Bodhi: Decentralized Predictive Market at Scale

White Paper

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Abstract

In this paper, we introduce Bodhi, the next generation blockchain based platform that decentralizes the prediction market. Bodhi leverages the advantages of the state-of-the-art decentralized prediction markets by integrating third-party Oracles and voting based decentralized Oracles via its Oracle abstraction layer. We introduce a novel replaceable Oracle framework where the prediction market is more effective and autonomous. Bodhi will be deployed on Qtum at the initial launch.

Keywords

Bodhi, Prediction Market, Smart Contract, Qtum, Ethereum

I. Introduction

Humanity has developed strong interests towards understanding history and predicting the future. What is the weather like tomorrow? Which soccer team will win the UEFA European Championship this year? Is Apple stock going below 100 USD per share on the first weekday of next year? People bet on their preferred results of simple yet non-trivial questions. The desire to predict what happens next generated heavily regulated conventional prediction markets such as lottery systems and stock markets, as well as illegally operated underground casinos and insider

trading. Excessive regulation and legislation, implemented at large monetary costs, greatly limit the prediction market from performing its market functions. Meanwhile, conventional prediction markets have been heavily depending on centralized Oracles who set all prediction results and their fairness and charge a large amount of money. Oracles' high cost has significantly lowered the users' return and prevented the prediction markets from a large scale adoption.

Prediction Market is a platform that allows individuals or a group of entities to predict the outcomes of future events and being rewarded from the results. Fortune will be redistributed upon the realization of outcomes of an event in which all parties participated. The fortune redistribution follows a simple yet powerful rule, that the fortune flows from losers to winners. In order to win the prediction, participants aggressively gather information, and apply mathematical modeling to maximize the chance of prediction accurately. The price associated with each outcome has high positive correlation with each outcome statistically. Meanwhile, the accuracy of the prediction is largely determined by the number of participants. Starting from the very beginning of information revolution, people has been devoted to making online prediction markets to minimize the onboarding barrier for participating in prediction. However, centralized online products have yet to earn people's trust while excessive regulation and legal restrictions also greatly limit the development of the prediction market.

With the deluge of the continuous development of blockchain technologies, there is an increasing trust within communities on enabling public blockchain as Oracle that is fair and decentralized. Blockchain technology is a perfect candidate to form the building block of prediction market due to its characteristics such as information transparency and data immutability. The fairness of blockchain makes the prediction market run at low-to-no administrative cost. The application of Smart Contract empowers blockchain with a programmable and dynamic decision-making capability. All of the above emerging phenomenon resulted in the creation of decentralized prediction market.

Bodhi's mission is to build a credible, autonomous, and scalable prediction market that promotes the application of prediction market at a global scale to enhance the effectiveness of decision-making process [1].

II. Related Work

Augur [2] is a blockchain based decentralized prediction market. A user can create a prediction event using Ethereum's [3] smart contract, followed by other users' bets on their preferred results. When event eventually happens, Augur REP holders report to Augur the right prediction result. The REP holders are the building blocks of Augur platform, where these holders maintain the platform and constitute the arbitration mechanism. However, as the Augur platform scales, a fully decentralized arbitration mechanism becomes less efficient. When a large group of prediction events have been created, it is increasingly challenging for REP holders to vote for all events. REP holders might also have different domain expertise and have been exposed to events at different comfort levels. The matchmaking process between an event and event-specific expertise has yet to be improved. Moreover, problems such as high time-cost and low efficiency associated with REP holders result in a longer cycle to reach a consensus at the end of a prediction event.

Similar to Augur, Gnosis [4] is another common blockchain based decentralized prediction market that utilizes Ethereum's smart contract for event creation and prediction. Unlike Augur, Gnosis leverages a default centralized Oracle for judging prediction results. The advantage of using such as centralized Oracle solution is that prediction judgment can be performed autonomously and therefore significantly increases the judgment efficiency. However, a centralized Oracle solution can cause single point of failure in the events of, eg., server failure, and data being maliciously tampered. When any of such events occurs, all bets will be locked and the credibility of Gnosis platform will be decreased.

Bodhi is the next generation blockchain based platform that decentralizes the prediction market

by overcoming the disadvantage of both Augur and Gnosis. In contrast to Augur, Bodhi uses third-party Oracle to automatically judge the prediction results to guarantee the efficiency of the decision making process. Different from Gnosis' centralized Oracle solution, Bodhi enables Bodhi Token holders to take over the voting process and make the final decision of a prediction event in the event of Oracle failure.

