
ethbet

# Ethbet Whitepaper

Version 2.0



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## Abstract

Ethbet is a decentralized, peer-to-peer, and provably-fair Ethereum-based dicing game without a mandatory house edge. Ethbet is able to offer bets without a house edge because players bet directly against other players instead of against a centralized house. The disadvantage of this is that in order to place a bet, there must be another party willing to place the same bet. For this reason it is possible that a player must wait for their desired bet to take place, especially if it is very large. To combat this, an additional feature of an optional player-defined house edge is added, allowing players to offer and take ('call') bets with any house edge that they desire. Thus, a player that prioritizes speed over their expected return can agree to a bet that gives him a slight disadvantage (i.e., a bet that gives his opponent a small house edge). Similarly, a player that is patient and prioritizes their expected return can offer bets that the formerly mentioned player may choose to call. This results in a model where players are effectively able to become their own casinos, allowing market forces to provide players with bets as quickly as possible at the best possible rates. The Ethbet protocol features an efficient off-chain matchmaking relay in order to allow players to quickly and cheaply communicate their intent. The protocol can also be extended to support betting using any Ethereum-based (ERC20) token and for use with other games.

## Gambling Without a House Edge

A house edge is a statistical bias in favor of the house, so that the house has a slight advantage in every bet. House edges of various games found in physical casinos often range from 2% to 15%, with some games having a low house edge (such as craps) and other games having a higher house edge (such as slot machines). With the advent of online gambling using cryptocurrencies, various websites offer players relatively lower house edges, such as 1%. Although 1% sounds like a low house edge, one must keep in mind that this house edge is applied to every individual bet. Thus, if a player only places one bet, they are expected to lose 1% of it, on average. But it's likely that most players will want to bet more than just once. If a player places 100 bets, they are expected to lose 1% of each of those 100 bets, making it increasingly difficult for the player to turn a profit, inevitably leading to gambler's ruin (the player running out of funds). This is how dice sites are able to consistently generate steady streams of profit for their owners and investors – they slowly but surely make sure that the more people play, the more likely they are to lose all of their money to the house.

Betting without a house edge saves players much more than a trivial amount. Because a player's expected loss can be zero for every bet they make, they can now make hundreds or thousands of bets without statistically being likely to lose more and more of their money over time. With a house edge of 0%, a player's probability of gaining capital is equal to their probability of losing it – they are no longer making an inherently irrational decision with a negative expected gain.

## Provable Fairness

Most modern cryptocurrency dicing sites offer provably-fair betting. This is done by having a client seed and a server seed. The client seed is picked by the client, often generated randomly by default. The server seed is picked by the server. The server then hashes its server seed using a secure cryptographic hash function (such as a sha2 or sha3 function) and provides the hash to the client before their roll. Then the client submits their client seed and bet information to the server, and the server combines both seeds, using a public algorithm to generate a random number. After the roll has been made, the client is able to view the server seed that was used, and can confirm that the server did not modify the client seed or the server seed, and therefore also the result of the roll. This results in a roll that is mathematically impossible to bias or otherwise predict by either party, given basic assumptions including that the client does not use a predictable seed, and that the hash function used is secure. Although this model of provable fairness is suitable for a client-server model, it cannot be performed in a smart contract, as the blockchain is public information and no fully-unbiased source of entropy exists.

Most solutions put fourth to securely generate a random number on the Ethereum blockchain pose significant downsides, as there are too many actors that are able to influence the blockchain when money is at stake. For example, if the hash of the next Ethereum block was used as a source of randomness, then a miner can choose to modify a block before they publish it, or can decide against publishing a block altogether, depending on if it is favorable to them. Given that there have already been notable instances of miners acting selfishly in a way that hurts other users, this is not an acceptable solution.

