Juris Adjudication Protocol

Human-Powered Dispute Resolution for Smart Contracts

Adam J. Kerpelman, JD // Ramsay Brown // Akash Desai // Matt Mayberry // Jake Dodd // Vince Enachescu // T. Dalton Combs, PhD

team@jurisproject.io | Telegram

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Abstract

Contract disputes occur. **Off the blockchain**, we resolve them through the court system or a form of Alternative Dispute Resolution (ADR). The more structured form of ADR, called "arbitration," involves the airing of grievances before a panel of neutral jurists, who assess the facts and provide a decision. The power of arbitration is recognized internationally, with ~150 countries required by UN treaty to enforce arbitration judgements. In the United States neutral arbitration is a for-profit business. **On the blockchain**, there does not yet exist a protocol for the fair and efficient resolution of disputes in smart contracts. In this paper we introduce the **Juris Protocol**, an open source arbitration protocol built for the blockchain, and **Juris Token (JRS),** a utility token to facilitate and incentivize Juris platform activity. Through the use of Juris' Mediation Tools, Contract Development Kit (CDK), and Adjudication Protocol, the disputed outcome of any smart contract may be contested through United Nations compliant neutral arbitration. Additionally, the Juris Protocol introduces a novel reputation system based on prior certification, ongoing community activity, machine learning, and graph analysis. The protocol is intended to facilitate the inclusion of both professional human arbiters and a larger community of novices. In this paper we review Juris' improvements on the current state of the art, explore Juris as a framework, and describe a governance model for launch and future development. As a platform, Juris seeks to improve both the safety and security of smart contracts. This will reduce the risk in the transition of traditional transactions onto blockchain-based alternatives and, in turn, increase broad adoption of blockchain technology.

Summary

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System Attack Resistance

Sybil Attack

The reputation algorithm and Repchain will make it very expensive to produce high ranked Jurists without providing value to the network. That value creates a prohibitive cost for the creation of a new users (in good standing) which makes a Sybil attack on the Juris protocol itself extremely difficult. (See Reputation Blockchains Section for more on Repchain sybil attack resistance.)

50%+1 Attack

On top of the mechanisms that make a 51% attack difficult on any blockchain platform, the bicameral structure of Juris Foundation governance will make Juris much more resistant to a 51% attack. Even if someone could control a super majority of Juris Proof of Stake they would be blocked by the Proof of Judgment chamber from forcing any changes to the Foundation Contract.

Conclusion

> No freemen shall be taken or imprisoned or disseised or exiled or in any way destroyed, nor will we go upon him nor send upon him, except by the lawful judgment of his peers or by the law of the land.

-Article 39, Magna Carta (1215)

> Whoever controls the courts controls the state.

-Aristotle

In the last thirty years we have witnessed the rapid digitization, decentralization, and distribution of myriad services and tools we would, only ten years ago, have

declared to exist steadfastly in the "real world". These technologies have fundamentally alternated the way humans communicate. With this transition we have seen the rise of new problems, and new solutions. Among those solutions we find blockchain technology, which gives us a simple but fundamentally different way of recording transactions between humans. And on the back of this fundamental change we now find ourselves with a tool: **the smart contract**.

In the realm of "Silicon Valley," and tech innovation, there is a popular notion of "disruption" typified by the idea of tearing down and replacing previous institutions. Disruption carries with it the notion that these institutions, built on the "old" way of doing things, must make way for better solutions. Naturally, this has, thus far, been the tone of the conversation about distributed financial systems, blockchain, Bitcoin and smart contracts. But there are some systems of such great importance, which are important on such an individual level, that every successive "disruption" has merely refined their application. From monarchies, to oligarchies, to the republic, and the democracy. Through centuries of decentralization in systems of government. From English common law to modern systems of judicial resolution and arbitration, the idea articulated in the Magna Carta that "lawful judgement" of one's "peers" is the only way to fairly and peacefully resolve a dispute is not a notion to be "disrupted," but a notion to be refined and incorporated anew in any system of governance which proposes to facilitate human cooperation.

