Patent Prediction Markets

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Introduction

Patents and other intellectual property assets are a fundamental component of any developed economy. Annually, more than three million patent applications are filed world wide to protect innovations and guarantee freedom to operate in a particular market. Over the past several decades, a stagnant, siloed patent system has struggled to keep pace with the increasing complexity of technology and the globalization of modern business. Failure by governments and lawyers to adopt technical solutions for the patent system creates widespread waste, undermines the ability of stakeholders to efficiently gain patent rights, and provides opportunities for patent trolls and other bad actors.

Patent.pm is bringing the patent system into the 21st century by providing tools that support functions traditionally performed by lawyers, governments, and other trusted third parties. Prediction markets provide market-based solutions for patent insurance by allowing companies to hedge litigation risk and uncertainty in a public patent invalidity market. Incentives for participating in prediction markets help aggregate predictions about patent outcomes such as validity and infringement from a distributed network of experts. Machine learning and AI tools curate and augment these predictions to create robust and accurate forecasts of patent events. The patent bounty and search platform similarly combines automated results with human analysis to decentralize prior art search. The comprehensive record of prior art assembled on patent.pm allows industries to police technical domains and make patent examination more thorough and efficient.

Opportunities

Patent Litigation. Globalization and an increase in technology investment has made the patent landscape more competitive than ever before. Last year, over four thousand patent infringement lawsuits were filed in the US and more than twenty thousand were filed in China.[1] Emerging markets like China are seeing as much as a 50% increase in patent litigation year on year as a result of increased competition between local firms and foreign entities. Patent litigation is known as the “sport of kings” because of its

[1] https://www.lexology.com/library/detail.aspx?g=72c4bd95-9bb0-4afe-b767-4d4dd9e90975

high risk high reward nature. The average cost to defend a patent litigation lawsuit in the US is $3.2 million but, if successful, the payoff can be enormous, often in the hundreds of millions or even billions of dollars. Despite the considerable risk patent infringement poses to companies and the increase in patent litigations worldwide, no efficient mechanism of hedging against patent infringement exists today.

Patent Trolls. So-called "patent trolls" are among the most active and successful participants in patent litigation. They use domain expertise to game the patent system and extract more than $33 billion from innovative companies every year. Patent trolls prey on innovative companies using overly-broad, low-quality patents to demand licensing fees. Numerous low quality patents granted in a particular technical field, for example, blockchain technology, form a patent thicket that makes innovation cumbersome and risky due to the lingering threat of patent trolls. The Asicboost vs. Bitmain patent war[2] and well documented explosion in blockchain patent filings[3] foreshadow the impact patents and other intellectual property rights will have on the blockchain community as it matures. Despite striking similarities between early stage development of conventional software fifty years ago and today's nascent blockchain industry, no solution for policing patent trolls in the blockchain space currently exists.

Prior Art. Prior art is any evidence that an invention is already known. A prehistoric cave painting can be prior art. A centuries old piece of technology can be prior art. Anything can be prior art.[4] Some common examples include patents, patent applications, scientific journal articles, white papers, products, and inventions. Prior art is the most valuable information in the patent ecosystem because it determines whether a patent is worthless or worth millions of dollars. Currently, prior art can be difficult to find because it is discovered through a centralized, manual process. Most prior art search is performed by a single examiner during patent examination, the process of getting a patent approved at a government agency such as the United States Patent and Trademark Office (USPTO) or the State Intellectual Property Office (SIPO in China) On average, patents are granted in the US after consideration of only 10% of relevant prior art contributing. This underexamination leads to a 50% invalidation rate for asserted patents. Annually, the estimated market for prior art search and pre-application analytics is $340 million to $1.4 billion (USD).