RANDAO[1] attempts to solve the problem of untrustable miners by effectively crowd-sourcing entropy. Anyone who wants to participate in RANDAO may contribute to its pool of entropy, and is incentivized to do so as they are paid a small reward, which RANDAO in turn collects from those that call its contract. It would take every participant to collude with one another in order to manipulate the result[2]. Unfortunately it takes a wait time of several blocks for RANDAO to be statistically confident that a miner has not manipulated its pool of entropy. RANDAO is also limited in the amount of entropy that it can provide per unit of time, and potentially per unit of ether.

A similar algorithm called the Signidice[3] algorithm is being used by early versions of DAO.Casino[4], a blockchain protocol designed for provably-fair gambling. Although sound from a statistical and game-theoretic point of view, this algorithm is computationally expensive, relatively complex, and has been used less frequently in production settings. This RNG method is best implemented in a separate smart

contract that has a large amount of participants that are unable to collude among each other. Due to the complexity and amount of risks involved with this algorithm, we have chosen not to adopt it.

One solution which is used by Etheroll[5] and others is to use Oraclize[6] and random.org[7] to generate a random number. Oraclize is a service that fetches external (outside of the blockchain) data for use on the blockchain. Oraclize makes a call to random.org, returning the integer roll from random.org, the id associated with it, and a TLSNotary proof[8], showing that Oraclize did not modify the result. As the id associated with the bet (returned from random.org) is supplied as well, it can be shown that Oraclize only made one call to random.org for every call it was requested to make. This solution has two downsides, the first being that it introduces a liability of depending on Oraclize, which is not desired. The second is that random.org must be trusted to provide a secure random number. This solution is currently implemented in at least one decentralized dicing game due to the lack of appealing and efficient alternatives. Performing statistical analysis on the results that have been returned from Oraclize via random.org, it appears that this solution has thus far succeeded (with high probability) in its goal of providing a source of entropy that is unbiased. Although the previously mentioned issue of a miner choosing not to publish a block if it would result in a RNG output that is detrimental to them re-occurs in this scenario (with Oraclize instead of the miner, however), a single instance of this occurring could be detected as there would be a gap in the integer IDs returned from random.org. If, hypothetically, Oraclize attempted to game this system, it could only be done once before it ceases to work (as they would no longer be trusted afterwards).

An additional solution is currently being tested by Oraclize[9]. This solution involves a hardware random data source that is integrated with the Ethereum network. The random bytes generated by the data source are periodically published onto the Ethereum network along with a proof that they have not been modified. Although fully functional, it is currently only available on the testnet. When available on the mainnet, this will likely become the best option to use for Ethbet's source of randomness. Until that period, the aforementioned solution that has an additional liability of random.org is scheduled to be used for Ethbet.

Additional models of provable fairness are being investigated that leverage the off-blockchain relay. More updates will be posted about this as development progresses.

## The Optional Player-Defined House Edge

Placing bets with a house edge of 0% does not come without a disadvantage, i.e., a bet can only take place if there are two parties that wish to make it. As bets are significantly more advantageous for players when made with a 0% (or otherwise negligible) house edge, network effects may cause the majority of players to use Ethbet, as it will be more profitable than other betting alternatives. Even with

this, however, it may be possible that players are not content with the amount of time they have to wait between bets, especially for larger bets, which fewer players are willing to call. To solve this problem, an optional feature is added: allow players to offer and call bets with a player-defined house edge.

With the ability for players to offer and call bets with an arbitrary player-defined house edge, the problem of large wait times for bets can now be solved with negligible downsides. Players are effectively able to become their own casinos within Ethbet, setting their own house edge. As every player that offers bets is competing against other players to have their bets taken, they are incentivized to set their house edge as low as possible.

For example, if a player wants to make a very large bet, they may be incentivized to offer a house edge to whoever calls the bet, so that they do not have to wait too long for someone to bet against them. This player decides to prioritize speed over their proportional expected gain.

Similarly, if a player has a large amount of ETH and wishes to make a profit over time with it (with high or variable probability), they can offer bets with a small house edge in their favor, making it easier for others to play the game while giving them a small profit over time for their service. This player is providing ‘bet liquidity’ to Ethbet by acting as their own casino, and in return is rewarded with a house edge in their favor.