III. Bodhi Overview

Bodhi, the next generation blockchain based prediction market, leverages the advantages of the state-of-the-art decentralized prediction markets by integrating third-party Oracles and voting based decentralized Oracles via its Oracle abstraction layer. We introduce a novel replaceable Oracle framework so that the prediction market is more effective and autonomous.

Bodhi will first be deployed on the Qtum [5]. As more users around the world are accessing the Internet from mobile devices rather than from desktop computers, mobile computing will be increasingly important to prediction markets. Qtum combines the advantages of Bitcoin and Ethereum to provide better user experience on mobile devices. Event forecast is very time-sensitive, but smart contract can only rely on the number of blocks to estimate the time. However, Ethereum has yet to implement the Proof of Stake (PoS). As the Difficulty Bomb of Ethereum's current Proof of Work (PoW) starts to take effect, the block time is increasing exponentially, as shown in Table I, which greatly affects the estimated time of the forecast. Qtum, which is different from Ethereum, will ensure the stability of the block time by introducing PoS at the beginning its release. Bodhi will firstly be deployed onto Qtum to avoid existing problems with Ethereum. However, as the user base grows, we do not eliminate the possibility to roll out Bodhi onto other public blockchain.

Block Number	Time	Block Time
3000000	2017-01-16 00:38:33	14.86
3500000	2017-04-11 18:09:34	15.27
4000000	2017-08-15 18:20:24	30.01
4500000	2018-11-03 05:55:48	136.71
5000000	2025-10-02 11:47:30	835.81
5500000	2128-03-20 09:14:16	17183.83
6000000	5189-09-26 20:57:59	520901.19

Table I
THE EFFECTIVENESS OF DIFFICULTY BOMB AFFECTS BLOCK TIME

Bodhi uses third-party Oracle to automatically judge prediction results to guarantee the efficiency of the decision-making process. Bodhi Token holders can take over the voting process and make the final decision for a prediction event if Oracle fails. Algorithm 1 shows how Bodhi works.

As you can see, Bodhi's Oracle is replaceable. If consensus cannot be made through arbitration, users can continue to make deposits to request the next iteration of arbitration. As the number of rounds increases, more pledges get accumulated and Bodhi Token (BOT) holders are more motivated to maintain the accuracy of the Bodhi platform to protect their token value. Ultimately, arbitration result will converge to an accurate state. Bodhi leverages the advantages of the state-of-the-art decentralized prediction markets by integrating third-party Oracles and a voting based decentralized Oracle via an Oracle abstraction layer. This method combines the advantages of existing decentralized prediction market.

Algorithm 1 Bodhi Algorithm

User creates a prediction event on Bodhi
Users bet on the prediction event
When a future specified time arrives, Oracle automatically polls the event result from outside and determines the prediction result.
$Agreement \leftarrow False$
while $Agreement \neq True$ **do**
    Publish decision on prediction market for 48 hours
    if Consensus is made & Oracle is valid **then**
        $Agreement \leftarrow True$
        Users who predict correctly get principal and reward
    else
        $Agreement \leftarrow False$
        Users deposit to request next iteration of arbitration
    end if
end while