Patent Transactions. Patents, copyrights, trademarks, trade secrets, and other intellectual property assets are an essential component of operating companies efforts to protect market share, enter new markets, and gain a competitive advantage from R&D. Every year more than $180 billion dollars

[2] https://bitcoinmagazine.com/articles/bitmain-may-be-infringing-asicboost-patent-after-all/
[3]https://www.economist.com/business/2017/01/12/a-rush-to-patent-the-blockchain-is-a-sign-of-the-technologys-promise
[4] EPO Inventors Handbook, *What is Prior Art?*, available at: https://www.epo.org/learning-events/materials/inventors-handbook/novelty/prior-art.html

of patent transactions are completed despite only 2% of patents being involved in at least one transaction during their 20 year lifetime.[5] These statistics indicate that some patents are high value assets, but most do not generate any revenue. Few reliable methods for separating valuable patents from junk and the outdated and lawyer-dependent patent transaction silo are factors currently limiting the number of patent transactions.

The Patent.pm Platform

Prediction Markets. Markets are predictive of future outcomes.[6] Prediction markets aggregate predictions of many participants, including human and AI experts, who buy and sell contracts on outcomes like shares of stock. Unlike a poll which encourages participants to respond with the outcome they hope to happen, the incentives and consequences associated with responses in a prediction market encourage participants to respond with what they actually *believe* will happen. All prediction markets function as a result of this basic idea and the first prediction market was developed by the Defense Advanced Research Projects Agency (DARPA).[7] Numerous prediction markets currently exist and projects including Augur (augur.net) and Gnosis (gnosis.pm) have proven blockchain as an efficient and effective technology for supporting prediction market transactions.

Patent.pm provides the first ever public prediction market for intellectual property ("IP") events. IP stakeholders including technology companies, inventors, law firms, examiners, venture capitalists, banks, and insurance companies can all make and participate in Patent.pm prediction markets to gain insight into the novelty or infringement of a particular patent, copyright, or trademark. Prediction markets synthesize multiple predictions by expressing event probabilities in the price of the asset. Market-based predictive methods are more robust than traditional human analysis or AI alone because they can combine these methods into a single prediction. Additionally, these markets provide opportunities for hedging against litigation risk and monetizing technical knowledge.

Mechanically speaking, Patent.pm prediction markets are binary outcome contracts asking the basic question: is the patent valid or invalid? At the expiration of each market, participants owning shares of the winning outcome are rewarded and participants owning the losing outcome receive nothing. These

[5] http://www.wipo.int/edocs/pubdocs/en/intproperty/944/wipo_pub_944_2011.pdf
[6] *Combinatorial Information Market Design,* Robin Hanson, *Information Systems Frontiers* 5:1, 107–119, 2003, available at:
http://weigend.com/files/teaching/stanford/2008/readings/PredictionMarkets/Hanson2003.pdf
[7] *Prediction Markets,* Justin Wolfers and Eric Zitzewitz The Journal of Economic Perspectives Vol. 18, No. 2 (Spring, 2004), pp. 107-126

are dynamic, parimutuel markets[8] allowing participants to enter and exit the market up and until the contract expiration.

In our blockchain-based system, one share of the prevailing outcome is worth one unit of the collateral token. Before the contract expiration date, contracts trade between 0 and 1 tokens per share. The price per contract represents the implied market probability of the event occurring as determined by the crowd. For example, in a patent validity market, a price per contract for Invalid of 0.71 represents a 71% chance of patent invalidation occurring. If patent is invalidated and determined to be not novel by the contract Expiration Date, owners of Invalid contracts would receive 1 token and make a profit of 0.29 per tokens per contract purchased at 0.71. Patent.pm includes prediction markets for granted patents as well as patent applications. Markets may be priced and pay out in a variety of collateral tokens including the platform token, IP Gold ("IPG"), any ERC20 cryptocurrency (BTC, ETH, DAI), or fiat currency (USD).

