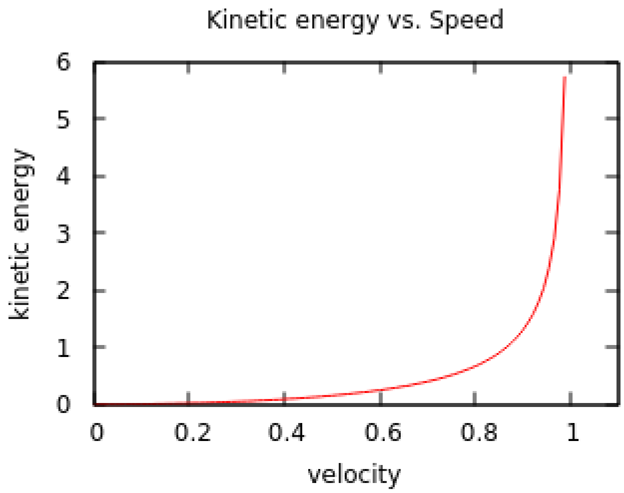


Fig. 1. Kinetic energy required to reach a certain velocity as a fraction of the speed of light. To reach the speed of light would require infinite energy.

Lorentz Transforms The Lorentz transforms are a system of equations that can be derived from Einstein's Postulates. They are for transforming reference frames. They are:

$$x' = \gamma(x - vt) \tag{1}$$

$$t' = \gamma(t - vx/c^2) \tag{2}$$

$$\gamma = \frac{1}{\sqrt{1-(v/c)^2}} \tag{3}$$

Notice that t' is dependent on position, that is to say, that space and time are entangled. This was a fundamental principle of Einstein's theory, one that was long rejected by his contemporaries. Why hadn't these been derived before? Well let $c \to \infty$ and our equations become $x' = x - vt$ and $t' = t$. These are the classical Galilean transforms, which work just fine at small speeds compared to c. From these, one could have deduced (incorrectly) that time passes at the same rate for all frames of reference.

Suppose two events occur at the same place in some reference frame, but at different times, then (2) reduces to:

$$\Delta t = \gamma \Delta t' \tag{4}$$

What this means is the faster you go, the slower time gets for you relative to slower frames. For example, if you leave earth when you are born on a rocket going $0.99c$ relative to earth, When the earth clock says it should be your 100th birthday, the rocket clock will say that you are only a little over 14 years old, and you will look and feel only 14.

If a rod is at rest in some reference frame, then any observer in that frame and easily measure its length by subtracting the positions of its two endpoints, that is to say, $L = \Delta x$. Suppose the rod is moving. The length of the rod can only be measured if the endpoints are measured *simultaenously*, which is to say $\Delta t = 0$, then (1) reduces to:

$$\Delta x = \frac{\Delta x'}{\gamma} \tag{5}$$

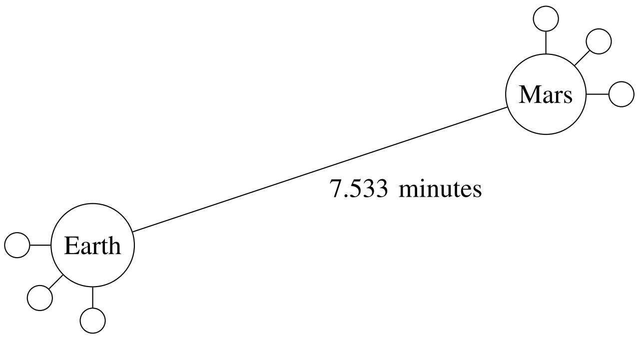
What this means is that the faster something is moving relative to you, it will appear longer to you. For example lets say you are in the same rocket going $0.99c$. If you on your rocket measure it end to end to be 100 meters, then on earth they will measure it to be a little more than 708 meters.

