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Implementing Trades of the National Football League Draft on Blockchain Smart Contracts

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Abstract

Purpose - Demonstrate proof-of-concept for conducting NFL Draft trades on a blockchain network using smart contracts.

Design/Methodology/Approach - Using Ethereum smart contracts, we model several types of draft trades between teams. An example scenario is used to demonstrate contract interaction and draft results.

Findings - We show the feasibility of conducting draft-day trades using smart contracts. The entire negotiation process, including side deals, can be conducted digitally.

Originality/value - This research demonstrates the new application of smart contracts in the intersection of sports management and blockchain technology.

Research limitations/implications - Further work is required to incorporate the full-scale depth required to integrate the draft trading process into a decentralized user platform and experience.

Practical implications - Cutting time for the trade negotiation process buys decision time for team decision-makers. Gains are also made with accuracy and cost.

Social Implications - Full-scale adoption may find resistance due to the level of fan involvement; the draft has evolved into an interactive experience for both fans and teams.

Keywords: blockchain, smart contract, National Football League, trades.

Paper type: Research paper.

1 Introduction

The NFL Draft, like most reoccurring events in sports, has drastically evolved from its rudimentary beginnings in a 1936 Philadelphia hotel conference room. At the time, there were no scouting operations, no media coverage, and if drafted, players had to choose between playing football and a more financially stable profession (NFL, 2023*a*). Team representatives sat in a room with a phone, while draft picks were handwritten on boards. Decades later, Commissioner Pete Rozelle had an aggressive vision for marketing, negotiating an unprecedented $28 million TV deal with CBS for exclusive broadcasting rights in the mid-1960s (Leggett, 1964). In 1980, Rozelle decided to broadcast the draft on live television for the first time, despite protest from NFL owners (Ellenport, 2020); it has only grown in popularity since. In 2010, the draft expanded to a three-day event; in 2015, the draft moved away from New York for the first time, and now cities bid to host the event each year (NFL, 2023*a*). Today's draft includes seven rounds, and the selection sequence is in reverse order of the previous season's final standings. Each pick is made within a time constraint, which varies from round to round (NFL, 2023*b*). If a team does not submit a pick by the allowed time, the next team in the order can make a selection. Regarding trades, both teams must independently call the league and relay the same information (NFL, 2023*b*); the NFL ensures that both parties agree to the same terms, verifies salary cap issues, roster limits, etc.

The draft is now a full-scale production event, with military flyovers, national anthems, celebrity introductions, and fan picks. Most recently, in April 2023, in an effort to engage with the younger fan base, the NFL not only broadcast the event live on YouTube (allowing fans to chat with each other), but the league also hired social media influencers and content creators to interact with fans at the draft to increase its digital and social footprints (Cannon, 2023). While TV and media are significant technological innovations to the NFL Draft, bringing interest and exposure to an otherwise routine event, they also present some challenges. TV networks often operate within strict time constraints, making it difficult to manage delays in the draft or trading processes. The event now spans three days, with the first round averaging around four hours in duration (National Football League, 2025). With the inclusion of celebrity, fan, and guest pickers, the delay only becomes more visible (Helmkamp, 2022). Furthermore, TV networks must find ways to fill gaps in coverage with other content. Most recently, the NFL and its broadcast partners drew criticism from media and fans for excessively drawing attention to player trauma, exploiting personal stories of drug addiction, family health issues, and body image shaming (Belson, 2023, Heck, 2020). Although fitting the draft within TV time constraints is a challenge, the NFL must also acknowledge its sponsors in the form of advertisements and commercials, which take time away from draft analysis and the general viewing experience. The draft's rules combined with TV constraints make for a challenging environment in which to make complex trades as well; other negotiations are not under the same stress that comes from live TV. Thus, time management is a key skill that NFL team general managers (GMs) must master in order to execute a draft.

There are several examples in the current draft era where time was a factor in conducting a trade negotiation and drafting a player.

> **2003 NFL Draft**: The Minnesota Vikings held the seventh pick; they tried to reach a deal with three different teams, finally settling with Baltimore. The Ravens offered three picks in exchange for the seventh pick (Pasquarelli, 2003). Baltimore failed to provide the league with their version of the trade details, and Minnesota's clock expired. Unfortunately, the Jacksonville Jaguars and Carolina Panthers were ready and made their selections at eight and nine before Minnesota ultimately made their selection.

> **2011 NFL Draft**: The Baltimore Ravens (26th pick) discussed a potential trade with the Chicago Bears (who owned the 29th pick) (Raffel, 2011). According to reports, Baltimore submitted their trade proposal to the league, but Chicago did not (Moriarty, 2017). Consequently, time expired, and Baltimore did not select a player; the Kansas City Chiefs held the 27th pick and immediately selected someone. Baltimore selected their desired player soon after the Chiefs, with rumors swirling that perhaps Chicago intentionally sabotaged the Ravens; Bears leadership attributed the error to internal miscommunication (Associated Press, 2011).

> **2017 NFL Trade Deadline**: – This next scenario was not related to the draft but bore similarities to the same issues. The NFL imposes a trade deadline—a calendar date and time by which trades must be completed. The Cleveland Browns agreed to a deal with the Cincinnati Bengals involving their backup QB (Owczarski, 2017). However, the teams did not follow the league's appropriate trade procedures. Only Cincinnati submitted the deal with a signature from the Browns; Cleveland apparently assumed that their signature was sufficient (Chiari, 2017). However, the deadline passed, and the league rejected protests from Cleveland.

These examples are rather dramatic and seem to be rare, but they highlight issues with time management, trust, accuracy, and centralization of information in the TV era of the NFL draft. It begs the question: *What will be the next technological advance in the NFL Draft, and can it improve operations?*

Blockchain could be the next wave of technology to make its mark on the NFL Draft. However, this does come with some considerations. First, the NFL's willingness and readiness to adopt blockchain is unknown. Some of these feelings may be unfairly attributed to cryptocurrency, as many people associate the volatility of Bitcoin with blockchain; the former has actually crashed numerous times since its inception (Partz, 2022, Pinkterton, 2023). Note, blockchain and Bitcoin are not the same thing. With more blockchain service providers in operation now, there are more opportunities to expand this technology to areas other than cryptocurrency trading. However, as a shared, immutable ledger with decentralization as a key feature, blockchain may also serve to threaten the league's involvement in its operations. Blockchain is often heralded for its ability to remove the middle man; a third party is not necessary to handle most transactions. If the league was removed from its role in the NFL Draft in favor of a blockchain network, for example, regardless of utility or ease of use, some decision makers would predictably take issue with this design. Additionally, blockchain could affect NFL revenue streams. Since much of the NFL's profit (shared with team owners) comes from TV deals and sponsorships, blockchain could potentially reduce the reliance on broadcasting efforts. It is estimated that over the next 10 years, the NFL could accumulate more than $125 billion from its TV deals (Ozanian, 2023); TV is not going away anytime soon. Administratively, changing the structure of the draft would also require a change to league bylaws and rules, which would require a vote among team owners; this sentiment is also unknown. Soccer has taken the global lead in incorporating blockchain-based technology (Demir et al., 2022, Ersan et al., 2022, Socios, 2023, The Tokenizer, 2021); even the most recent World Cup in 2022 showed the growth of blockchain as Crypto.com was announced as an official sponsor (FIFA, 2022). However, for mainstream U.S. sports, that relationship is still unknown.