AI Assisted Bounty Platform. The Patent.pm bounty platform is assembling the world's most comprehensive open prior art database. Instead of relying on a single examiner at the USPTO to find all relevant prior art references, Patent.pm bounties incentivize the network of human and AI experts to find, submit, and tag prior art references. The platform features automated prior art search tools on top of an international corpus of six million software, blockchain, and drone patents. This specialized database is made available to our users to expedite the prior art search process and feed relevant information into the prediction markets.

Researchers are rewarded for submitting prior art found manually and uncovered using the platform's automated methods. Additional rewards are provided for human feedback on the relevance of automated results to incorporate insights derived from the human search process into improving automated search models. Bounty rewards may be distributed in the platform token (IPG), another cryptocurrency (BTC, ETH, USDT, DAI), or fiat currency (USD). By combining search tools with real incentives, Patent.pm distributes the work of prior art search across a scientific community.

Research Network

Prediction markets coordinate crowds by providing public forums for establishing domain expertise. Participating in prediction markets over time generates a track record of accurate and inaccurate

[8] *A Dynamic Pari-Mutuel Market for Hedging, Wagering, and Information Aggregation,* David M. Pennock, Yahoo! Research Labs (2004): available at: http://dpennock.com/papers/pennock-ec-2004-dynamic-parimutuel.ps

predictions for users. By rewarding accurate predictions with tokens, Patent.pm provides opportunities for domain experts to compete head to head to determine who knows the most or has the best intuition about IP.

Enterprise Solutions

Prediction markets are accurate and robust predictors of future outcomes, so it is possible to answer many different question types with market-based methods. However, there are certain markets that are more compelling than others because they produce business value. Prediction markets can be used by companies to manage risk and coordinate internal crowds to create new legal products for managing risk, such as:

Invalidating Granted Patents. Every year nearly four thousand patent infringement lawsuits are filed in the US. Most of the these lawsuits are filed by non-practicing entities (NPEs). Pejoratively known as patent trolls, NPEs are organizations that develop technology and/or aggregate patents with no intent to work their IP by commercializing products.To combat assertion activity by NPEs, Congress recently authorized the creation of post grant review (PGR) proceedings to more efficiently evaluate validity of granted patents. Inter Partes Review (IPR) is the most commonly used PGR and since its creation in 2012, more than 7 thousand petitions for IPR have been filed.[9] Post grant review Despite facing high exposure to patent infringement lawsuits many companies have no way of hedging litigation risk.

Patent Insurance. Patent.pm offers a market-based solution to hedge against litigation risk. In advance of litigation, companies can create invalidity markets on patents that pose a significant litigation threat. After market creation, companies hedge their risk by taking a position on an undesirable event such as the validity of a dangerous patent. If the unfavorable outcome comes to pass, the company collects a risk premium on their position. If doesn't come to pass, it is because the patent was effectively rendered invalid by prior art and the litigation risk is gone. This is a win-win situation for the company.

In addition to providing an efficient hedging mechanism, taking a position against validity of a dangerous patent incentivizes activity in favor of invalidity. Researchers, insurance companies, and financial institutions monitoring the market will see the company's validity position and work to gain that position by finding prior art search and possibility funding litigation depending of the size of the tech company's position. The market based solution also functions during ongoing litigation because money invested in the market is put to work incentivizing invalidity instead of passively going a third party.

[9] *USPTO Patent Trial and Appeals Board (PTAB) stats*, available at:https://www.uspto.gov/sites/default/files/documents/AIA%20Statistics_March2017.pdf

Invalidating Patent Applications. Every year more than seven hundred thousand patents are filed in the US. Many of these applications contain revolutionary technology developed with years of work and millions of dollars in R&D investment. Protecting these innovations is vital to a company's success and impacts market share within an industry for years to come. Despite the importance and volume of patent applications, the patent Office usually takes two to three years before providing an initial opinion on the patentability of an invention disclosed in an application. With no reliable solution for forecasting initial examiner actions, companies make resource intensive decisions about R&D, products, ip, and marketing without a firm understanding of the feasibility of obtaining patent protection.