## Market Potential

The global online gambling market is estimated to be worth over $50 billion USD by the end of 2017[10] and is forecast to grow by around 10% for years to come[11]. With the advent of cryptocurrencies, allowing players to gamble with ease and with a lower house edge than previous options, cryptocurrency gambling has already garnered a significant proportion of this market potential. A 2013 estimate suggests that up to 50-60% of all bitcoin transactions were related to gambling at one point[12]. Although previously dominated by Bitcoin, Ethereum has become a major player within the cryptocurrency world, offering significantly more features as well as a shorter block time and lower transaction fees. As Ethereum gains more users it benefits from network effects, which are currently leading many users to invest in and use Ethereum over Bitcoin, leading its market cap to increase to $38 billion USD in June, 2017[13]. Although it is already possible to gamble using Ethereum, even via a smart contract[14], players are still faced against a house of 1% or more, which is significantly detrimental even to casual players, as mentioned above.

Given that Ethbet will be able to provide the most competitive house edge that the market allows for, there is a strong possibility that it will acquire a significant proportion of the cryptocurrency gambling

market share, as there is no reason for a user to gamble against a house edge of 1% or higher when they can instead gamble with house edges significantly lower, or possibly zero. Ethbet can allow users to bet any amount that is technically possible, using any house edge that they desire, potentially deprecating all other forms of gambling for users that wish to maximize their expected value.

Bitcoin dicing sites such as PrimeDice and SatoshiDice (among many others) have reported profits of millions of dollars, with SatoshiDice selling for 126,315 BTC in 2013, which was ‘only’ $11.47 million USD at the time[15]. Ethbet has significant advantages over these platforms, including that it is decentralized, transparent, peer-to-peer, uses Ether over Bitcoin, and, crucially, provides the lowest possible house edge. For the aforementioned reasons, the market potential of a platform such as Ethbet is extremely large.

## Ethbet Tokens (EBET)

For the purposes of decentralization, enforcing beneficial market incentives, decentralized governance, further developmental funding, and future endeavors of Ethbet, an Ethbet token (EBET) has been created on top of the Ethereum network. EBET is a standard ERC20 token, and thus is secure, easy to store, use, and trade, as wallets and exchanges already have the needed technical infrastructure to interface with tokens that implement the ERC20 interface. For the technical details of the ERC20 specification, see the EIP on Github[16].

An early version of Ethbet will use EBET as the supported betting currency. Later on, EBET can be integrated in other ways, using it as credit for the platform, as fees, and allowing those that own EBET to help steer the platform in their desired direction. In order to provide incentives to run Ethbet relays as described later in this paper, a small fee can be charged for the service of matchmaking. This fee is dynamic and fluctuates based off of the bet liquidity of the platform. For example, if few users are offering bets, the fee can be low or even negative, compared to a higher fee when many users are offering bets. Additional experimental features can be implemented as needed to encourage market adoption.

## Project Architecture

The structure of the Ethbet code is intended to be highly modularized, clean, and secure, with the full project functionality being split into several smart contracts based off of the principles of high cohesion and low coupling (where applicable). The contract for the crowdsale is separate from the contract for

the token, the contract for the game, and others. All contracts will be audited and tested extensively, ensuring that best practices are followed and no major bugs exist.

The first implementation of the Ethbet dice game will be relatively lightweight and is intended as a fully-functioning proof of concept. There are only three types of calls that can be made into the game contract: place_bet, call_bet, and cancel_bet (that the player previously placed, but that has not been called by another player). A bet is composed of several variables: the bet ID, the address of the player placing or calling, the bet amount, and the house edge.