Furthermore, when we examine the current research and application space for blockchain in sport, very little exists that leverages this technology for management operations. Even though we are seeing slow growth in blockchain-based sports material such as ticketing (Regner et al., 2022) and fan tokens (Socios, 2023, Stegmann et al., 2023, Vidal-Tomás, 2023), the major player in this space is the non-fungible token (NFT). Players are creating their own NFTs of personal highlights (Broadcast, 2022), and companies are using NFTs to sell highlights like trading cards (Conti, 2023, Knight, 2021). Sports leagues are not yet using blockchain to execute their business operations, and the NFL Draft is no exception. Most academic research on the NFL Draft deals with traditional optimization methods, trying to determine the best drafting strategy (Brams and Straffin, 1979, Crofford Jr, 2021, Fry et al., 2007). There are also some human resource efforts to examine the draft from a talent management standpoint (Harris et al., 2022, 2015), but existing research on the NFL Draft is limited. This is not to suggest that the NFL Draft requires an upgrade. As Stegmann et al. (2023, p. 723) explains, "as with many new technologies, there is a propensity to overrate their benefits and an urge to apply them even though they might not be needed." Rather, blockchain is a potential next step for the NFL, and we explore a conceptual idea for how to execute the draft.

Streamlining NFL Draft operations via a blockchain network could potentially help prevent these types of procedural mistakes and allow teams to focus more closely on player selection and the substance of trade deals. Blockchain technology can improve efficiencies by automating some of the trade-related tasks so that teams can execute deals without fear of inaccuracies and time mishaps. Additionally, blockchain could be a marketing opportunity for the NFL to explore with the draft. The NFL is already attempting to reach a younger audience through the use of social media and TV, but blockchain offers an expansion to a wider audience. Fantasy football already draws millions, even non-sports fans, because of its social aspects and relation to gambling (Bonte-Friedheim, 2023). Granted, there are some cost and management issues that need to be addressed with blockchain, but those are outside the scope of this research. Instead, this paper investigates a blockchain-based trading process for the NFL Draft using Ethereum smart contracts. Various scenarios are explored via an illustrative example, leading to time-saving measures and increased accuracy. We extend the current NFL Draft research by exploring non-traditional methods for executing a draft. No research has yet to implicate the use of blockchain in NFL operations. However, this study is primarily a demonstration of conceptual feasibility; the implementation is simple. While not a call for change, we propose a blockchain format for the draft as a potential technological advance for the NFL that can also mitigate some of these time and trust issues raised in the preceding examples.

In consideration of the preceding motivating examples, we propose the following questions:

1. How can the trade negotiation process and execution be handled via blockchain smart contracts? What are the benefits gained from using this technology?

2. How can side deals be implemented via smart contracts? How are these enforced?

3. How can smart contracts help with information management?

Following this introduction, a literature review is provided to help understand the related research in the field of sport, along with connections to blockchain technology. Afterwards, a conceptual framework is presented for conducting the NFL Draft based on blockchain and smart contracts; feasibility is shown with a simple example. Finally, suggestions for future study are presented.

2 Literature Review

The literature review focuses on several different areas of sports-related research. Some work is necessary to highlight the traditional sports strategy scenarios and their solution approaches. Other research provides background on current trends in the digital sphere, highlighting the increased efforts to bring blockchain into sports.

2.1 Sports Decision Making

Sport involves decisions, some made by players and others made by managers. Many decisions are even surrounded by uncertainty, further complicating the activity. One such area in which competitive team sports must consider is the substitution process.

Substitution opportunities are an area of common research with regard to strategy. Myers (2012) examines soccer and proposes a decision-tree-based rule for the timing of substitutions. Iglesias et al. (2022) analyze a collection of matches from the European Champions League and find significant connections between wins and the timing of substitutions given a particular score. Hughes (2017) explores the lesser-researched area of basketball, using an approximate dynamic programming model to optimize lineup value while accounting for fatigue and recovery rates. Young (2010) creates a decision support tool for NFL team managers, treating roster building as a knapsack problem within a strategic hiring context.

In many sports, decisions are made linearly in the sense that one decision typically follows another. Kohler and Chandrasekaran (1971) model a two-player sequential selection game (referencing a sports draft as an example) from a game theoretic perspective and provide an algorithm for optimal play. Deck et al. (2014) model pit stops during a caution flag in a NASCAR race, finding that drivers tend to follow simple heuristics rather than the optimal play. Using simulation-based reinforcement learning, Valluri (2006) finds that agents choose to cooperate over time rather than defect (as theory predicts) within an iterated Prisoner's Dilemma setting. Clarke and Norman (1999) use dynamic programming (DP) to model the decisions and strategies of cricket batters who have different scoring abilities. Lee and Liu (2022) analyze the decision strategy of humans in a fantasy football draft, concluding that humans tend to follow a narrow set of strategies in drafting.

Brams and Straffin (1979) show that for a draft consisting of at least three teams, an outcome corresponding to an assignment of players to teams could result in a non-Pareto optimal solution; this can create a Prisoners' Dilemma situation, whereby when teams act in their own self-interest, the global outcome is worse than had they chosen a cooperative strategy. Fry et al. (2007) attempt to model drafting strategies with a stochastic DP, but the state space becomes intractable and the problem is reduced to a linear program. Summers et al. (2007) design an expected value model for drafting the best National Hockey League (NHL) fantasy team. Crofford Jr (2021) seeks to explore the best draft strategy for an NFL team using approximate DP (ADP), comparing solutions to established strategies.

2.2 Blockchain

Blockchain applications are rapidly expanding with some recent advancements in the sports industry. The most promising area may perhaps deal with fan tokens, where teams involve fans through a digital experience.

2.2.1 Digital Tokens

A digital token is an asset with representation on a blockchain; the two primary types are fungible and non-fungible (Chen, 2021). Carlsson-Wall and Newland (2020) describe the seven emerging markets for blockchain in sport: sports betting; fantasy sport; club and league management; health and personal integrity; ecosystem development; collectibles and memorabilia; and talent investment and crowdfunding. However, sport includes human emotion and a requirement for maintaining competitive balance, and thus the integration of blockchain technology into commercial sports remains a challenge (Carlsson-Wall and Newland, 2020).

Fan tokens are an area of popular growth, providing a deeper level of team exposure and interaction. Socios (2023) has capitalized on the fan token concept, partnering with sports teams and leagues to sell tokens via digital currency. Fans receive rewards and have buy-in on some club decisions; likewise, teams receive a share of the sales (Socios, 2023, Vidal-Tomás, 2023). Demir et al. (2022) explore the relationship between soccer team performance and fan token pricing, finding that losses have a negative effect on the abnormal returns in fan tokens. Ersan et al. (2022) examine the connectedness of fan tokens and stock for four prominent European soccer clubs, concluding that the two asset classes are largely independent of each other, with connectedness decreasing over time. Vidal-Tomás (2023) studies the performance of Socios tokens (which use its own form of digital currency called Chiliz); contrastingly, he finds that the two are connected, hypothesizing that fan tokens are an ephemeral trend that lost popularity during the cryptocurrency crash in 2021.

When the asset in question is something that requires proof of ownership or proof of authenticity, such as artwork or personalized memorabilia, then a fungible token will not suffice. Instead, a *non-fungible* token (NFT) is required, a "cryptographically unique, indivisible, irreplaceable and verifiable token that represents a given asset, be it digital or physical, on a blockchain" (Valeonti et al., 2021, p. 4). Perhaps the most famous NFT story involves CryptoKitties (CryptoKitties, 2023), a blockchain game that allows participants to buy, sell, and breed a digital kitten. The associated fame, however, is due to one user's purchase of a kitten for 600 ETH (Varshney, 2018) in 2018 (approximately $170,000 USD at the time), sparking an interest in NFT research. NFTs are also being used in the sports industry to manage admissions and tickets, which traditionally suffer from fraud and overpricing on secondary markets (Courty, 2019, Waterson, 2016). Regner et al. (2022) design a NFT-based ticketing system prototype, showing that it aids with fraud prevention and secondary market price control while also providing validated ownership. In 2021, Ukrainian professional soccer team Dynamo Kyiv became the first major sports team to sell NFTs to fans, using them as event tickets and collectibles (The Tokenizer, 2021).