IPX patent application markets provide a forecast from a distributed network of technical experts in a fraction of the time it takes a patent Office to issue an action. This forecast is able to provide the accurate and robust prediction on patentability because it combines human and machine intelligence. The well reasoned experience of hundreds of human experts with the comprehensive and deep insights provided by AI models leveraging big data. Having an accurate patentability forecast will allow companies to more efficiently spend R&D dollars and develop better strategies for using IP to gain and maintain a competitive advantage in their industry.

Enterprise Prediction Markets.

Patent.pm offers public markets and private markets. Public markets are open to participation from anyone and private markets are limited access markets available to users within an organization. Public markets are intended for assets in litigation, competitor assets, and other assets company bears infringement risk. One example public prediction market is provided below:

Public Market Ex 1: Will *any of claims 5, 6, or 12* of US6085219 - "Home page creating systems apparatuses and program recording mediums, and home page displaying systems and program recording mediums" - be held invalid on or before March 1, 2019?

*US6085219 - one of three patents asserted by Hyper Search, LLC against Facebook, Inc. in patent infringement suit filed on October 3, 2017 in US District Court for Delaware.

Private markets provide a mechanism for aggregating expertise within an organization such as a company, trade group, or industry. Private markets are intended for patent events including asset maintenance, invention disclosures to patent, applications to abandon, asset valuation, etc. One example private prediction market is provided below:

Private Market Ex 1: Will US9119032 - “User activity tracking system and device” - be maintained for its first maintenance term on or before February 25, 2019.

*US9119032 is a patent assigned to Facebook Inc. that was granted on August 25, 2015. The period for paying first term maintenance fees operns August 25, 2018 and closed February 25, 2019.

Many of the most active participants in the patent system are large, global companies with hundreds or even thousands of technical employees. These technical teams are comprised of different professional backgrounds and operate in multiple time zones. Logistical obstacles, management, data sharing rules, and different areas of expertise restrict cross team communication. Scientists may collaborate with other scientists, engineers with other engineers, patent attorneys with other lawyers, but inter-department collaboration must overcome high organizational inertia.

Private prediction markets solve these coordination costs by introducing an open forum to pool knowledge across a large organization. Companies can use prediction markets to aggregate knowledge from different technical experts around the globe on sensitive issues such as viable R&D direction,, next steps in litigation, etc. The market tallys results of the knowledge aggregation process in convenient price metrics that transcend language barriers. Companies can also build market participation into employee compensation packages by leveraging financial incentive models already developed by IPX such as bounties or payouts for accurate predictions.

PM Use Case	Target Verticals	Advantages over Current Solution
Patent Applications	Technology Companies file 300k applications per year $3B Legal services market for patent preparation	-Faster validity prediction 1 mo vs. 18 mos for response to application -More robust prediction model Public market vs. 1 examiner
Granted Patents (invalidation)	5k patent infringement lawsuits $ 33B in litigation damages	-Companies can hedge litigation risk - Bounty driven research network generates prior art
Private Markets	Sensitive matters - litigation events, infringement risk, R&D directions Coordinate large, global workforces	-Source collective intelligence on technology matters -Research network extensible to other technical and legal applications

Token Model

Dual Token Economy. IPL employs a dual token economy with a security token and a utility token. Both tokens are ERC-20 and token functionality is programmable and self executing. The security token, IPX, is a non-equity security of IPL and entitles the token holder a share of the the platform income from fees collected on the prediction markets. At the Initial Distribution, 100% of the supply of this token will be owned by IPL. In the future, IPL may distribute IPX to a limited number of investors who meet certain criteria. The utility token, IP Gold (IPG), is awarded to researchers who make accurate predictions. It is used to track reputation in the network and access features of the application, such as market or bounty creation. IP Gold is also required to pay platform fees in the smart contract ecosystem. IPG is analogous to other platform tokens such as PokeCoins or World of Warcraft gold in that it's utility is confined to platform services.