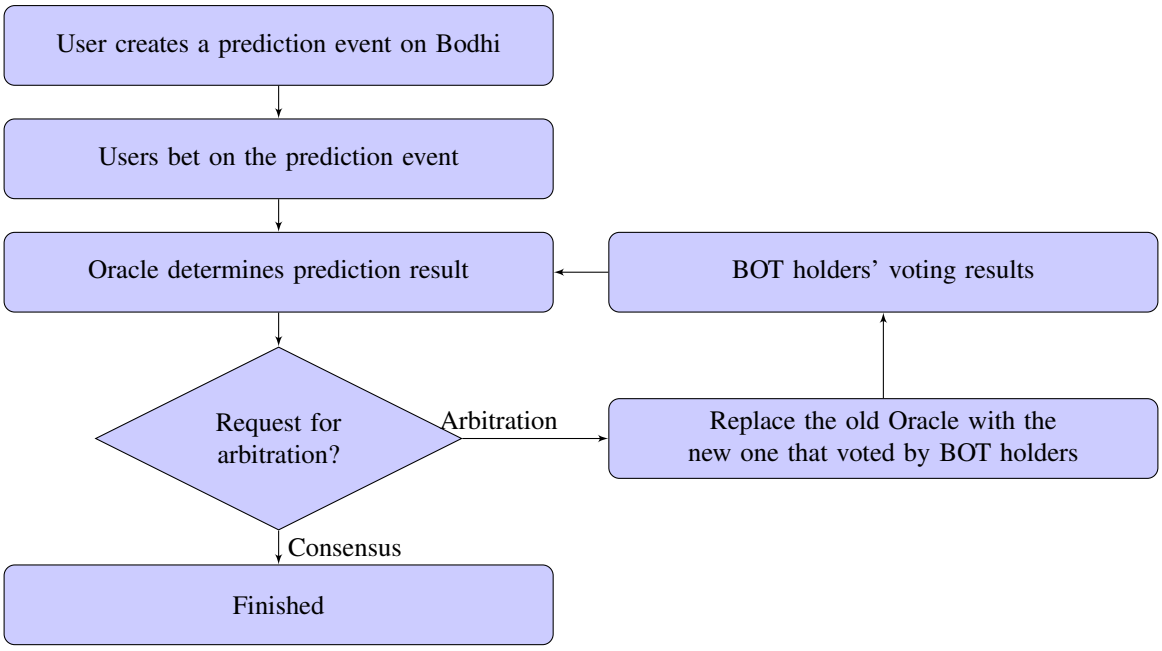

Figure 1. Bodhi Platform Operation Diagram

IV. BODHI PREDICTION MARKET PRICING

Bodhi is committed to creating a free, low-cost prediction market. On Bodhi, Oracles serve as judges and BOT holders are maintainers. Incentive (service fee) is provided to motivate more Oracles to provide credible and stable services for Bodhi.

Equation 1 shows how the rate is calculated. Let F_s be the percentage of the service fee and F_t be the percentage of the transaction fee. S_{loss} denotes the total loss of all parties that failed the prediction and S_{win} denotes all the gains from all users that win the prediction.

$$S_{win} = S_{loss} \times (1 - F_s - F_t) \tag{1}$$

F_s and F_t will be dynamically determined in the future as we plan to create a prediction event to let all BOT holders determine the best fees .

V. BODHI TOKEN

The token for Bodhi prediction market is called Bodhi Token (BOT). BOT will be issued during the crowdsale phase, with a total of 100 million units.

In order to ensure the simplicity and independence of platform logic, Bodhi does not issue WIZ tokens like Gnosis. At the initial phase when we take Bodhi online, we will only support BOT and QTUM. Users may hedge to link together their bets and the respective fiats. With the rapid evolvement of blockchain technology, stablecoins and cross-chain technologies are emerging. In the near future, Bodhi will allow the use of any cryptocurrency to participate in the bet.

BOT represents two main interests:

1) Arbitration and Compensation. BOT holders are entitled to initiate arbitration for disputed results of prediction events and receive compensation accordingly. Before initiating the arbitration, a BOT holder must lock up certain amounts of BOT as deposit. If the arbitration result is in favor of the BOT holder, the holder is entitled to receive certain amounts of BOT as compensation from the losing party of the arbitration.
2) Vote and Reward. BOT holders are entitled to vote for arbitration results of the disputed prediction events and receive rewards accordingly. Before voting, BOT holders must lock up certain amounts of BOT as deposit. If a BOT holder's vote is consistent with the arbitration's final result, the BOT holder is entitled to receive certain amounts of BOT as reward from the losing party of the arbitration. In addition, BOT holders may shut down illegitimate and malicious prediction events through voting procedure.

VI. Bodhi Review Mechanism

Bodhi is a blockchain based free prediction market. However, a free market does not mean that Bodhi is a completely unmonitored platform. Bodhi platform will provide a decentralized review mechanism where BOT holders can vote to eliminate illegal and malicious predictions to protect their interests.

VII. Bodhi Development Timeline

Bodhi prediction market token ICO is scheduled at September of 2017. Qtum testnet deployment of Bodhi prediction market beta version is scheduled at December of 2017. The MVP, production and premium versions will be deployed onto Qtum main net in 2018 and 2019 respectively. Figure 2 shows the detailed development timeline for Bodhi.