2.2.2 Digital Media

Aside from the token community, there is also a growing desire for digital memorabilia and content. However, blockchain presents issues with regard to content trading, particularly with rights management/copyright, authenticity, and storage limits (Savelyev, 2018). NBA Top Shot is a digital highlight platform where fans can buy, sell, and trade video clips in the form of NFTs; the highlights can not be altered, and authenticity is guaranteed (Conti, 2023, Knight, 2021). Chen et al. (2022) propose a NBA digital trading card management system on blockchain, utilizing encryption and smart contracts to ensure ownership, resist tampering, and enable traceability. Even athletes are venturing into this space, creating their own NFTs of video clips and signed memorabilia (Broadcast, 2022).

2.2.3 Blockchain, Smart Contracts, & Sports

Very little work has been done in the intersection of smart contracts and sports operations. Li et al. (2021) conceptualize a blockchain structure over the entire sports industry, but due to a lack of data, the model is essentially limited to financial transactions. Lopez-Barreiro et al. (2022) review recent journal articles relating blockchain to the sport and physical activity domains, noting that none of these employ smart contracts or oracles. Glebova and Mihal'ová (2023) discuss the potential applications of blockchain, financial technology (fintech), and NFTs to the sports industry, but the analysis is limited to theoretical understanding. Yu (2021) argues that sports health data collection can further evolve through integration with blockchain, but predictions of wide usage are yet to be realized. Lv et al. (2022) compare the innovation efficiency of sports industry companies that use and do not use blockchain technology, finding that the former group is better at adapting to the digital transformation in sports.

2.3 Technology Adoption

2.3.1 Theoretical Background

Implementing new technology into an organization is sometimes viewed as an element of innovation, "the creation and introduction of new sports products, services or processes, or the modification or improvement of existing ones, aiming to introduce novelty in a sports entity and improve its performance" (Alonso Dos Santos et al., 2022). This is typically not a single, immediate event, but rather the result of a deliberate planning process to assess and understand the impacts to an organization. The psychological and social components to the incorporation of technology often deal with acceptance, use, and enjoyment; there are numerous theories that attempt to explain human behavior in this regard, and we highlight several relevant ones.

Ajzen (1991) presents a *Theory of Planned Behavior* (TPB), suggesting that behavior is determined by a person's intention, which is driven by attitude, subjective norms, and perceived behavior control. Several subsequent efforts show successful application of TPB to acceptance and use of information systems (IS) and/or information technology (IT) products (Harrison et al., 1997, Mathieson, 1991, Taylor and Todd, 1995). Davis (1989) contributes the *Technology Acceptance Model* (TAM), positing that IT acceptance and usage on the job is predicted by perceived usefulness (PU) and perceived ease of use (PEOU). Lin et al. (2007) add technology readiness (TR) into the TAM model to create the *Technology Readiness and Acceptance Model* (TRAM); TR accounts for a user's opinion and belief about technology acceptance. Rogers (2003) provides *Innovation Diffusion Theory* (IDT), in which innovation (typically synonymous with technology) is communicated and spread through channels in a system over time. Moore and Benbasat (1991) adapt IDT for the diffusion of IT innovations, refining a comprehensive scoring system to measure an individual's perception of the technology. Bass (1969) proposes a model for the timing of new product growth (although it is sometimes applied to technology incorporation), suggesting that sales increase exponentially up to a peak before experiencing exponential decay. Venkatesh et al. (2003) attempt to synthesize multiple models of new technology user acceptance with the *Unified Theory of Acceptance and Use of Technology* (UTAUT) model, which explains that performance expectancy, effort expectancy, and social influence all impact the behavioral intent to use a new technology. Additionally, facilitating conditions, i.e. the organizational support structure, and a user's behavioral intention directly determine technology usage (Venkatesh et al., 2003). The UTAUT model is extended with UTAUT2, which adds hedonic motivation, price value, and habit as predictors of a user's behavioral intent to use technology in a consumer context (Venkatesh et al., 2012, 2016). Specific to online behavior, Hur et al. (2011) propose the *Sports Website Acceptance Model* (SWAM) to understand fan use and adoption of a particular sports website.

2.3.2 Applications

Several studies employ technology acceptance theories to the wearing and use of fitness devices. Cavdar Aksoy et al. (2020) apply UTAUT to the wear of a sports fitness device, finding that performance expectancy, effort expectancy, facilitating conditions, and social influence affect the user's intent for usage. Additionally, the authors find that a psychological aspect of technology acceptance, technophobia, moderates the relationship between performance expectancy and attitude (Cavdar Aksoy et al., 2020). Hahm et al. (2023) devise a framework to identify common functions of wearable devices and assess their relevance to the user with a TAM-based approach, finding that PU, PEOU, and knowledge are the most important factors in determining usage. Kim and Chiu (2018) apply TRAM to a variety of consumer acceptance factors on sports wearables, finding associations between positive TR and PU/PEOU, as well as linking negative TR with decreased PU/PEOU. Raman and Aashish (2022) employ a TRAM based study to determine the intent to use wearable devices for gym users; PU/PEOU are positively influenced by innovativeness and optimism, while negatively influenced by insecurities such as distrust and privacy. Oc and Toker (2022) study a multitude of fitness devices, revealing that effort expectancy is the most important determinant of intent to use sports technology; they also find that sports type (dynamic or nondynamic) affects technology use. Mason (2006) examines the existing social pressures that affect the incorporation of fitness wearables in hockey, also suggesting that sabermetrics can serve as a *supervening necessity* to gain better information about players so that it can be used by media, coaches, and evaluators.

Other research examines technology acceptance within sports media. Ha et al. (2015) design a TAM-based framework to evaluate fan intent to use smartphones for sports consumption, indicating that three perceptions exist simultaneously: PU, PEOU, and perceived enjoyment (PE). O'Reilly and Rahinel (2006) conduct a case study of various media technologies on hockey games, including a forecast of high definition television (HDTV) diffusion in Canada. Hur et al. (2012) apply the SWAM to study fan choice of sports web portal, finding that PE is the most important factor affecting use. Kwak and McDaniel (2011) apply the TAM to investigate fan usage of fantasy sports league websites, suggesting that domain knowledge, PEOU, social support, and gender are positively associated with attitudes about an online technology system.

Recent research explores new frontiers in fan engagement. Schlimm and Breuer (2023) study interest in virtual environments (VE) and Web3 applications related to a fan's favorite team. Both VE and Web3 are being used to enhance the fan experience and reward loyalty. Not surprisingly, results show that fans with higher levels of team involvement are more interested in VE and Web3 than those with less involvement (Schlimm and Breuer, 2023). Stegmann et al. (2023) investigate how the tokenization platform of a sports team affects fan engagement behavior with personal interviews. Although the results are mainly qualitative, several of the implied challenges are worth noting: blockchain (and tokenization) are not easy fixes to increase fan engagement; fungible tokens do not provide value without a well-defined reward system; barriers such as lack of trust, scalability, and complexity make it difficult to employ tokenization platforms (Stegmann et al., 2023). Digital ticketing is another area witnessing growth in the United States, although resistance still exists, especially at lower levels. Marquez et al. (2020) use a TAM-based model to investigate adoption factors, showing that fans are more likely to use digital ticketing with a higher PU, but this is moderated by the presence of mobile fees. Fans do not find digital ticketing useful when they do not agree with the associated fees (Marquez et al., 2020). Some research sheds light on user involvement in esports (Jang and Byon, 2020), but users still seem wary of implementing a blockchain-based rewards system because of lack of information and trust issues (Yadav et al., 2022). In a similar study, Yadav et al. (2023) scrape Twitter for 'sports blockchain' discussions, sensing a positive attitude towards the usage of blockchain technology; NFTs are among the most popular topics.

3 Modeling of NFL Draft on Blockchain Smart Contracts

To investigate the feasibility of conducting the NFL Draft on a blockchain network, a simple draft example serves as the test bed for blockchain smart contracts to deal with trades. By considering several different types of trades, we aim to show the versatility of smart contracting programming. While there are some quantitative measures associated with blockchain research (e.g. computational effort, smart contract gas usage, transaction costs, etc.), those are not of concern in this research because the focus is to introduce a concept. However, future research could investigate these metrics in more detail.