Example Problem To demonstrate some of this material, we present a famous example problem. There are two planets known to be hostile towards one another, A and B which are 4.0×10^8m apart. You are in a rocket traveling at $0.98c$ relative to A and B. Your rocket follows a straight line, first past A, then B. You detect a high energy microwave signal from A and then, 1.10s later, an explosion on planet B. Clearly A has attacked B. Should you prepare for a confrontation? First we set up our reference frame. We let the rocket be stationary and the A-B planetary system moving at $0.98c$ relative to the rocket. We could have chosen another equivalent reference frame but this will make calculations simpler. let x_A and x_B denote the position of the signal from A and the explosion on B respectively, and t_A and t_B the times. Therefore $\Delta x = x_B - x_A = +4.0 \times 10^8$m, and $\Delta t = t_B - t_A = +1.10$s. We now transform the reference frame to that of A-B and calculate $\Delta t'$ and $\Delta x'$. with $v = 0.98c$, $\gamma = 1/\sqrt{1-(v/c)^2} = 1/\sqrt{1-(0.98c/c)^2} = 5.0252$. Therefore $\Delta x' = \gamma(\Delta x - v\Delta t) = 3.86 \times 10^8$m, and $\Delta t' = \gamma(\Delta t - v\Delta x/c^2) = -1.04$s. Well $\Delta t'$ is negative. What does this mean? Well $\Delta t' = t'_B - t'_A = -1.04$ seconds. This tells us that $t'_A > t'_B$ which implies that the signal happened 1.04 seconds *after* the explosion. But we witnessed the signal *before* the explosion, so which is it? If there is a relationship between these events, then information must travel from one to the other. If we check the speed of this information, we see $v_{info} = 4.0 \times 10^8$ meters / 1.10 seconds $= 3.64 \times 10^8$ m/s. But this speed is impossible since it exceeds c. Therefore neither event is dependent on the other, and these are unrelated events.

III. GRAPH THEORETIC MODEL OF OUR NETWORK

We first contruct the structure in which we will base our network models on. Our structure will be a simple graph with weighted edges. Each node will represent a user on our network. An edge will form between two nodes if and only if they are connected peers on the network. Not all peers connect to each other so our graph is not necessarily complete. The weight of an edge is a variable real number which represents the time in which it takes information traveling the speed of light to reach the other node. We will consider nodes travelling with non zero velocity but none of the cases of acceleration. This puts us squarely in the realm of special relativity.

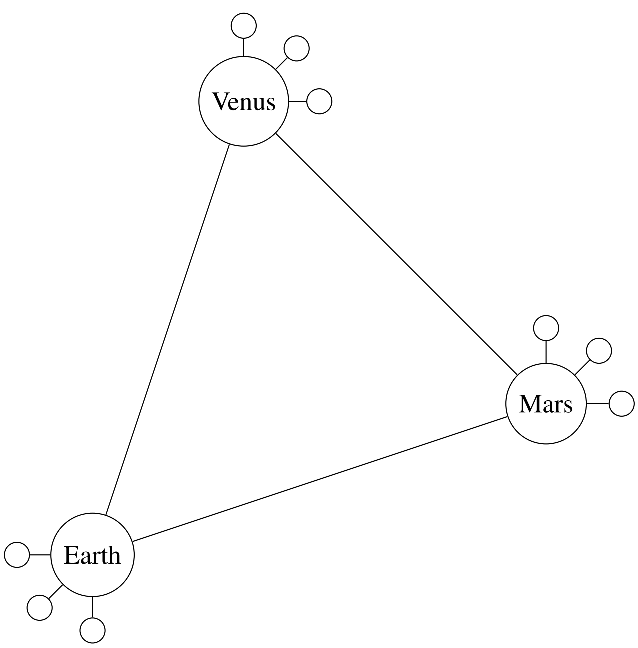
pool mining of two nodes Consider the of only two simplified nodes. For this example we use the Earth-Mars planetary system. All the miners on Earth have formed a pool, as have the miners on Mars. transactions from Earth to Earth or Mars to Mars is no big deal. If a transaction from Earth to Mars is created, sending the information at the speed of light would take over seven minutes just to reach the other planet.



If we chose planets farther and farther apart for our example, the distance between them would become larger and larger and sending shares would take more time. If a transaction is sent, the entire network must also verify the transaction before a new one can proceed. We will discuss this more in the section on propogation. [3]

Because we only have two main nodes, we only have two cases. If one is greater than the other or if they are both equal. The second case is a statistical improbability so we will not consider it (All it takes is one user on either side to drop out of the pool for this case to reduce back to the first case). Consider the case where Earth is greater than Mars. Since there are only two nodes, Earth must have greater than 50% of the network. Then nearly 100% of the blocked solved would be on Earth, as if a miner on Mars wants to submit shares, The delay between Earth and Mars must be accounted for, and as that distance increases, the probability that shares from some planet arrive stale to Earth increases as the distance increases. The 51% attack is also entirely possible, and Earth miners could censor transactions to and from Mars.

pool mining of n nodes Now we consider generalizing the previous case to some n nodes.