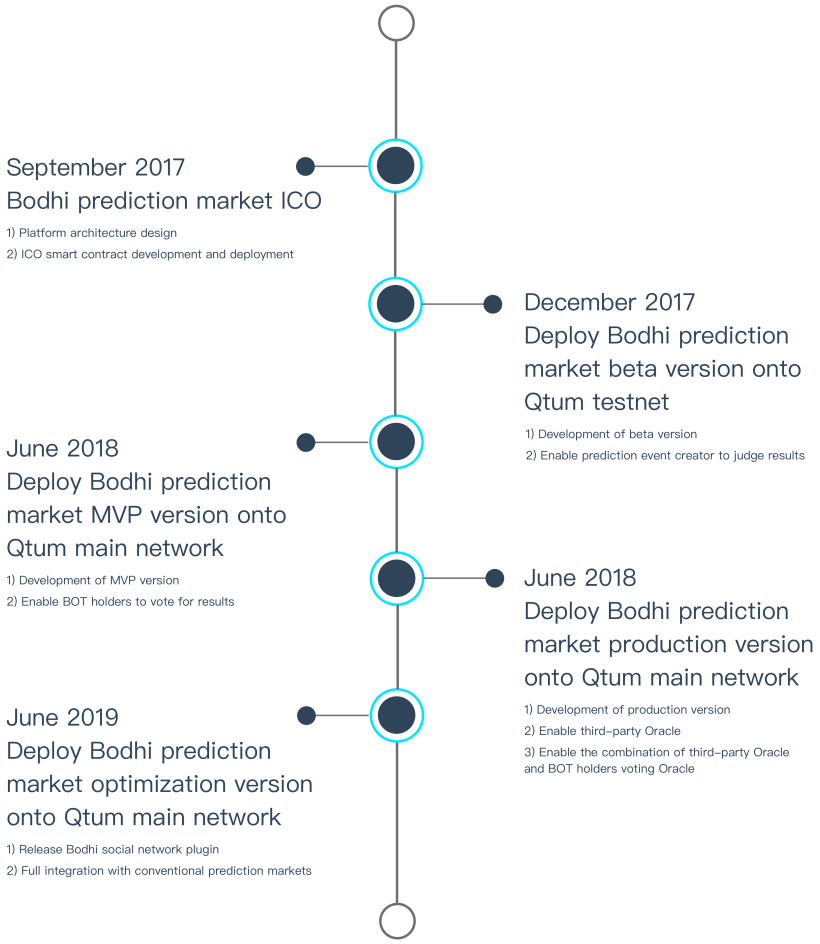

Figure 2. Bodhi Development Timeline

VIII. Applications of Bodhi Prediction Market

A. *Financial Tool*

Conventional financial market forecasting tools have limitations such as high service costs, professional barrier, poor scalability, limited ability to express, lack of accuracy, low efficiency, etc. Bodhi prediction market overcomes those limitations by providing a more detailed description

of economic events, where value and risk assessment can be thoroughly made at both macro and microeconomic level. Therefore, Bodhi reduces service costs, removes professional barrier, improves accuracy and efficiency and scales easily. For instance, a simple prediction event - What is the opening price for Apple stock at January 1st 2018? - conventional financial market prediction tools need to analyze investment environment, basic corporate information and their finances to calculate investment returns, before giving an incomprehensive prediction result. Using Bodhi, however, the prediction result is calculated by the entire network for better accuracy and efficiency, as well as lowering the cost. The same mechanism can be applied to predict other stocks at any given time.