Data for this research is internally generated; there are no external data requirements. Similar to other literature (Ahmadisheykhsarmast and Sonmez, 2020, Li et al., 2022, Omar et al., 2021), results are reported in the form of Remix (Ethereum, 2023) Integrated Development Environment (IDE) screenshots. The programming language used is Solidity, which is derived from C++ and Java. As an object-oriented programming (OOP) language, source code execution is a result of successful compilation and deployment. Thus, if code deploys successfully on the IDE virtual machine, this is proof of feasibility. Our goal in this paper is to demonstrate the structure and viability of a successful deployment. Assessing the economic benefit of such a deployment, however, is beyond our scope, as we recognize that its implementation has an associated financial cost.

3.1 Structural Overlay

3.1.1 Network Concepts

We consider the NFL as a whole to be a network consisting of nodes (teams) with a central server (league). Furthermore, the NFL Draft represents a specific event in which this network participates in. In the context of a blockchain, there are two considerations for network architecture. Although the desirable features of a blockchain are its decentralized, public nature, a public blockchain such as the one referenced in Figure 1a is perhaps inappropriate for this concept. The typical features of a public blockchain, such as anonymity, demand-driven cost, and permissionless access, do not apply to the NFL. Instead, the NFL shares more features of a private blockchain, such as in Figure 1b, where membership is permission-based, the cost is controllable, and certain details may be kept private. We acknowledge that a private network may seem to invite centralization, but in this concept, the league has minimal requirements.

(a) Public blockchain. (b) Private blockchain.

Figure 1: Two typical blockchain network architectures (adapted from Barbarov (2017) and Hub (2023)).

3.1.2 Transactions & Blocks

Within the blockchain, each team maintains a node. When a team selects a player, this selection corresponds to a transaction within a block on the chain. Figure 2 depicts this scenario. The chained, ordered nature of blocks is preserved with the draft process since teams follow a strict sequence order, and once the pick is recorded, it cannot be changed.

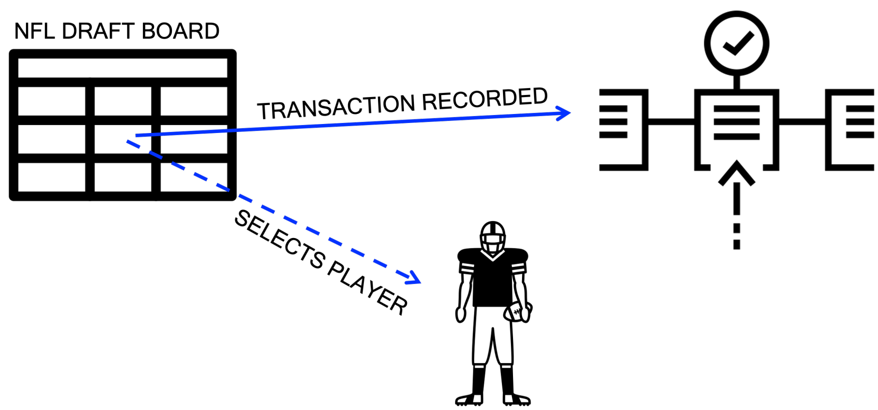


Figure 2: Player selection correspondence to blockchain (conceptualization by authors using Bok (2018*a*), Icon 54 (2015), The Pyramid School (2016)).

3.1.3 Validation

As of today's writing, Ethereum's consensus mechanism is Proof-of-Stake (PoS) (Roy, 2023). Consider the network shown in Figure 3. The nodes of the blockchain network are divided into two categories: participants (green) and validators (red); both types operate on the same blockchain. In some networks, validators perform strictly in a validation role; in others, validators are also participants. Here we assume the NFL adopts a PoS consensus system (Wan et al., 2020); NFL teams, particularly the owners or GMs, are the participants in this private blockchain and may also validate.

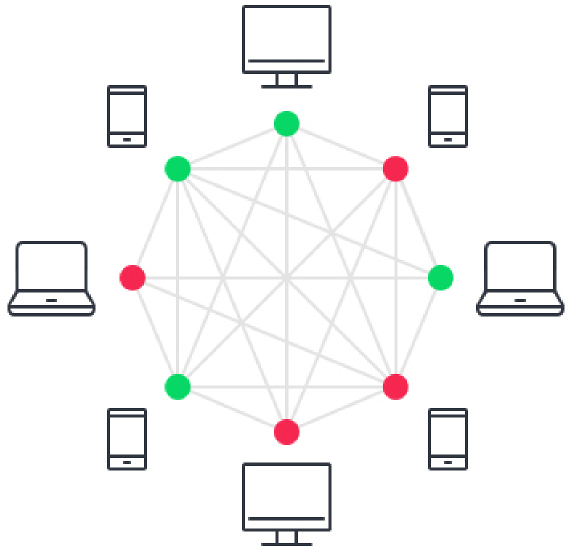


Figure 3: (color online) Simple blockchain network (adapted from Lastovetska (2021)); red denotes a validator node, while green is a participant node.

There are two options presented for validation, neither of which matter for this implementation but which are shown as conceptual possibilities.

i. **Teams as strict participants**: validators would come from trusted third parties (or single parties). Outsourcing validation would also warrant an overhead cost. The league could also serve as a validator, but this comes with costs, namely that this counters the original idea of decentralization. Also, since transaction details are visible to a validator, teams may not prefer to involve the league if a side deal is involved for fear of blocking the transaction as illegitimate.

ii. **Teams as participants and validators**: Teams have little motivation to prevent validation purposely, and even the current validator stake for public blockchains is negligible for NFL owners; teams can also serve as validators. With this option, there are several design choices:

- Validation rotates throughout each team, with the team next in line serving as the validator for the current selection.
- Subset of teams forms a validation committee, which can either remain constant throughout the draft or change at a specified time period. A single validator builds the block, and a validation committee votes to accept or reject it from inclusion in the chain.
- With either of the options above, there is a chance that a team is simultaneously involved in a transaction and validation. Thus, it is plausible that a team serving as a validator for a certain pick may also be involved in a trade negotiation with the selecting team. This situation may give rise to preferential treatment or bias, but this can be avoided with a committee of validators. Additionally, this may be a situation in which the staking of ETH is inappropriate; perhaps staking a draft pick is more impactful to a team that considers cheating the system.

3.1.4 Trades

Draft trading of picks and players is executed via smart contracts. In traditional negotiation, GMs call each other to discuss a potential trade. Instead, GMs submit a trade offer to a smart contract, and the GM owning the pick relies on the contract code to execute the desired transaction. Once the trade is executed, this data is written to the blockchain, and the state is updated (e.g., the draft order is updated, the trade is recorded on the chain, etc.). Note, just like in public Ethereum chains, we assume the selling team pays the cost upon contract deployment. Likewise, bidding teams pay a small cost to interact with the contract. Figure 4 depicts this trade concept via smart contracts.

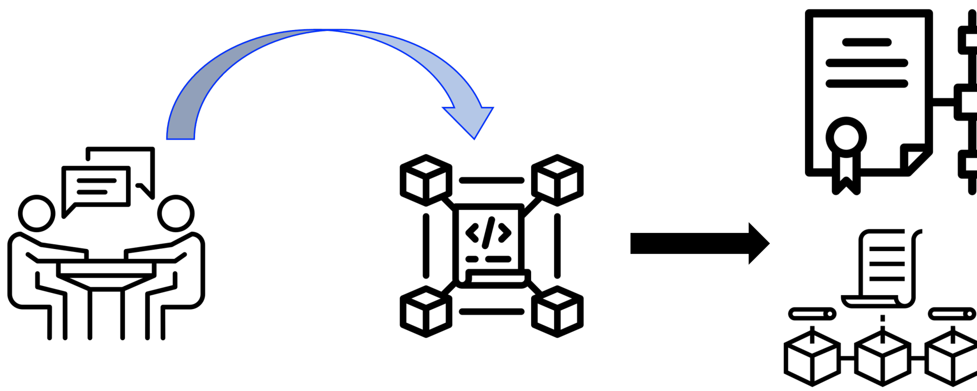


Figure 4: Trades conducted on smart contracts (conceptualization by authors using Bok (2018*b*), Design Circle (2021), IconMark (2019), Roaayala (2021)).