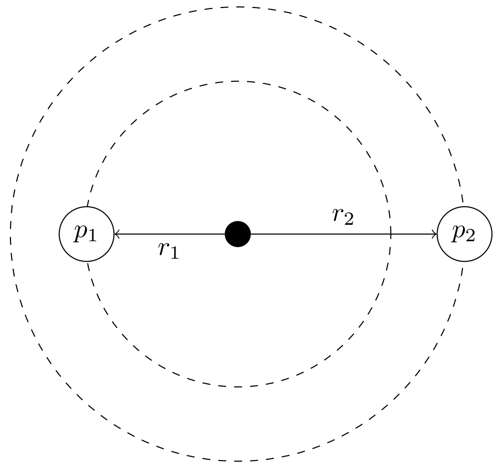


With 3 or more nodes, We avoid the immediate outcome of the 51% attack. ... ADD MORE HERE LATER

IV. Rotational Scenarios

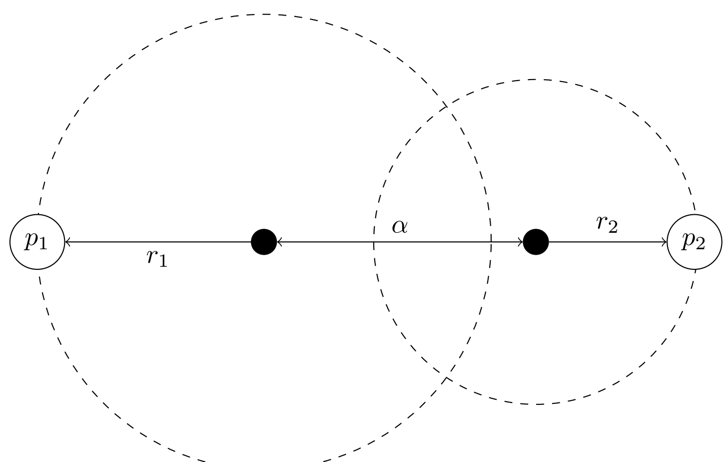
We now give several cases of which to determine the blocktime for this system.

concentric orbits Consider the case of two planetary bodies in the same solar system. They orbit some large mass at the center, like a sun or a black hole.



We want to choose a blocktime in which these two planets can still submit shares to each other reasonably. Well The maximum distance these two planets can ever be apart is the sum of the two radii. The blocktime should then be chosen to be greater than this worst case scenario. If we henceforth denote b as our blocktime, then the blocktime should be greater than the average of these to radii, that is: $b > \frac{r_1+r_2}{2}$. To generalize this for some n planets, simply pick p_1 to be the planet of smallest radius and p_2 to be the planet of largest radius.

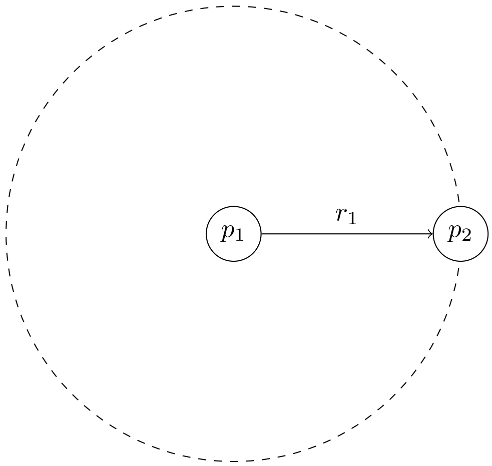
separate orbits Consider the case of planets in two separate systems.



This ends up being a very similiar case. We choose our blocktime here to be $b > \frac{r_1+\alpha+r_2}{2}$.

BLAH BLAH BLAH GENERALIZES THE SAME AS POOL MINING OF N NODES WHICH ISNT ADDED YET

planet - satellite relationship



V. Reforking Blockchain

ayylmao

VI. Linear Scenarios

proof of only two cases Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

moving towards Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

moving away Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim.

Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

VII. Propogation

blockchain sync problems Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

sidechains effect Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

VIII. Extras

mining security with thermodynamics Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

quantum computings effect on mining Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

information loss due to blackholes Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

References

[1] N. Satoshi. (2008) *Bitcoin: A Peer-to-Peer Electronic Cash System* [Whitepaper] Available: https://bitcoin.org/bitcoin.pdf

[2] M. Farrell. (2013). *What Bubble? Bitcoin Tops $1000* [Online]. Available: https://blogs.wsj.com/moneybeat/2013/11/27/what-bubble-bitcoin-tops-1000/

[3] J. K. Author. (year). *Title* (edition) [Type of medium]. Available: https://www.example.com