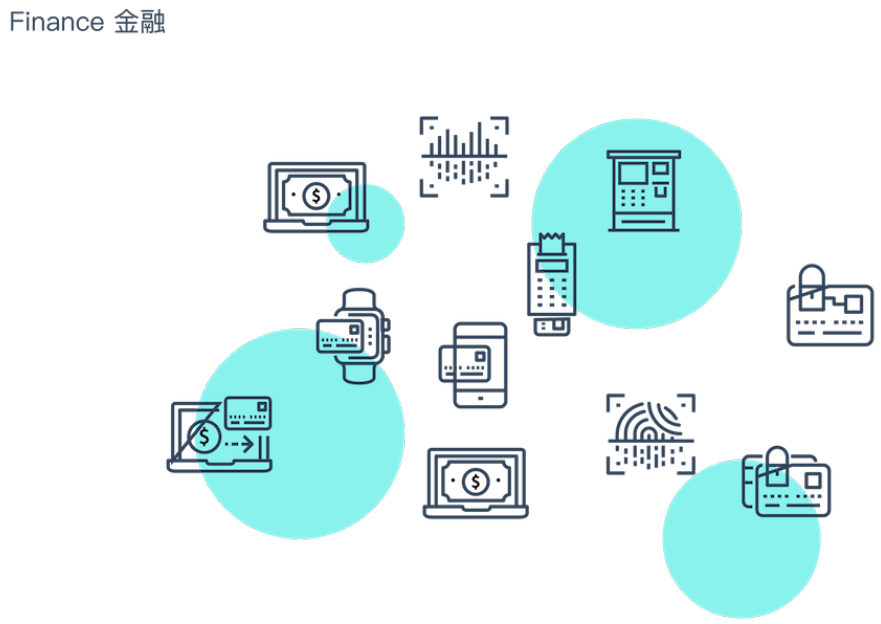

Figure 3. Financial Tool

B. Information Management

Information plays a critical role in the development of society where many decisions are made based on accurate and reliable information. In order to obtain accurate information to

improve decision-making accuracy, people use a variety of information retrieval methods, e.g., surveys and paid data. However, these information retrieval methods are considered costly and unscalable. Prediction markets can motivate people to provide information proactively with bet. In 1988, professors at the University of Iowa created a prediction market where participants can bet a certain amount of money to predict who would be elected as the next US president. Since then, the market has predicted for every US presidential election, where the prediction accuracy is much higher than the political commentators and the results of public polls. Bodhi enables prediction markets creation as ease. The value flow of the blockchain is becoming a profound foundation for prediction markets. Bodhi make prediction result more accurate due to its decentralized characteristics and large-scale user engagement.

Figure 4. Information Management

C. Insurance

Insurance industry has various effects on society through the way that it changes who bears the cost of losses and damage. Traditional insurance industry typically has long and complex claim process due to its centralized management. The massive agent model that is used to drive the business has introduced high operational cost. Bodhi's decentralized solution is a natural fit to solve these problems. Taking flight insurance as an example, passengers can bet on a flight delay before boarding. In most cases, the flight will be on time, so that the bet token will be locked in the smart contract of the prediction event. Should a flight delay occur, the Oracle will write the flight number of the delayed flight to the smart contract. The Bodhi platform will automatically process the claim for the passengers who purchased the flight insurance on the corresponding flight. The entire process is fully automated so that no human intervention is needed. Most of the fund will be used to reimburse passengers and the platform only charges a small portion as service fees.

Figure 5. Insurance

D. Sports Lottery

The global online sports lottery is a huge market with billions of dollars of regulated market funds. Sports lotteries are highly localized where each lottery market operates individually due to the difference in regulations among the regions. Accessibility is limited in those localized markets where data is isolated and fragmented. Data isolation and fragmentation have limited the accessibility of those localized markets where it is impossible to create new interesting lotteries in a timely manner. Regulation is a double-edged sword. On one hand, data shows that the unregulated lottery market is 10 times of regulated ones, which makes fraud and illegal operation a common regulatory issue of the global lottery market. On the other hand, centralized service is prone to hacking, system failure and other uncertainties from service providers. These uncertainties ultimately result in high cost of creating lottery market and user taxation. It further limits the lottery markets from high user engagement and being free markets. The public has associated the lottery markets with speculation, due to its high risk profile. Bodhi brings an innovative way to solve these problems. Bodhi is an open platform based on blockchain where anyone can be transparently involved. Users can create prediction events without high transaction fees. This free and open platform will greatly improve market liquidity and thus create objective odds.

Figure 6. Sports Lottery

E. Conventional Prediction Markets

Although conventional prediction markets will still play critical roles and involve in decision-making processes in all market segments, we foresee the globalization trends in participating and collaborating in prediction markets. Bodhi is committed to building the next generation decentralized prediction market. In the near future, Bodhi will co-exist with conventional prediction markets and will gradually serve itself as an infrastructure of conventional prediction markets to lower the operational cost. Bodhi platform provides most if not all logic to implement prediction markets where it creates alternative solutions that allows conventional prediction market to operate on Bodhi's infrastructure. Bodhi significantly lowers the system failure rate and operational cost, and it enables users to enter the market easily.