3.2 Assumptions

In order to model the NFL Draft with a blockchain structure, we make the following assumptions:

Cost: Blockchains have an associated financial cost, which could be a barrier to entry for those wishing to become a validator or deploy their own decentralized application (dApp). Some of these costs include contract deployment, contract interaction, validator stake, and tip fees. We treat the NFL as a private network, and we assume that costs are agreed upon and reasonable to all participants. The complete cost is not calculated because the total cost of implementation with a dApp is unknown and specific to that application. However, contract deployment and interaction costs can be estimated with currently available gas prices, assumedly negligible for an NFL team.

Efficiency: No claims are made that the smart contract code presented here is the most efficient in terms of speed, memory, gas usage, and cost. Follow-up work may be needed to optimize the code for execution.

Team draft strategy: The weighted positional randomization presented in Table 1 is not meant to depict NFL team priorities accurately. It is merely a computational tool to analyze value and selection order.

Oracles: The process of league verification of trade details is done via oracles (see Figure 5), which are used by the smart contract to obtain the necessary external data (e.g., salary cap, roster limit, etc.). Oracles are not physically employed in this project but are assumed to be present.

Block structure: Conceptually, individual picks could occupy a single block or could be batched according to a predetermined organization scheme. While no real-world blockchain promotes one transaction per block, as this is highly inefficient and costly, this is merely a conceptual option. Physical mining and block creation are not modeled.

Security: There are many different types of attacks on a blockchain, some particular to Proof-of-Work (PoW) consensus (Wan et al., 2020) and others to PoS, and some overlap. For example, in a PoS setup, a malicious attacker with a stake greater than 33% could theoretically control the network by denying the validator committee the ability to achieve a 67% consensus on any block validation (Ethereum, 2022). Other attacks can target smart contract code, e.g., a reentrancy attack, in which a smart contract function makes an external call to another smart contract owned by a malicious attacker (Alchemy, 2022). In this project, proactive security measures are assumed to be employed, but further work is needed to eliminate this assumption.

Encryption: basic off-chain encryption with a public-private key algorithm is used to ensure privacy with side deals. On-chain encryption methods are an area of active research but are not employed in this project.

Nodes: NFL teams operate their own nodes and have the potential to be validators. The cost for NFL teams to serve as validators is assumed to be negligible and agreed upon before draft execution.

Trust: While most teams have little incentive to mislead or cheat another team, it is plausible that one team attempts to delay the trade process for personal gain. There is an element of trust involved with any trade negotiation, but we do not attempt to model or capture any form of dishonesty or deceit.

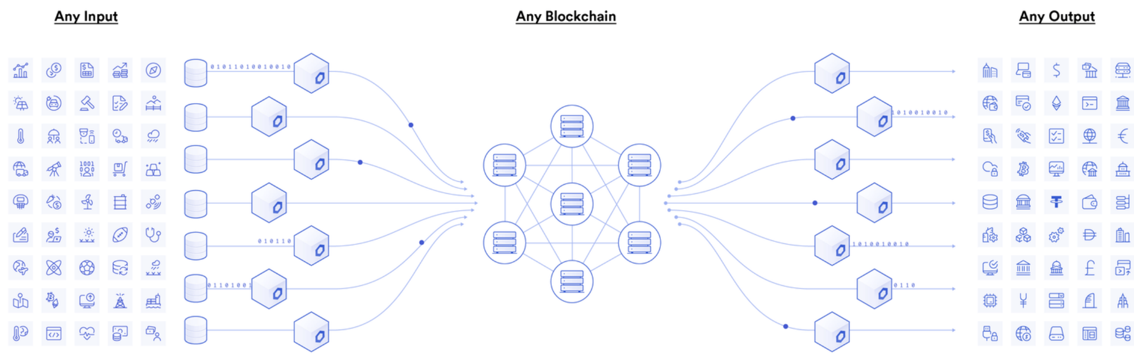


Figure 5: Example oracle framework (adapted from Chainlink (2021)).

4 Implementation

4.1 Draft Setup

We implemented a simplified version of the NFL Draft using Ethereum smart contracts as the vehicles through which trades were negotiated and executed. The draft board was created using the ESPN player rankings as of January 2023 (ESPN, 2023), using only the top 100 players. Six hypothetical teams participated, each having a weighted prioritization of positional needs across a common set of positions. The weights for each team and position were randomized; see Table 1 for the weights and Appendix 9 for abbreviations. Using a $[0, 1]$ scale, a higher weight implies that the team places greater emphasis on that position, i.e., its draft strategy is based on selecting players with the highest weight first.

Table 1: Randomized positional weighting by team (created by authors). Higher weights indicate higher priority. Refer to Table 9 for player acronym definitions.

	QB	RB	WR	TE	OL	DL	LB	DB
Team A	0.16	0.06	0.19	0.14	0.15	0.11	0.02	0.18
Team B	0.16	0.05	0.13	0.03	0.11	0.17	0.17	0.17
Team C	0.04	0.11	0.00	0.14	0.17	0.18	0.17	0.18
Team D	0.24	0.07	0.07	0.22	0.18	0.09	0.14	0.00
Team E	0.18	0.02	0.11	0.17	0.18	0.03	0.14	0.17
Team F	0.18	0.10	0.05	0.18	0.17	0.16	0.11	0.05

4.2 Trades

Four trade scenarios were designed and randomly selected to occur in certain positions throughout the draft. The allowed trades follow one of the patterns below, with the terms *seller* and *bidder* borrowed from auction terms.

Type 1: This represents a single-pick swap, i.e., a team trades one pick to another team for a single pick. The selling team deploys the smart contract with a time limit. Other teams submit their bid in the form of their current pick number; the selling team may stop the bidding at any point or wait until the time expires. The contract code automatically selects the lowest bidder, defined as the closest pick to the current one. To finalize the deal, the winning bidder must submit a constant fee to the contract, withdrawn by the seller (simulating trade finalization). The contract also includes a function for the winning bidder to submit an encrypted message representing a side deal with another team. This is the only fully "automated" version of trade in that the contract code selects the winner.

Type 2: This is also a single pick swap, but the seller is allowed to select the best bid manually. All other details remain the same. This scenario is more realistic in that the most attractive offer is selected, which may or may not be the lowest bidder; the winner is not selected by code. Thus, the selling team can avoid providing an undesired advantage to a rival. Instead, the seller chooses the trade partner and offer; the contract merely facilitates storage of offers and the details of the transaction.

Type 3: Bidding teams may now offer two picks for the seller's one. The seller manually chooses the winning bid, and the contract again offers the opportunity of a side deal. This is more realistic to current trends in NFL Draft trades—the bidding team offers multiple picks in exchange for a higher draft position, especially in the earlier rounds.

Type 4: This also includes the same setup, but now bidding teams may offer three picks. The seller again manually chooses the winning bid, and side deals may occur. This deal is a variation of Type 3, typically seen for the very early picks (e.g., 2016 draft, the Los Angeles Rams gave three picks to the Tennessee Titans in exchange for the right to pick first (National Football League, 2016)).

4.3 Functionality Display

The draft initially follows a basic order across seven rounds, as depicted in Table 2.

Table 2: Draft order (created by authors).