Smart contracts and blockchain technologies evolve the way that transactions and agreements take place between people. Further they hold global promise to allow secure transactions, and enforceable agreements among a class of citizen to which such tools were previous unavailable. But smart contracts will never truly take hold if they do not arrive at the door of the average person bearing an equally evolved system of fair enforcement and dispute resolution. The innovation behind the first legally binding contract was not simply the idea of an agreement put on paper, but an agreement made enforceable "by the law of the land." The innovation behind the smart contract further refines the ability of an increasing number of people to access this sort of agreement, but we must realize that these contracts still work in service of humans, and must thus adhere to notions of justice that have so far provided for the scale of cooperation and coordination to which we bear witness today.

Any tool working in service of human cooperation, and for blockchain-based technologies and smart contracts to truly take hold, we must acknowledge this basic fact: **disputes will happen,** software will have bugs, humans will disagree, and humans will misunderstand, often through no fault of their own. When these disputes occur centuries of refinement, study, and application have shown that the only fair means of resolution is by a jury of one's peers.

It is the mission of the Juris Foundation, and the goal of the continuing development of the Juris Protocol, to create a decentralized and distributed justice system; a justice system able to provide fair dispute resolution at the scale and accessibility of the Internet. For, it is only on the back of such a system of

fair dispute resolution that the promise of blockchain technology to bring about global democracy can be realized.

Background, Motivations, & Opportunities

Contract Law & Contract Disputes

The contract is one of the foundational innovations of human society. Contracts, backed by rule of law, allow for the creation of trusted agreements between parties who may have limited ability to check backgrounds, or enforce promises without the help of a government. Contracts, and contract law, allow cooperation to scale beyond the village square. And in the past half-century, the ability to work together has given birth to even more advanced means of cooperation. We've seen the progression from radio to television, the internet, the web, social media, and now blockchain technology. Each of these innovations has resulted in more communication, taking place further and further from the comfort of the village square. This means more and more reliance on contracts to back our agreements.

Disputes under contract law arise when there is a perceived failure of cooperation. Fingers are pointed, and arguments are made about meaning and understanding. Contract law does its best to provide a peaceful solution, and codify results for future reference. But, disputes regarding intent, expression of intent, and understanding of that intent by all parties are forever rooted in the vagary and nuance of human life and language. For this reason, there will always be contract disputes. When these disputes occur, the parties call on the government and rule of law to resolve confusion and enforce resolution.

Smart Contracts

Uniquely enabled by blockchain technology, the "smart contract" is a new evolution of cooperation via agreement. Over the past decade, blockchain has crept into the backbone of myriad previously centralized, analog processes. From currency exchanges and crowdfunding, to identity management and self-governance systems. Activities previously reliant on central authority are leveraging blockchain's distributed, immutable, record-keeping to become more fault tolerant, more inclusively accessible, and more democratically operated. At the core, all of this works in service of the same end as does contract law: increased ability to co-operate securely. It makes sense that blockchain would carry with it a new evolution of the contract itself, the "smart contract."

The smart contract introduces new components to the contract structure. They aren't "contracts" really, they're computer programs structured like contracts. They live and run directly on a blockchain (like Ethereum) not on any one local machine. They are both an agreement between parties **and** distributed executable computer software. This means the drafter of a smart contract can

not only program in the terms of an agreement, but write a program to execute those terms automatically.

Standard contracts are documents that represent the agreement between two parties. When it comes to executing the terms, it's on the parties to hold up their side of the agreement, and the expectation that they will do so is backed by the right to sue for enforcement. A smart contract doesn't need the threat of legal action as backing. Execution is built into the program. If the terms are met by one party, the rest of the contract code simply executes, and the agreed upon outcome is enforced. Here, the agreement is enforced not by fear of the courts, or the police upon court order, but by the code's execution and persistence on a distributed immutable blockchain.

Because of this, blockchain technologies and smart contracts are sometimes called "trust-less," as they enable a measure of enforcement without government backup. You don't have to trust the other party to an agreement to fulfill their obligation; the code just does it. But this code is a "contract" insofar as it represents intent by multiple parties that a form of co-operation is to take place. In this way even smart contracts will inevitably, on occasion, fall prey to the same trappings of human frailty we encounter in the practice of contract law.