IPX Profit Sharing. In order to incentivise the ownership of IPX, a portion of platform fees (initially 50%). is awarded to IPX owners through staking. These awards are distributed with a lottery system that runs on a periodic basis (every 1 hour). The probability of a user winning the lottery is in proportion to the number of locked IPX tokens in a wallet address. This is similar to proof of stake mining except the source of lottery awards comes from fees. Note that IPX which is not locked will not count towards the probability of a user winning the lottery.

IPX Locking. A token locking model is useful in promoting price stability. Users are forced to choose between collecting profits via staking and having unlocked tokens which can be sold at any time. There is a time delay in both locking and unlocking a token (1 day). While a set of tokens is in the transition period of being locked or unlocked, those tokens can neither be sold nor generate profit.

IPX to IPG Conversion. In this dual token economy, IPX can be freely converted into IPG on a 1 to 1000 basis. However, IPG cannot be converted back into IPX. Under normal circumstances a user would never actually convert IPX into IPG because IPG does not entitle a user to the staking rewards. The only time a user should consider converting IPX into IPG is at the moment they want to pay platform fees in IPG.

IPG to IPX Recycling. Even though a user cannot convert IPG into IPX, the IPG that is burned via fees is recycled as IPX when profit sharing occurs. This is possible because the only way to generate IPG is by destroying IPX. This ensures that the total number of IPG tokens divided by 1000 plus IPX in circulation is a constant 1 billion: #IPG/1000 + #IPX = 1 billion. We award IPX instead of IPG because it is more valuable and incentivizes users to stake their tokens.

IPG Airdrops. Using an airdrop contract, IPL can distribute IPG efficiently. This contract enables IPL to send IPG to hundreds of users in a single blockchain transaction. This airdrop contract can be used for marketing purposes by awarding IPG to users who sign up for our mailing list or who use the platform.

How Prediction Markets work on IPX

Collateral Token. The collateral token defines what currency is used to buy shares in a market. The collateral tokens will be ERC-20 tokens, including a wrapped Ether token (W-ETH). A share of the correct outcome is worth one unit of the collateral token as defined within the scope of the market. For example, on W-ETH based market may define one unit of the collateral token to be 0.001 Eth such that a single share is not so expensive.

Pricing. IPX features a double dutch auction that enables users place limit orders. This eliminates the need for an automated market maker to determine pricing. Market makers like logarithmic market scoring rules (LMSR) can have a negative impact on prediction accuracy by artificially manipulating market prices, for example, by increasing the price of an outcome in response to placing a bet on outcome. With a double dutch auction, users can specify their price preferences in a limit order and wait until there is a match. Since the one share of the correct corresponds to exactly one unit of the collateral token, the price per share of an outcome is also the implied probability of the event. This system is therefore more straightforward and more dynamic than other market scoring systems.

Order Matching. There are two ways buy and sell orders can be executed. In the straightforward example, users can sell shares of an outcome and other users can buy them. When fees are not included, the formula is simply P(ask) >= P(bid). But orders can be matched to either create or destroy shares of opposite outcomes. Since the smart contract API allows one unit of the collateral token to be exchanged for one share of each outcome YES and NO, we can use the principle to match orders on the opposite outcome. Bids that meet the formula P(yes) + P(no) >= 1 are considered matches. When those bids are matched in the order book, shares of the appropriate outcome are distributed to the users. Shares can be destroyed with the same process but in reverse. Two asks of opposite outcomes which meet the formula P(yes) + P(no) <= 1 are matched in the order book. The IPX matchmaker buys the shares from each party then immediately exchanges those shares for the collateral token.

Prediction Market Development Roadmap

Development Philosophy. IPL is a company that uses blockchain technology to build innovative legal technology solutions for intellectual property applications. Our focus is delivering a platform that can drive participation in the patent process on multiple levels, for example, prediction markets and prior art search. Despite the immense promise of blockchain technology, blockchain development is still in its infancy and there are many drawbacks and limitations in a fully decentralized application. As a result, there are three planned phases for smart contract development with steadily increasing decentralization and complexity.