Rd1	Rd2	···	Rd7
Team A	Team A		Team A
Team B	Team B		Team B
Team C	Team C	···	Team C
Team D	Team D		Team D
Team E	Team E		Team E
Team F	Team F		Team F

We see from Table 1 that at least three teams have the QB position prioritized. The pool of players in this example includes three highly-rated QBs in the top 15% of the draft class; the first trade scenario occurs for the first pick, with each team trying to move up for a QB. A Type 2 trade scenario is implemented, with three teams submitting offers. Teams are represented with their Ethereum account addresses; these are the default ones provided by the Remix (Ethereum, 2023) Integrated Development Environment (IDE) (see Table 3).

Table 3: Teams and Ethereum account addresses (created by authors).

Team	Address
Team A	0x5B38Da6a701c568545dCfcB03FcB875f56beddC4
Team B	0xAb8483F64d9C6d1EcF9b849Ae677dD3315835cb2
Team C	0x4B20993Bc481177ec7E8f571ceCaE8A9e22C02db
Team D	0x78731D3Ca6b7E34aC0F824c42a7cC18A495cabaB
Team E	0x617F2E2fD72FD9D5503197092aC168c91465E7f2
Team F	0x17F6AD8Ef982297579C203069C1DbfFE4348c372

Team A starts the bidding process with contract deployment; the constructor requires a time limit, the seller's address, and the pick owned by the selling team. Figure 6 shows that Team A deployed the contract to the blockchain, opening the door for offers on the first pick.

Figure 6: Remix log displaying successful contract deployment (created by authors).

Once deployed, Teams C, D, and F want to place a bid. To do so, each submits the required parameters to the function **addBid**, as depicted in Figure 7; this includes the bidding team's Ethereum account address and the offered pick. Once the bidding team sends this transaction to the contract, their offer is stored in a contract state variable. The contract also includes a public view function[1] **getAllOffers** (no cost to call) that stores all offers, showing the team's address and pick number offered. The three offers are displayed in Figure 8.

[1] A *view* function simply reads the state from the blockchain; it does not alter the chain and thus costs 0 gas to call.

Figure 7: **addBid** function accepting input from Team C (created by authors).

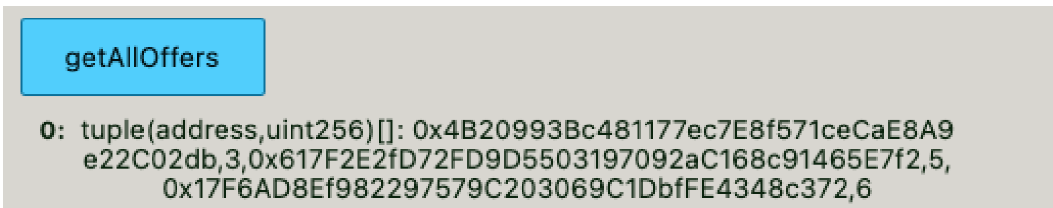
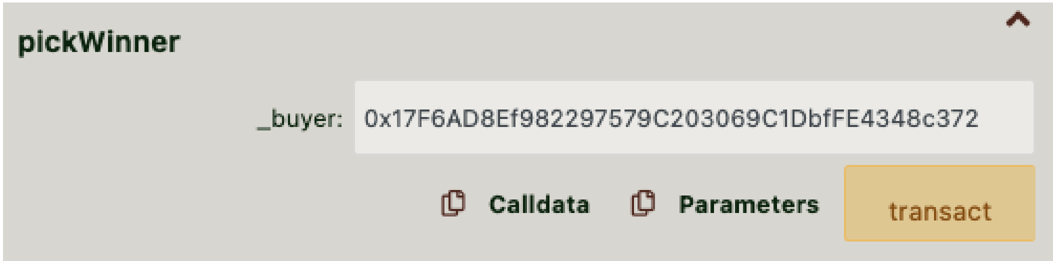


Figure 8: Output of **getAllOffers** showing three trade offers stored in array (created by authors).

After reviewing all offers, Team A selects the preferred bid package from Team F. Recall that with the Type 2 contract, the selling team manually chooses the best offer via interaction with the contract. Team A calls the **pickWinner** function by submitting Team F's address. This transaction is shown in Figure 9.



(a) Seller selects offer with bidder's address (created by authors).

(b) Bidder's address is stored in **highestBidder** variable (created by authors).

Figure 9: Trade offer selection process.

The **getWinner** function is not technically required, but it is a view function that returns the value of **highestBidder**; see Figure 10. View functions are convenient for debugging and testing, but the state is also viewable through the Remix logs.

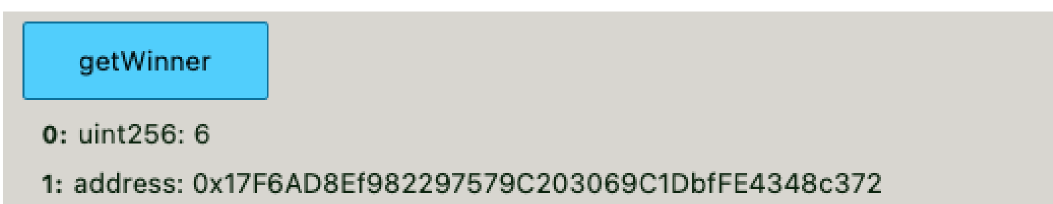
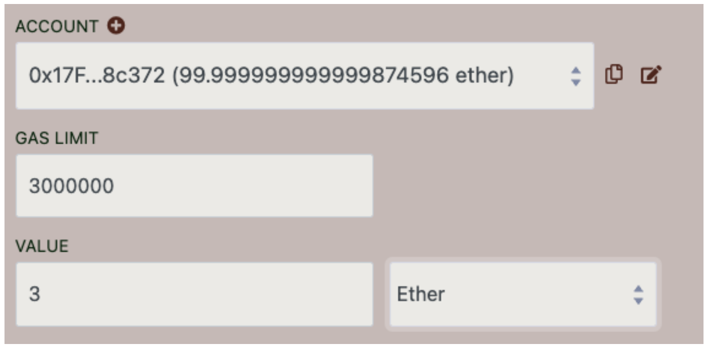


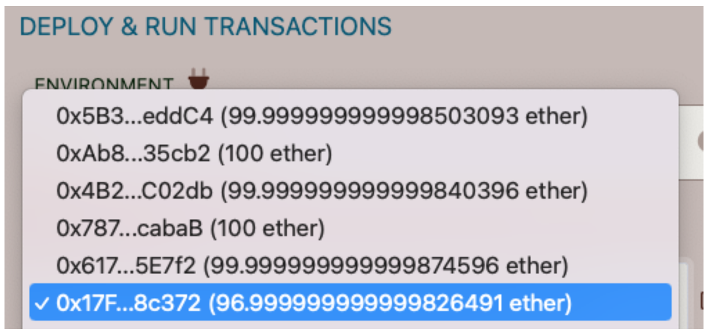
Figure 10: Winning offer and bidder's address (created by authors).

As a quirk to this contract, the action that initiates the trade execution is in the form of a fee (constant value set to 3 ETH) paid from the buyer to the smart contract. If the buyer does not submit this exact amount, then an error is thrown by the contract; this is done as a checks-and-balances action to ensure that the bidding team is serious with the offer.[2] Note in Figure 11b that 3 ETH is deducted from Team F's account balance; this amount is temporarily sent to and stored on the smart contract. We must reiterate that the fee is not intended to replicate current draft processes; it is simply a tool to aid in the simulation visualization since the scope of this research does not include the transfer of assets within a dApp.

[2] As of Feb 2023, 3 ETH ≈ \$4671; not necessarily relevant in the NFL.



(a) Bidder fee submission (created by authors).



(b) Fee deduction (created by authors).

Figure 11: Trade fee process.