Alternative Dispute Resolution

As society has grown and technology has provided for more and more cooperation – and corresponding legal agreements – the frequency of such disputes has given rise to judicially recognized Alternative Dispute Resolution (ADR) mechanisms[^3]. For the parties tied up in a dispute, these alternatives provide a means of peaceful resolution that is faster and cheaper than the court system. For the court systems, ADR helps them keep their docket under control so they can worry about important matters like criminal trials. Modern contracts between parties frequently include "arbitration clauses," which stipulate that in the event of a dispute the parties agree to air their grievances before a neutral third party, and accept the decision rendered, rather than using their right to pursue resolution via the court system.

Under most ADR systems, arbitration is overseen by a professional neutral arbiter, who is frequently provided by an organization like JAMS, the largest private ADR provider in the world. Arbitrators are usually experienced legal professionals, lawyers, or retired judges. The Juris Platform will provide greater access to this class of professional assistance, and will allow an increasing number of legal professionals to weigh in, provide services, and establish themselves as skilled Jurists.

For all their recognition and respect, ADR systems have fallen behind. The Juris CDK, Mediation Tools, and Adjudication Protocol are the next evolution of dispute resolution, built for the next wave of human communication, cooperation, and innovation.

Human Tools, Human Rights

Blockchain technologies and smart contracts present the world with a new way of structuring and executing agreements between parties. Yet, for all of their revolutionary capacity, those technologies work in service of human ends, and will never be free of the aforementioned vagary and nuance. People will misunderstand or misrepresent. Intent and meaning will mis-match. Software will have bugs. And, so, people will desire a mechanism to protect their right to a fair resolution of wrongdoing, disagreement, negligence, or conflict. Millennia of contracts, contract law, cooperation, and conflicts have given rise to modern international systems of arbitration. Held to United Nations convention standards, arbitration is a recognized means of dispute resolution. The Juris Protocol we propose evolves those systems for blockchain applications, and in doing so represents the next evolution of fair and peaceful dispute resolution, and justice.

While creating Juris, we hold it as truth that peaceful resolution of disagreements is a human right. We believe that the progress of further human cooperation and technological expansion will depend on the ability to feel secure in one's agreements, and in one's ability to seek justice when those agreements fail. It is only a matter of time before this new form of cooperation, fed by the evolution of blockchain technology, progresses into the function of democracy, systems of law, and dispute resolution. As such, our goal for Juris is to digitize and decentralize the mediation and arbitration process, and to bring arbitration to decentralized contract systems such as the Ethereum smart contract. At maturity, an arbitration platform for the blockchain holds the potential be an indispensable part of participation in any smart contract, **any contract**, and any system of human cooperation.

Bringing Rule of Law to the World

> The rule of law and development are strongly interrelated and mutually reinforcing[.] [T]he advancement of the rule of law at the national and international level is essential for sustained and inclusive economic growth, sustainable development, the eradication of poverty and hunger and the full realization of all human rights and fundamental freedoms, including the right to development, which in turn reinforce[s] the rule of law.

- UN Declaration on Rule of Law

Contracts have the power to facilitate cooperation only to the extent that they are backed by government legal systems, and rule of law. In countries without functioning courts, parties to contracts cannot be compelled to perform. Even in countries with strong civil law, getting an arbitration judgement is just half of the battle. If a party does not conform to the judgement, the aggrieved party can go to the court to get an order to seize assets, garnish wages, or similar. Globally, this process is often difficult, time consuming, complicated across borders, and

still cannot happen in many places that suffer from weak rule of law.

Hence, the imperative for a system like Juris. Here we leverage the smart contract constraint that a token asset can be inextricably linked to the execution of the contract itself. Because of this link we are able to ensure that - should dispute arise - the process of performance is automatically executable, just as the standard behavior of the contract would have been without dispute. Over the past decade, disruptive technologies like Bitcoin[^4] and Mpesa[^5] have distributed banking services to over 1 billion people. We see here the opportunity for a similar distribution of Rule of Law via Juris. When arbitrating a smart contract running through Juris, an arbitrator would be able to directly enforce their judgement regarding the assets described within the code of the smart contract, distributing the assets as law and justice require. This removes the need for local judicial backup behind the terms of an agreement.