The ability to decide the probability of winning a given bet (such as the ability of a user to set the ‘roll under’ or ‘role over’ values before their roll) will not be available in the initial version of Ethbet. Instead, the win and loss chance will be set to a static value of 50%. This is done for several reasons:

- The original implementation should be as lightweight as possible to encourage a small codebase and fewer potential bugs.
- The user experience should be as smooth and simple as possible, to decrease the overhead involved when users use the Ethbet platform.
- The market will likely have an easier time providing all types of players with a desirable selection of available bets if all bets have the same risk/reward ratio.
- Users are still able to manage their risk profile in an arbitrary fashion; they must instead make several bets with potentially differing amounts if they desire a certain ratio of risk to reward. In practice this causes the risk and reward ratio to be equivalent to one found in a variable-probability bet[17].

With that said, there is no reason why this feature cannot be implemented in some manner if the token holders are in favor of it.

## Off-Chain Matchmaking

When information is stored on the blockchain, a fee must be paid (referred to as gas) in order to provide an incentive for miners to include the information in the blocks that they mine. The more information that one wishes to store on the blockchain, the higher the fees will be. As the blockchain is immutable and must be stored by all full nodes, storing information on the blockchain is generally a costly transaction, and should be avoided if possible. The blockchain is secure and decentralized, but at the cost of extreme redundancy. For this reason, the blockchain is only needed when we desire a secure, decentralized, and immutable environment.

Offering and canceling bets on the blockchain is highly inefficient: if a player wishes to offer many bets and then cancel them, they will pay high gas fees to have that information stored on the blockchain forever, even if the bets are never actually executed. A solution to this is to match bets off of the

blockchain, and then have players confirm and execute their bets by submitting them via a smart contract.

This is a common system used by decentralized exchanges so that every order placement and cancellation does not need to be stored on the blockchain, and instead the blockchain is only used where its advantages of security and immutability are highly relevant, i.e. for the actual transaction.

One example of an off-chain matchmaking system is used by the decentralized exchange protocol 0x[18], where anyone is able to set up a 'relay' that allows for efficient communication of intent between exchange users. Users are incentivized to set up honest relays through a fee structure that allows them to profit off of providing this valuable service. Another example is the decentralized exchange known as EtherDelta[19], which hosts their own service that allows for this.

A system similar to this can be implemented within Ethbet: We can have a service that acts as a relay and functions separate from the blockchain which allows users to signal their intent. After a match can be found between the intent of two users, both users can submit their bet to a smart contract, which ensures that their bet is executed fairly and securely. This matchmaking service can be hosted by anyone as the code will be open-source. An official version of the service will be provided even though there is no obligation to use it or to use a matchmaking service at all.

This system offers a significant number of improvements over a more naive implementation in which all information is exchanged only via the blockchain. Aside from the significant reduction in fees for users, it allows bets to be communicated significantly more quickly and makes it much easier for users to cancel their bets safely. Instead of placing and canceling a bet by broadcasting and storing two pieces of information in the blockchain, a bet can be placed and canceled instantly and with zero fees by signaling intent and then revoking this intent afterwards.

## The Ethbet Protocol

The Ethbet protocol is a description of what information users need to relay to each other in order to signal their intent to bet assets. This protocol is open, meaning that it can be implemented and executed by any actor. There is no need to use a specific website, browser, or even medium of communication, as the information can be exchanged via any method including email, a forum post, or a physical message. In addition to this, the protocol is extendable in that it can be modified for use with not just Ether, but also with any ERC20 token on the Ethereum blockchain. This would allow users not only to bet with each other using Ether, but also any other Ethereum-based token. The original version and deployment of the Ethbet protocol will focus on Ether, leaving the option of arbitrary ERC20 token support for a later period.