The seller completes the transaction by calling the **auctionEnd** function, which performs several actions. It emits an *event*, which is important to the Ethereum Virtual Machine (EVM) logging process; it transfers the fee from the contract to the seller's account and prints a message to the log. There is built-in security, as only the seller may call this function. Figure 12 shows the log output of this function.


```
[
    {
        "from": "0xd9145CCE52D386f254917e481eB44e9943F39138",
        "topic": "0xa0fb15ce4bc38fa6151bf16630e38863764a7bb541866d083619bc5b6b93ad02",
        "event": "AuctionEnded",
        "args": {
            "0": "The bidding window is closed. The winner chosen is",
            "1": "0x17F6AD8Ef982297579C203069C1DbfFE4348c372",
            "2": "6"
```


Figure 12: Auction ended (created by authors).

The last part of this negotiation includes a side deal between Team F and Team A. Under the assumption of privacy, we suppose that Team F provides additional assets to sweeten the deal. The encryption is performed off-chain, so Team F encodes a plaintext message using RSA; both Python and Javascript offer RSA encryption libraries (Python, 2022, Rivest et al., 1978). Team F proposes the message shown in Figure 13, in this case, the demonstration is shown using Node JavaScript (Node.js), but Python also works well.

```
const secretMessage = 'I am also offering a weeks stay at my resort and $10,000';
```

Figure 13: Bidder side deal in plaintext showing "I am also offering a weeks stay at my resort and 10,000" (created by authors).

In this scenario, Team F encrypts the message shown in Figure 13; the output is a character string of ciphertext. Team F copies this ciphertext and sends it as input to the **setSideDeal** function, which may only be called by Team F. After storage of the ciphertext, Team A then copies it and decrypts it off-chain with their private key in the usual manner. Note we assume that the actual execution of this side deal is handled off-chain in private and executed in good faith.

```
Public key: 043ef8dda2a880aca93390dc4432035468ea430b6468b826f8c0e84aa144b99535414aab6185f4c7eb57fe4a5fdef84289dcd9dc59501d11748bd02346996cc3
 Ciphertext: a5b31ffafedce62fbf07d2e638439f1f0321be964b64b26eb8af22713b60c70af29590a144c08a0f5818ccc300cd0358677b73d400ac94a596cd1b555a5679f510e3b6
465259393cdd407e395ab48dabaae4fdd9d1effbf445b6477bcb0cac8356f1b951660602d27a79e47dda71455709e5e08f78bae8336abc47f856272dee2b31814ff4028fd133489c96d
ce2bc9f7a780e265466585ef75d1810133a3f700264c3c4437c9bb915c41166972e5459101fc099f089c42d6d2d0d98c59b5934b22db38e1d0c28db22fc8f8d5587bbf97b254d761d6d
5b8c237d5e5ff7046bafcdb7b7ad15df32a936c785eb5c371c4f2ed3927d577a6d817da5336755acffb7ab661b24b4fe9b8015e9bc9f1821f9423a60f6dd56444784cba9b276af6a53e
063081fd70201c3280c3c486f3ff8c789c2
```

(a) Off-chain encryption of plaintext using Node.js (created by authors).


```
{
	"string _message":
"a5b31ffafedce62fbf07d2e638439f1f0321be964b64b26eb8af22713b60c70af29590a144c08a0f5818ccc300cd0358677b73d400ac94a596cd1b555
a5679f510e3b6465259393cdd407e395ab48dabaae4fdd9d1effbf445b6477bcb0cac8356f1b951660602d27a79e47dda71455709e5e08f78bae8336ab
c47f856272dee2b31814ff4028fd133489c96dce2bc9f7a780e265466585ef75d1810133a3f700264c3c4437c9bb915c41166972e5459101fc099f089c
42d6d2d0d98c59b5934b22db38e1d0c28db22fc8f8d5587bbf97b254d761d6d5b8c237d5e5ff7046bafcdb7b7ad15df32a936c785eb5c371c4f2ed3927
d577a6d817da5336755acffb7ab661b24b4fe9b8015e9bc9f1821f9423a60f6dd56444784cba9b276af6a53e063081fd70201c3280c3c486f3ff8c789c
2"
```


(b) Storage of ciphertext in contract variable (created by authors).

Figure 14: Encryption process.

Once the trade is finalized, the draft order is updated (simulated), and picks proceed as per Table 4. Recall as picks are made, the selections are stored as transactions on the blocks (also simulated).

Table 4: Updated draft order, first two rounds (created by authors).

Rd1	Rd2
Team F	Team A
Team B	Team B
Team C	Team C
Team D	Team D
Team E	Team E
Team A	Team F

Round 1 includes two other trade opportunities in the third and fourth positions. For Team C, they are also involved in a Type 2 trade offer, but they only receive one offer from Team E, listed below. However, suppose that Team C does not prefer this offer and chooses to reject it. We assume the contract has been deployed, but Team C chooses to allow the contract clock to expire or ignores the offer and makes its selection. The contract does include a **manualStop** function in the case of ignoring offers, in which only the seller may call; this function stops the bid clock and disallows further negotiations. Figure 15 shows the log output of using the **manualStop** function; the current clock time is also shown for future reference.

Table 5: Trade offer for third pick (created by authors).

Team C gets	Team E gets
5th pick Side deal	3rd pick


```
{
        "from": "0x9ecEA68DE55F316B702f27eE389D10C2EE0dde84",
        "topic": "0x34e77d6c34e02a55c8206e81ef0076bbf2c53e5b68e898d6fef1752724508773",
        "event": "AuctionManualEnded",
        "args": {
                "0": "Bidding closed, no offers accepted",
                "1": "1693356365"
        }
}
```


Figure 15: Seller manually ends the bidding process (created by authors).

The last trade offer of the first round occurs in the fourth position, with Team D entertaining offers with a Type 4 contract. The only difference between the other contracts is the number of offered picks (see Table 6). The code is executed in the same manner as described in the previous demo; selling Team D manually chooses the best offer; in this case, it is the offer presented by Team E.

Table 6: Trade offer for fourth pick (created by authors).

Team	Offer (Pick Numbers)
E	5, 11, 17
A	6, 12, 25

The trade is executed via the smart contract, and the draft order is again updated. The other trade scenarios occur similarly. We also demonstrate the draft outcome via an expected value system based on the player grades and team position weights. In the initial ordering prior to trades, if each team were to draft strictly according to its most pressing need, the first round would yield the results shown in Table 7.

Table 7: 1st round outcome prior to trades (created by authors).

Team	Player	Position	Grade	Expected Value
A	12	WR	92	16.56
B	2	LB	95	16.15
C	15	DB	90	16.20
D	1	QB	95	22.80
E	6	OL	93	16.74
F	11	TE	92	16.56

Now considering the outcome of trades, the draft order changes and teams adapt strategies. Team F sees a target of opportunity and chooses to draft a QB, in this case the top overall prospect in the draft. Given the draft strength at the QB position, Team F believes that two or maybe even three QBs could be selected by the sixth pick. Since the QB position is often the most pivotal role on a team and Team F's priorities give equal weight to QB and TE, they select a QB instead of a TE. Table 8 displays the results of the first round.

Table 8: 1st round outcome after trades (created by authors).

Team	Player	Position	Grade	Expected Value
F	1	QB	95	17.10
B	2	LB	95	16.15
C	3	DL	94	16.92
E	4	QB	93	16.74
D	11	TE	92	20.24
A	12	WR	92	16.56

Thus, Team F has improved its draft value by executing a trade. Teams B and C did not change positions, but Team C also sees a target of opportunity. Since Team C gives equal treatment to the DL and DB positions, they choose to select the third best overall prospect, and they also improve their draft value. Team D's value declines in this scenario, but that is primarily because the top two QBs have been selected by the fifth pick. The next best QB has a grade of 91; since Team D received a big return with the trade involving Team E, they choose to select a TE (of higher grade) instead with the fifth pick. This is also not unimaginable, teams do forecast ahead what they could potentially gain or lose by moving back in the draft (Crofford Jr, 2021). In this case, Team D observes that QB is no longer a pressing need for the other teams and is reasonably sure they can still select one in the next round.