The United Nations, Arbitration, and International Law

Carried out to United Nations standards, arbitration is well suited for dispute resolution in the distributed, often multi-jurisdictional context of blockchain and smart contracts. 157 of 193 UN countries[^6] are signatories to The New York Convention[^7], which recognizes arbitral awards across borders if those awards are the result of arbitration proceedings which follow UN mandated minimum rules. Additionally, many countries have adopted UNCITRAL Model Arbitration Laws, which provide for the same. This treaty and these laws mean that any system of arbitration built to UN standards is already internationally enforceable via traditional means, if need be.

Built to parallel the UNCITRAL arbitration rules[^8], the Juris CDK will provide a way to build UN standards for arbitration process, and jurisdiction independent arbitral award enforcement, into any smart contract. This will provide a globalized, decentralized system for dispute resolution, built to United Nations standards for due process.

The Juris platform seeks to provide global citizens with viable and reliable access to internationally enforceable options for contractual agreement, and conflict resolution. Smart contracts are able to reach the farthest corners of the connected world, creating the opportunity for an increasing number of people to take part in secure transactions that may have otherwise been questionable, or impossible. For citizens, this means increased access to justice. For jurists, this means access to new markets which will grow with the adoption of blockchain, mobile devices, and the web, instead of markets that grow only at the pace of stable government.

All Software Has Bugs

Through decades of software development and the composition of billions of source lines of code, by millions of programmers, at least one maxim has held

true: where there is software, we will find bugs. Estimates vary, but at least one thorough study suggests that software defects cost 1.1 trillion dollars in the year 2016 alone.[^9] Browse through the commit history of any one of thousands of open source projects on GitHub, and it will be readily apparent that bugs are both a) pervasive and b) not limited to novice programmers.

The second inference—that bugs are committed by experienced and novice programmers alike—has grave implications for the future of smart contracts. After all, smart contracts are just software. It would be an extraordinary claim to suggest that the increased adoption and correspondingly increased sophistication of smart contracts will reduce the incidence of bugs when history has shown us otherwise. We can expect quite the opposite, actually; as smart contracts are adopted more widely, they'll be applied to increasingly difficult problem domains, with an increase in complexity to match. Software defects will continue to be a fact of life, and will worm their way into smart contracts—often, with dire consequences.

Current State of the Art

Especially following the collapse of the DAO, the need for mediation and arbitration on blockchain-based smart contracts has spurred teams to investigate what frameworks may be developed to build this necessary part of the blockchain ecosystem. Two projects in particular serve as compelling starting points for discourse and improvement, and have been taken into consideration while developing Juris.

DAMN

In May of 2016, pre DAO hack, Third Key Solutions – founded by Pamela Morgan and notable Bitcoin advocate Andreas M. Antonopoulos – released a proposal for DAMN: a Decentralized Arbitration and Mediation Network[^12]. The proposal was brief, and outlined an open source project intended to create a network similar to Juris on many fronts, in particular the adherence to United Nations arbitration standards. Their proposal was submitted to the DAO for funding approval and sentiment regarding the proposal was largely positive[^13]. The last activity on the project Github repo was in late May of 2016, with the DAO hack taking everyone's attention shortly thereafter.

Kleros

Released as a concept whitepaper in 2017[^14], Kleros represents a more focused look R the idea of smart contract arbitration, and presents an example of the use cases for a decentralized arbitration system. Additionally, it outlines the attack risks against such a system (bribery, surreptitiously controlling the majority of tokens, and a Sybil Attack). Drawing game theory underpinnings from Ethereum

founder Vitalik Buterin's initial proposals of SchellingCoin, Kleros proposed to incentivize arbiters to collaboratively vote as to reach "truth," where truth (or a proxy of it) must emerge from a costly voting process and incentives apropos. Game theory challenges emerge when voters are asked to vote how they think everyone else will vote. This problem, known as the Beauty Pageant Problem, remains unaddressed in both SchellingCoin and Kleros. Additionally, Kleros calls for the top-down segmentation of the judicial system into sub-categories and sub-courts of dispute. Escalation in the Kleros system calls for an increasing number of arbiters for each stage of a case, with those arbiters selected via cryptographic hash function. All of these factors impose an unnecessary operational overhead on the project.

Platform Specific Dispute Resolution Tools

Part of the initial excitement for smart contracts was the elimination of ambiguity and human judgement from the process of contract execution. But most of the community has retreated from that view, and disputes in many of today's most promising blockchain applications involve matters of judgement (crowd-funding, freelancing, content licensing, etc). Did a crowd-funded team hit their milestone? Did a freelancer deliver what they promised? All judgement.