The Ethbet protocol closely mirrors the protocol outlined in the 0x whitepaper[20], as the Ethbet protocol has almost the same goal's as 0x's: 0x intends to allow users to *exchange* tokens with each other, while

Ethbet intends to allow users to *bet* tokens with each other. The following example demonstrates a scenario of two users using the Ethbet protocol to make a bet with each other. In this example ‘Maker’ is the user that offers a bet and ‘Caller’ is the user that accepts that offer:

1. Maker approves the Ethbet contract to access their balance that they intend to wager
2. Maker creates an offer to bet their balance, specifying their desired amount, edge and bet expiration time, then signs this offer with their private key, proving both their their ownership and intent
3. Maker broadcasts their bet via any medium. Theoretically the best place to broadcast a bet will be an Ethbet relay, but there is no reason why it cannot be posted on a forum or sent via an email, as it is only a string (text)
4. Caller reads the bet offer from Maker and decides they would like to call it
5. Caller approves the Ethbet contract to access their balance as well
6. Caller submits the Maker’s signed order to the contract
7. The Ethbet contract authenticates Maker’s signature, verifies that the bet has not expired and that the bet has not already been called
8. The Ethbet contract executes the bet and transfers the bet amount between the two parties based off of the outcome.

The primary method of communication with the Ethbet protocol is intended to be via relays, as outlined in the previous section. The full protocol description of Ethbet is not yet finalized, but the information and format of it will be relatively standard, containing the parameters of a bet (amount, edge, expiration, and later on, asset type), as well as the necessary information to secure it, including a cryptographic hash function like SHA3 and an ECDSA signature from the private key of the participants.

## Development Timeline

At the time of the crowdsale, the Ethbet token and Ethbet crowdsale contracts will be deployed on the mainnet and fully functional, as necessary for the crowdsale to occur. The code in these smart contracts is a relatively standard and lightweight implementation of the ERC20 standard, and the possibility for critical bugs is small in comparison to that of more complex and novel contracts, such as the primary Ethbet game contract. If a significant problem occurs that is recoverable, the necessary steps will be taken to remedy the situation. For example, if there was somehow a critical flaw in the Token contract, allowing someone to steal all Ethbet Tokens, we could fix the problem, deploy the new token contract (with the problem fixed), and restore the balances of all users, migrating the entire platform to the newer version of the token, similar to what happened with Ethereum and the DAO. An issue like this is is very unlikely to occur unless it is caused by a problem within Ethereum itself, as the Ethbet Token is nearly isomorphic to most Ethereum (ERC20) tokens, so a critical problem with one could indicate the same problem with many others.

After the crowdsale is complete, Ethbet tokens will become unfrozen and can then be sent to other users. At this time the development of the primary game contract will proceed. This is a relatively lengthy process despite the simplicity of the game architecture. The general timeline is as follows:

1. Develop primary contract functionality and tests
2. Extensively test and audit the contract for potential flaws
3. Deploy the contract onto the testnet
4. Allow users to interact with the contract during a beta period
5. Continue to improve the contract as needed
6. Perform final third-party security audit(s)
7. Deploy the contract onto the mainnet
8. Continue to improve non-contract code, such as improving accessibility and user interfaces, only updating the contract to fix critical issues or to later implement new features.

In addition to this, there's other developmental overhead, such as the off-blockchain relay and various user-interfaces required to interact with Ethbet in a user-friendly fashion. In order to make interaction with the smart contract user-friendly and simple, users will be able to interact with it via the Mist browser, giving them an experience similar to traditional websites, but while still interfacing only with smart contracts for their betting.

## Timeline

| | |
|---|---|
| Q1 2017 | Market research, feasibility assessment, other planning– completed |
| Q2 2017 | Website and Whitepaper – completed |
| Q3 2017 | Crowdsale, live demo, development, and community building – complete |
| Q4 2017 | Continuation of development and other improvements, alpha/beta launches |
| Q1 2018 | Full launch, playerbase building, community growth, further improvements as needed |
| Q2 2018+ | Additional features, projects, games, advertising, and community building |

## Future Possibilities

As Ethereum matures as a technology, it will allow decentralized applications such as Ethbet to run more efficiently. Improvements in other technologies such as Web3 browsers (Mist and the Metamask extension) also help to further Ethbet's goals. As Ethbet progresses as a project, there will be

opportunities for more features to be added. Examples include a more feature-rich implementation of dicing, other games such as lotteries or card games, the possibility to bet arbitrary ERC20 tokens, and more advances in gas/time efficiency, such as the use of state channels. The inclusion of these features depends on the success of the Ethbet crowdsale as well as the opinions (votes) of the Ethbet token holders. In addition to this, many opportunities for lowering gas costs and increasing the quality of provable fairness will exist as more research and projects are performed in these areas.