Figure 7. Conventional Prediction Markets

IX. Bodhi Token Crowdsale Plan

A. *Bodhi Token Distribution*

BOT will be issued during the crowdsale phase, with a total of 100 million units. Table II and Chart 8 show the allocation plan of BOT. Participants will get BOT right after crowdsale. Bodhi employees will be granted restricted BOT upon employment. These BOT will be eligible to vest upon the satisfaction of a service condition. The service condition is vested over four years, with the first 20% vested upon the completion of crowdsale, second 20% vested on the one-year anniversary of vesting commencement date and the rest of 60% vested monthly thereafter, subject to continued employment.

1) Vest 20% BOT after crowdsale
2) Vest additional 20% BOT in one-year cliff.

3) Vest 60% BOT monthly in the next three years

Table II
BOT ALLOCATION

BOT Percentage	Allocation
60%	Issued to crowdsale participants
15%	Development and Consulting
10%	Employee incentives
10%	Early stage emergency arbitrations locked by Foundation
5%	Bug bounty

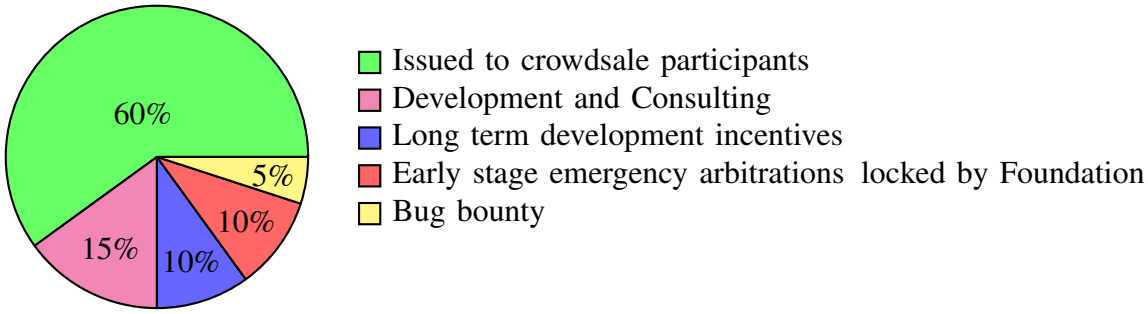

Figure 8. BOT Allocation

B. Crowdsale Fund Allocation:

The budget from crowdsale fund will be allocated for the following purposes by the foundation, see Table III. The budget covers a 5-year period.

Fund Percentage	Allocation
65%	Development
10%	Consulting
10%	Legal
10%	Marketing
5%	Misc.

Table III
CROWDSALE FUND ALLOCATION

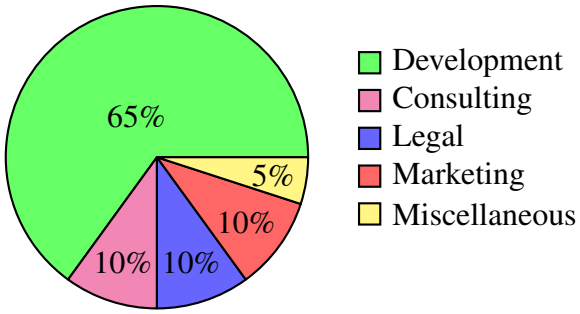

Figure 9. Crowdsale Fund Allocation

1) Development: Prediction market platform is a sophisticated system that consists of a large number of subsystems. Sufficient funding needs to be allocated for recruitment, team building, and research and development.
2) Consulting: Prediction markets involve in many areas across different segmentations where domain knowledge is needed for carrying out market analysis. We will allocate fundings for consulting domain experts and corporations.
3) Legal: Prediction market is a highly-regulated segment and therefore legal service is needed to ensure the regulatory compliance. We will allocate fundings for general legal advice and emergency legal services.
4) Marketing: Branding and marketing operations are important pieces to promote Bodhi to potential customers for growth. We will allocate fundings for promoting Bodhi platform and blockchain industry in general.
5) Miscellaneous: Miscellaneous expenses that exclude all above expenses.

X. Summary

Bodhi is a Qtum based platform that decentralizes the prediction market and enables free flow of valuable information via public wisdom and incentivization. Bodhi leverages the advantages of the state-of-the-art decentralized prediction markets by integrating third-party Oracles via its Oracle abstraction layer and a voting based decentralized Oracle mechanism. We introduce a

novel replaceable Oracle framework so that the prediction market is more effectiveness and autonomous. Bodhi is committed to influencing the Chinese prediction markets through global engagement.

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