The best players in each of these spaces have recognized that there will be disputes, and have outlined dispute resolution procedures. However, these platform specific tools are often customer support oriented and not built to sound legal standards. Many lack any incentives, many are vulnerable to simple attack patterns, and all necessarily use members of their general community, or support personnel to adjudicate disputes. Not only do these systems frequently fail, or result in unsatisfactory wait times, but the decisions delivered by customer support or the community will still be open to legal challenge after the fact. This then becomes a source of possible liability for the platform itself.

Juris is first-and-foremost a tool for these platforms to get out of the business of dispute resolution so that they can focus on their core value. By integrating Juris into their platform, they are outsourcing a highly technical, possibly existential problem.

The Juris Framework

Dispute Triggers

All disputes will be triggered manually, and the ability to trigger a dispute will be limited to a direct party to the contract, or other parties to which the ability has been delegated via the CDK at the time of contract creation. Dispute triggers will be accessible only to these parties through the CDK. The Juris Foundation, its agents, arbitrators, and Jurists are unable to trigger a dispute on behalf of another party.

Contract Freeze

The moment that a dispute is triggered the CDK code freezes smart contract processes. The contract code will not continue to run. If the contract is a public contract, or a contract with a massive number of parties, and a previously agreed upon dispute threshold is reached, processes are frozen and additional parties are unable to access the contract until the disputes are resolved.

Evidence, Arguments, and Discussion

When a dispute is triggered, the triggering party will be required by the Juris platform to include itemized claims, their desired resolution, and their initial arguments for that resolution (together, the "Formal Complaint"). Additionally, they will be able to provide any details or evidence regarding the case that may fall outside of the smart contract logs ("Supplementary Evidence"). All of these details will be attached to the smart contract through the CDK, and will follow the case through the Juris system.

The counter-party to the dispute will have a designated amount of time to respond to the claims of the triggering party. They will be required to provide a direct response to each item of the claim, as well as their initial arguments for their preferred resolution. Here they will also be able to provide any additional details or evidence for their case that may fall outside of the smart contract logs. If there is no response from the counter-party (and one is required to proceed,) the system may issue a default judgement in the favor of the other party.

The argument submission process will be locked following the response from the defending party, and the submission of additional evidence will be locked before the case proceeds to open discussion. New evidence may be submitted with majority High Jurist approval. Further discussion and questioning regarding the case, case details, and evidence will take place via resolution processes outlined below.

Holding Wallets

As soon as a Formal Complaint is filed, the CDK code generates a neutral blockchain wallet address into which the funds associated with the contract are moved. The funds can only be released from this wallet via the Juris CDK, and the use of one of the available resolution mechanisms. The neutral wallet address is maintained internally by the CDK code within the smart contract itself and is not known or accessible to contract parties, the Juris Foundation, or Jurists involved at any time.

Smart Contract Logs ("Hard Evidence")

One of the most critical pieces of evidence provided to the Jurists will be the history of logs and transactions associated with the smart contract in question.

This is especially true when a bug in the smart contract is what lead to Juris dispute resolution. At the moment that the dispute is initiated the Juris CDK collects and freezes all transaction logs, contract execution logs, contract state, and the contract code itself. These logs will be automatically summarized and made available to Jurists as evidence.