5 Discussion

The previous example is a conceptual demonstration of blockchain technology within a current NFL practice. It is not intended to replace the current draft process but merely show its potential. This work highlights the incorporation of smart contracts to automate the traditional draft trade process.

Teams have limited time to make a selection; a team that does not make a selection in time loses its place in line. Teams must account for the time to conduct trade negotiations—this includes discussions between GMs, the dual submission of particulars to the league, and the league verification of trade details. Any delay in this process can disrupt the selection order. In the traditional draft style, decision-makers are typically not co-located with the team table at the draft site; the relay time between the home site and draft site is also part of the time variable. Even though this concern is alleviated through the modern upgrade of digital submission brought on by COVID-19, teams are still allowed to attend the draft in person.

Another noteworthy feature is the ability to conduct side deals, which may or may not have an element of privacy to them. We offer two approaches for enforceability.

Private: Assume the owner does not want the details revealed; encryption is used to hide the details, but a bidder must submit a deposit in good faith. The deal is enforced with financial stake. In the example we used 3 ETH, but this can be any amount that is high enough to serve as enforcement.

Public: Assume that the owner does not care about details being made public; bids are collected up front, and other competing bidders may see the details of other offers. In this scenario (not modeled), public visibility serves as enforcement, and a dishonest team would suffer the wrath of other owners in the league.

The other area that this work highlights is information management. With limited time to make a selection or a decision about a trade offer, teams have to manage loads of information manually. This could lead to loss of information or incomplete information. As one former employee noted during his time with NFL teams, "As you get closer to the actual pick, it can get crazy with so many calls coming in referencing a trade. I have been in situations where there are so many calls coming in that sometimes three people have to handle that particular duty" (Gabriel, 2014). A smart contract can solve this problem because it can store lots of information in one location, even if this includes simultaneous interaction; any number of teams can submit bids to the contract, and there are no relevant memory or storage issues. This again provides more time for GMs and scouts to assess the cases involving multiple trade offers instead of also having to manage message intake. While smart contracts are still subject to human input error, we assume that the risk of information loss is lower compared to vocal relay because the chain history is public.

Trades suffer from time delays and information accuracy issues, and smart contracts can manage and process information within seconds. This automation not only buys increased decision time for the selecting team but also removes the league tasks involved in trades. Furthermore, given the financial impact of a potentially wrong pick, the blockchain architecture helps to maximize the available time to assess personnel decisions. High first-round draft picks are valued in the million-dollar ranges. Another careful example comes from the 2020 NFL Draft—defensive end Chase Young was selected second overall by the Washington Commanders, who rewarded Young with a four-year, fully guaranteed $34.6 million-dollar contract (Spotrac, 2023*a*). While he played most of his first season, Young played in only 35% of eligible games during the 2021 and 2022 seasons (Pro Football Reference, 2023). Thus, almost 5% of the team's annual salary cap is consumed by a franchise player who is unavailable to play (Spotrac, 2023*b*), yet he is still getting paid millions.

Finally, some might also argue that this process removes the human aspect of negotiation. Interaction with a smart contract is a digital experience from a computer without human conversation. Additionally, the trusted relationships enjoyed between GMs are removed. However, by removing personalities, negotiation tactics, and styles, we level the playing field of draft day trading. Any negotiator who is less skilled at these traditional abilities is not disadvantaged by this anymore. Instead, the GM can focus on the offers presented.

6 Limitations and Future Work

Limitations of this research include the adoption of blockchain technology in current NFL business practices. The NFL, like any other business, is driven by profit-related goals. It is possible that the transition to decentralized, distributed technology would reduce some of the impacts from television, media, and fan interaction. Hence, this idea is likely to be met with resistance. However, as the NFL increases its global footprint, it should embrace new advances in technology and find creative ways to use the new technology (Chadwick, 2006). Perhaps a future study to investigate fan, owner, and league interest in adopting blockchain technology is warranted. Additionally, the NFL draft seems to operate in a manner that is accepted by its participants. Thus, a drastic overhaul is not what this research suggests.

There are numerous ways in which this process can be improved or made more efficient. But there are also ways in which this concept can be applied to other areas of NFL business.

1. In line with comments above, further research is needed to explore how accepting the NFL and its partners are of blockchain technology. A sentiment analysis of fan interest is perhaps a starting point before attempting to assess league involvement. There are also marketing aspects worth exploring with the incorporation of blockchain that the NFL could use to widen its audience and create new interaction mechanisms.

2. Design a smart contract that includes all trade types; this would help with code and memory efficiency and limit confusion. Furthermore, the current setup only allows for the selected bidder to submit a side deal; ideally, we would allow teams to place both bids and side deals simultaneously.

3. Design a full-fledged dApp to support draft execution on a real blockchain. This implementation might include a front-end web interface to allow teams to interact with each other and the draftees, as well as the back-end P2P framework for the blockchain network. This would also incorporate oracles to pull the necessary external data on salary caps and contract details.

4. Use one of the active research methods to incorporate advanced encryption for side deals. This might include the practice of on-chain encryption processing.

5. Player contracts are written as traditional contracts, involving the actual players, agents, lawyers, team GMs, etc. Contracts are further complicated by the various clauses we see today, e.g., no-trade clause, guaranteed salary, injury protection, player development bonuses, etc. Players who do not negotiate their own contract pay a team (agent, manager, etc.) to handle this part of the business. Smart contracts could replace the traditional aspects of this process.

6. Salary arbitration: Other professional sports in the U.S., such as the National Hockey League (NHL) and Major League Baseball (MLB), utilize a third-party arbitrator who decides on a player's salary in the midst of unresolved contract negotiations. Smart contracts could replace not only the arbitrator's role but the pre-arbitration negotiation as well.
7. Other sports leagues: the other professional sports in the U.S. also hold yearly drafts, some of which mimic the traditional NFL draft structure. This research should translate easily to other drafts as well.

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A Additional Information

Table 9: NFL player position acronyms (adapted from Presto (2023)).

Term	Abbreviation
Defensive Back	DB
Defensive Line	DL
Linebacker	LB
Offensive Line	OL
Quarterback	QB
Running Back	RB
Tight End	TE
Wide Receiver	WR

A.1 Pseudocode

The **addBid** function allows a buying team to submit a trade offer.

Algorithm 1 addBid Function General Layout (created by authors)

Require: Buyer Ethereum address, pick number offer

```
function addBid(address,pick)
if currentTime > bidEndTime then
    bidding not allowed
end if
if pick < sellerPick then
    Invalid bid
end if
add (address,pick) to Offers[ ]
mapping TeamBid: address → pick
```

The **traditionalWinner** function belongs to the Type A trade, where the lowest bidder (in numerical value) is selected as the winner. Use of the term *highest* below implies the same meaning.

Algorithm 2 traditionalWinner Function General Layout (created by authors)

Require: Only seller can call

```
function traditionalWinner()
if currentTime < bidEndTime then
    bidEndTime = currentTime (stop clock)
end if
Set init = 1000; declare i
for i = 0; i < numPicks.length; i++ do
    if numPicks[i] < init then
        init = pickNums[i]
    end if
end for
highestBid = init;
highestBidder = TeamBid[init]
```

The **pickWinner** function is for Types B-D trades, where the selling team manually selects the best offer.

Algorithm 3 pickWinner Function General Layout (created by authors)

```
Require: Only seller can call
Require: Buyer Ethereum address
function pickWinner(address)
if currentTime < bidEndTime then
    bidEndTime = currentTime (stop clock)
end if
highestBid = TeamBid[address]
highestBidder = address
```

The **setSideDeal** function allows a bidding team to store an encrypted message in a contract state variable.

Algorithm 4 setSideDeal Function General Layout (created by authors)

```
Require: Only buyer can call
Require: string message
function setSideDeal(message)
myMessage = message
```