## Similar Projects

As the size of the blockchain and Ethereum ecosystems has grown considerably over the last few years, a number of projects with goals similar to Ethbet's have emerged. Although some of these projects are similar in nature, they either have different goals or are lacking some of the features of Ethbet. Some of these projects are summarized below, with emphasis on why they are different from Ethbet.

**Edgeless**: Edgelesss claims to offer betting on the Ethereum blockchain with a 0% house edge, however several notable caveats exist, namely:

- Edgeless claims their unreleased Blackjack game will have a house edge of 0%, but this only applies if every move and game played by a player is perfect. As a result, they expect the house to profit from this game[21]
- Although Edgeless is partially decentralized (exists on the blockchain), it is not peer-to-peer
- Edgeless does not support ETH, only their own token, EDG, thus you must purchase EDG first to use their platform
- Games such as Blackjack involve large amounts of data stored on the blockchain, and thus the fees paid to execute the involved smart contracts can be high
- Edgeless generates random numbers using their own server off of the blockchain
- No publicly readable changes to their smart contracts appear to have been made for at least several months[22]

Regardless of these drawbacks, Edgeless may be an appealing option for those wishing to play provably-fair games of blackjack on the blockchain in the near future, however we do not consider them a direct competitor for our target audience.

**Etheroll:** Etheroll was the first functioning dicing game on the Ethereum blockchain. It is similar to Ethbet, however is not peer-to-peer and has a house edge of 1% for every bet. Aside from this, it

appears to be a successful platform and one of the only Ethereum projects that is already generating revenue for token holders, making it a good model for future Ethereum-based projects to follow.

**DAO.Casino**: DAO.Casino is a recently-funded Ethereum-based blockchain protocol. It is not a gambling application in itself, however is intended to function as a framework that allows others to create blockchain-based gambling with a lower overhead. DAO.Casino utilizes a token called BET, which is required for all interactions using its protocol. The goals of DAO.Casino are to help casinos move their games onto the blockchain and to encourage on-chain game development and participation using its protocol. This differs substantially from the goal of Ethbet, which is to provide peer-to-peer dicing on the blockchain with no house edge.

**Peerplays**: Among all other projects, Peerplays[23] is the only one that markets itself based off of peer-to-peer interaction. Critically, Peerplays is its own currency and blockchain, completely separate from Ethereum, and thus the barriers to entry are much larger. Although Peerplays boasts its own technologies and smart contracts separate from the Ethereum network, as a result of this is is not able to benefit from the network effects of the Ethereum ecosystem or from the security and reliability of the Ethereum virtual machine and its associated smart contracts. In addition to this, there are no visible cases of dicing without a house edge being offered on this platform.

**Funfair**: Funfair[24] is another Ethereum-based project with the ambitious goal of ‘delivering next generation gaming anywhere in the world’, according to their technical whitepaper. Although Funfair’s scope includes gambling games, their focus is on providing a variety of immersive and graphically extensive games which are ‘fun’. To quote directly from their technical whitepaper: “We don’t want just simple, boring ‘pick a number’ games. (...) they are just not fun. We are fun.”[25] In order to interact with games built by Funfair, one must use Funfair’s token, FUN. Funfair uses a custom off-chain technology called fate channels which functions in a manner similar to Bitcoin’s proposed lightning network[26] and is attempting to secure patents related to this technology. Funfair claims that their implementation of fate channels is provably fair, although the server-side code to it is currently not open source and implementation details have not yet been made public, purportedly to allow Funfair to retain a competitive advantage over other players in the field. Although an interesting project with ambitious goals, their primary objectives are very different from ours.