Resolution Mechanisms

SELF (Self-Enforced Library Functions) Judgement

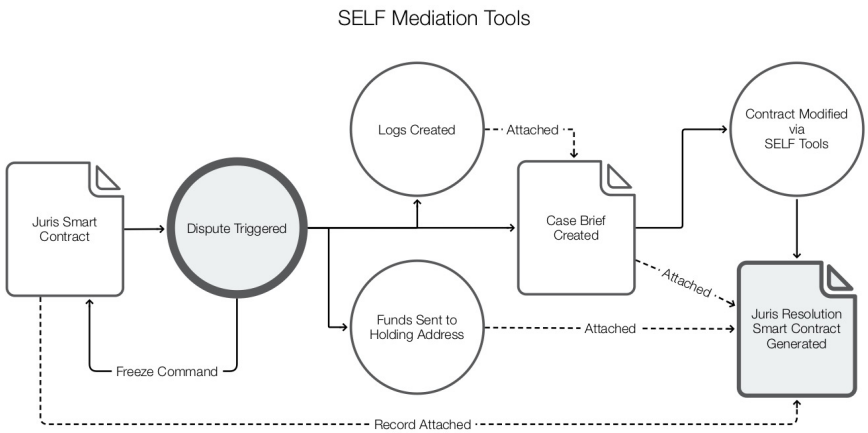
Problem it solves: Something has gone wrong with a smart contract, and a dispute has been triggered. All parties to the contract are able to agree what should happen next. This could be caused by a bug, a broken oracle feed, or any other unforeseen event. Whether right away, or after brief negotiation, the parties have a solution and they agree that the solution is fair. But, current smart contract structure does not allow for an adjusted outcome.

How JRS moves: No JRS changes hands when the self-mediation toolkit is activated, but all funds in the initial contract are locked.

From the parties' perspective: This is a free and fast way to amicably resolve a contract that has resulted in a dispute or undesired outcome.

From the Jurists' perspective: This keeps trivial matters off the docket.

How it works (figure 9.1): The incorporation of the Juris CDK allows the protocol to alter the outcome of a smart contract. Through the Juris dashboard, the parties to the contract have access a package of self mediation tools, which provide for the implementation of basic operations to designate a different outcome for the smart contract: void the contract, give all assets to party A, split assets evenly, etc. Once and outcome is selected, the details are incorporated into a new resolution smart contract which is uploaded to the blockchain, and executed. These tools will be open source and free.



figure

9.1

SNAP (Simple Neutral Arbitrator Poll) Judgement

Based on the Delphi method.[^15]

Problem it solves: If parties are unable to settle on an outcome on their own, and believe that a disagreement in their contract will be resolved by a quick review of the facts by a third party, they can escalate to a SNAP. This provides the opportunity to break a deadlock without escalating to binding arbitration.

How JRS moves: The minimum fee for a SNAP is covered by the pre-attached JRS, but the party initiating the SNAP may also attach additional JRS to incentivize Jurists to take the case. 5% of the fee goes to the Juris Foundation, the rest is split equally amongst all of the Jurists in good standing who take part in the SNAP.

From the parties' perspective: This is a cheap way to get a fast judgement and a lot of input from different perspectives. It may have the power to quickly resolve a negotiation stalemate.

From the Jurists' perspective: SNAP's don't pay as well, but they do offer a lot of opportunities to earn reputation. Jurists will always be on the hunt for a contract where their unique expertise will be decisive in order to earn increased reputation. Because everyone has to split the arbitration fee, it pays to look into disputes with fewer initial votes. Because every action impacts reputation, it pays to vote reasonably, be attentive, contribute, and choose cases where you have domain experience in order to increase or maintain your standing.

How it works (figure 9.2): After a dispute has been triggered, parties may initiate a SNAP. From the date the SNAP is initiated, the parties have a window in which to provide the additional details mentioned above for their Formal Complaint. This is added to the "Case Brief" containing itemized (e.g. bulleted) complaints, written arguments, and optionally itemized additional facts the parties would like to present during the judgement. At the close of this window, case briefs are anonymized posted to JRS Token holders publicly for review, and are all available to both parties.

Jurists may access any case brief without obligation to participate in the case, but must pass a Captcha test (or equivalent) before being given access to further evidence, or logs. If an individual chooses to join a SNAP as a participating Jurist, they are given access to further evidence and logs, and are required to cast their initial vote using only the information available. When casting their vote, a Jurist must cite justification from at least one of (a) an item of Hard Evidence, (b) an item of a Formal Complaint, or (c) an item of Supplementary Evidence. As part of their judgement, an arbitrator must also provide a short (255 characters or less) summary of their opinion. After submitting the above,

their "Independent Judgement," an arbitrator formally becomes a Jurist for the given SNAP.

Independent Judgements remain hidden from both the disputing parties and other Jurists until everyone has submitted theirs, or a time limit has been reached. (The number of Jurists that have joined the SNAP may be displayed publicly in a manner to incentivize Jurists to select cases with fewer assigned Jurists.) At the end of a designated period of time the case details are no longer public, and open discussion begins among SNAP Jurists.