Phase 1:Initial Markets

IPG Markets. IPG is freely distributable to users, therefore, the collateral token for the first markets will be in IPG. Most of the IPG used in these markets will be awarded to users through our marketing and airdrop campaigns.

Binary Outcomes. The first markets will be exclusively binary outcomes of a yes/no question.

Off-Chain Order Book and Matching. In phase 1, the order book is entirely off-chain and centralized. Orders only reach the blockchain once the matchmaking Java service has found a match; limit orders waiting to be executed do not go on the blockchain. This has two main benefits: saving gas and development costs. By pushing the order book and matching to the Java, we can limit the complexity of phase I contracts.

Centralized Oracle. Another expediency taken in phase I is with a centralized oracle. While a decentralized oracle is a great feature for prediction markets like Augur and Gnosis, those contracts add complexity to the product. And a decentralized oracle is only valuable once a robust community develops.

Phase 2: Security Tokens and Patent Futures

Phase 2 will introduce new markets with other ERC-20 collateral tokens like W-ETH and USDT. To participate in these markets, users will have to be verified through the KYC process.

Bancor Integration. Phase 2 brings markets with new collateral tokens. The platform will enable users to convert from IPX to and from other ERC-20 tokens. This is done with the Bancor protocol. At the core, the protocol is a non-profit making market maker which connects different ERC-20 tokens. These connectors allow users to switch between IPX and other ERC-20 tokens without using an external exchange. Each connector holds a balance of the token it is connected to such that as the price increases as more tokens are minted. The exact mechanisms of the bancor protocol are beyond the scope of this white paper (more details can be found on the Bancor website: https://about.bancor.network/protocol). IPL will utilize the relay token configuration (two connectors of 50% weight). This configuration was chosen because it's is best suited for providing liquidity for currency trading pairs.

Fee Model. Fees in phase 2 can be paid in either the market collateral token or in IPG. The starting fee rate will be 0.5%. Since the Bancor relay token contracts can determine the instantaneous exchange rate between IPX and the collateral token, that rate is used to determine the amount of IPG required for fees (since IPG is considered a proxy of IPX). The purpose of this feature is to allow users to spend IPG that was given to them in non-IPG markets. The Bancor converters will thus be integrated within the market contract.

On-chain Order Book, Off-chain Matching. Phase 2 will move the order book from a SQL database to the blockchain but keep the actual matchmaking in the Java service. In this system, a user can post limit orders directly to the blockchain. This enables the use of Metamask which is important to some users. But the smart contract does not try to fill orders by finding the best bid or ask. Instead, the order filling function takes a pair of order Ids, checks if they meet the pricing criteria (e.g. bid price greater or equal to the ask price), and then executes. This system requires an off-chain service to actually figure out which orders are matches before calling the order filling function. Since the matchmaking is off chain, the contract is less complicated than a fully decentralized model.

Phase 3: Fully Decentralized Markets

Phase 3 of markets is a fully decentralized model. This model has many similarities to other decentralized markets such as Augur and Gnosis.

Decentralized Oracle. Phase 3 will introduce a decentralized oracle. In these contracts, the stakeholders of IPX determine how a market should resolve. The voting of market resolution replaces token staking for distributing profits from the fees in a model similar to Augur's REP token. To incentivise users to resolve outcomes correctly, only users who vote for the outcome that is agreed to be correct are awarded.

On-chain Order Book and Matching. In Phase 3, the entire order book and matching is done on the blockchain. There is no dependency on the Java service in either placing orders or filling them. When orders are sent to the market contract, the contract determines the best matching orders and attempts to execute the trade pairs until there is no matching order left in the order book.

Multi-Outcome Markets. In Phase 3, markets will no longer be confined to pure yes no questions. Instead, there could be N number of outcomes for a particular question. This enables new markets that could not have been developed in a binary outcome model.