Although some of the above projects could be considered competitors to Ethbet, many of their stated goals are orthogonal to ours, and just as different cryptocurrencies serve different purposes and cater to

different audiences, these projects are able to do so as well. For these reasons, we believe that the demand for the market niche that Ethbet realizes has not yet been met by any of the above projects.

## Disclaimer

There are many risks associated with the Ethbet token, just like with Ethereum.

The entire Ethbet project is dependent on Ethereum; a critical issue in Ethereum could prove significantly detrimental or fatal to Ethbet.

There is no guarantee or expectation that Ethbet tokens purchased will increase in value, provide a return, or will have sufficient adoption and liquidity to enable exchange for other assets.

There is no guarantee that blockchain technology and smart contracts, especially those related to gambling, will remain legal, unregulated, and usable within your legal jurisdiction, even if they presently are.

Owning Ethbet tokens does not constitute a share of, equity of, or ownership of the Ethbet platform.

United States citizens are not allowed to participate in the Ethbet crowdsale. Do not participate in the Ethbet crowdsale if you are a resident of the United States.

There are many risks, both known and unknown, that are involved with cryptographic assets, including Ethereum and Ethbet tokens. These risks include but are not limited to critical bugs, security flaws, difficulty scaling, denial of service, and the risk of new cryptographic breakthroughs.

This document does not constitute a prospectus of any sort, and is not an Initial Public Offering or Share/Equity offering. The tokens involved with Ethbet do not in any way involve any form of ordinary shares in Ethbet, and no dividends are guaranteed on Ethbet tokens. Fiat currency is not accepted in the Ethbet crowdsale.

Ethereum is an experimental technology and all possible future risks cannot be enumerated here. Ethbet is not responsible for any losses that may occur. Please exercise caution with all cryptographic assets and do not invest money that you cannot afford to lose.

## More Information

For more information about Ethbet, or if you have any questions, please visit the Ethbet website[27] at https://ethbet.io/ or send an email to team@ethbet.io.

1 https://github.com/randao/randao

2 https://blog.ethereum.org/2015/08/28/on-anti-pre-revelation-games/

3 https://github.com/gluk256/misc/blob/master/rng4ethereum/signidice.md

4 https://github.com/DaoCasino

5 http://crowdfund.etheroll.com/etheroll-whitepaper.pdf

6 http://www.oraclize.it/#services

7 https://random.org/

8 http://docs.oraclize.it/#security-deep-dive-authenticity-proofs-tlsnotary-proof

9 https://blog.oraclize.it/the-random-datasource-chapter-2-779946e54f49

10 https://www.statista.com/statistics/270728/market-volume-of-online-gaming-worldwide/

11 http://www.businesswire.com/news/home/20161006005678/en/Global-Online-Gambling-Market-Worth-USD-66.59

12 http://lsvp.com/2013/08/23/at-least-half-of-all-bitcoin-transactions-are-for-online-gambling/

13 https://coinmarketcap.com/currencies/ethereum/

14 https://etheroll.com/ and other forks

15 http://www.coindesk.com/bitcoin-company-acquisitions-begin-gambling-site-satoshidice-sells-for-11-5m-126315-btc/

16 https://github.com/ethereum/EIPs/issues/20

17 For example, instead of a user making a bet with a 25% win chance and a 4X payout, the user can make 2 bets with a 50% win chance and a 2X payout on each, resulting in the same risk to reward ratio. The equivalent can be done for those who wish to risk smaller amounts, as they are able to make bets as small as feasible, dictated by network and gas fees and their preferences.

18 https://0xproject.com/

19 https://etherdelta.github.io/

20 https://0xproject.com/pdfs/0x_white_paper.pdf

21 https://medium.com/edgeless/ultimate-edgeless-faq-22081ae768aa

22 https://github.com/EdgelessCasino/Smart-Contracts

23 https://www.peerplays.com/docs/Peerplays_Whitepaper.pdf

24 https://funfair.io/

25 https://funfair.io/wp-content/uploads/2017/06/FunFair-Technical-White-Paper.pdf

26 https://lightning.network/

27 https://ethbet.io/