At this time all participants are made privy to the SNAP's tally of votes, the tally of evidence selected as justification, and the Independent Opinions, all of which are anonymized. During discussion, Jurists make material contributions to the discussion in the form of: questions posed for other participants, submission of general comments, citations of case history, comments on any item in the Case Brief or supporting materials, written responses to any of the above and to other written responses, and atomic responses (up/down vote) to any of the above.

After a designated period the window for discussion is closed, at which point interaction between and among all participants ceases for a period of deliberation. In this time, Jurists have an opportunity to independently review the case details and all additional supporting and discussion materials. After deliberation, each Jurist must cast a final vote, select one or more pieces of supporting evidence, and compose a written summary of their opinion no longer than 500 characters (collectively, their "Informed Judgement"). Until the close of the deliberation period, all informed Judgements are hidden from other parties as they are submitted.

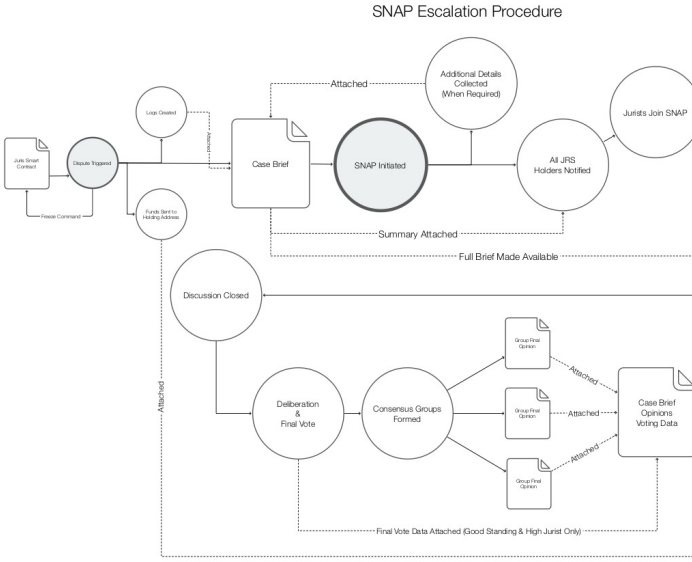
At the end of the deliberation period, all of the Informed Judgements are closed for modification, and each Jurist is immediately placed into a group of peers (a "Consensus Group") who voted in favor of the same disputing party. Each Consensus Group is firewalled from both the other Consensus Group and from the disputing party. Each group will have a designated amount of time to confer amongst its members and write an opinion on their ruling (the "Final Opinion"). The Jurist with the highest reputation within an individual Consensus Group is automatically selected as the leader of their cohort. Optionally, the default lead Jurist may appoint another Jurist within their Consensus Group as the opinion writer.

During opinion composition, all Jurists retain access to all case briefs, evidence, and discussion details. The Jurists in a given Consensus Group collaborate in the same manner as the earlier discussion. Before the end of the opinion composition, each Consensus Group compiles these Opinion Artifacts into a Final Opinion.

With the submission of the Final Opinion, communication between all participants ceases, and the Final Opinions from both Consensus Groups are delivered to all parties to the contract along with a breakdown of the final voting split.

All voting data, discussion records, and opinions are additionally attached to the contract recorded in case of further escalation.

At this point the disputing parties are again given access to the CDK resolution



tools to implement an agreed upon dispute solution.
9.2

PANEL (Peremptory Agreement for Neutral Expert Litigation) Judgement

Based on UNCITRAL Arbitration Rules[ˆ16]

Problem it solves: While the SNAP procedure provides assistance in dispute resolution, it does not rise to the level of due process required for a binding judgement under United Nations standards. Disputes reaching this level will be complex, will have a lot at stake, or will require binding legal resolution. UN rules thus require a small number of people to take their time examining all of the evidence, and hearing all of the arguments.

How JRS moves: The party(s) to the contract requesting the PANEL pay the market rate in JRS to convene a panel. 5% of that fee goes to the Foundation, the rest is split equally amongst the Jurists on the panel at the close of proceedings.

From the parties' perspective: For complex disputes that require deep attention of the most skilled jurists, or to break a deadlock with a final and legally binding decision, it's worth paying for a PANEL.

From the Jurists' perspective: This is more labor intensive, but this is where the real money is as fees are higher and split among fewer Jurists. In

order to get put on a panel, you need to have High Jurist standing. All of that work spent in SNAPs pays off here.

How it works: Similar to normal court systems, this is considered an escalation. Parties cannot proceed to a PANEL judgement without first running a SNAP. If one or both parties are unable to use the assistance of the SNAP to come to a resolution, they may choose to escalate to a PANEL judgement by (1) indicating their intent to escalate and (2) attaching the required JRS. At this time, all other parties to the contract will be notified of the case escalation, and their required actions. If, at any time, in the PANEL process a party fails to meet a required deadline, a default judgement may be declared at the discretion of the High Jurists.

Arbitration Panel Selection: Based on the domain specialties marked on the arbitration agreement, a list of ten available High Jurists will be provided to each party. The High Jurists will be notified at this time of their inclusion on this list, will have access to the case brief, and will be invited to remove themselves if there is a potential conflict of interest. Parties will have 30 days from the delivery of the High Jurist list after which they will be required to select three (or submit three alternatives), numbered by preference. If a party chooses alternative arbitrators, any arbitrator not registered through the Juris Foundation will be required to register and provide proof of credentials before the end of the 30 day period. At this time, each list of preferred High Jurists will be shared with the opposing party, which will have 15 days to eliminate up to two of the opposing party's choices. The remaining Jurists will select a third – neutral – "Presiding High Jurist," to complete a final panel of three High Jurists. If either party fails to provide a list within the designated 30 day period the Juris system will randomly assign an available High Jurist.

Hearing Process: All previous SNAP materials, opinions, evidence, and claims will be made available for review by panel high jurists. The High Jurists will be able to ask any questions of either party, and parties will be required to provide answers (and may be found in default if they fail to respond.) If relevant, this may extend as far as the coordination of video-based hearings. At this time, the parties will be allowed, at the discretion of the Jurists, to submit additional evidence, make additional arguments or counter arguments, provide witnesses, and amend previous materials. Any new materials, or communications, will be made available to all other parties at the time of submission.

Judgement: At the end of 30 days, (unless an extension is requested or granted by the panel,) the High Jurists will render a binding judgement on the facts of the case. Through the Juris dashboard the Jurists will input their decision, and the CDK will unlock the smart contract, and execute the code, automatically enforcing the judgement.

Juris Foundation Governance

Initial Governance

Initially, platform development will be governed in a fashion similar to other open source software projects at their inception: a single leader from the Juris Foundation's founding team will, amongst other roles, facilitate development, recognize contributions of the community, drive platform consensus, and break deadlocks. For example, direct vote by community members will be used to set technical direction, and anyone can submit pull requests. However, The Foundation will, at the outset, be the sole authority for which updates to the master Juris Framework will be manifest.

This model is necessary during the early days of the platform to increase attack resistance until the value of the platform and the resilience for the Juris Reputation System are maturely established. Once the system is sufficiently stable, The Juris Foundation will activate a meritocratic, bicameral liquid democracy to transfer power of governance to the Juris community.

Bicameral Liquid Democracy

Proof-of-Work and Proof-of-Stake are popular and effective governance tools for many blockchain-based communities. They give governance power to those who either bear the cost of maintaining the system or stand to gain the most from its continued success (respectively). Therefore, they are very effective incentive-alignment tools. Yet they are not without their limitations, namely that they encourage winner-take-all dynamics. Fortunately, the addition of a bicameral liquid democracy ameliorates these shortcomings.

There is a long tradition of separating judicial authority from monied interests. It is an affront to a common sense of justice that a judicial body should be governed by one-token, one-vote (Proof-of-Stake) system. As such, historically, judiciaries have governed themselves through bar associations: rule-setting bodies that constitute "the whole body of lawyers, the legal profession."[^18] Though, without popular oversight, a judiciary run by – and for – the bar would become solipsistic and self-serving.

Therefore, we propose Juris be governed by a bicameral liquid democracy; one chamber will operate on Proof-of-Stake, the other by Proof-of-Judgment. The assent of both chambers will be required to make a change to the master contract that defines the operation of Juris.

A Liquid Democracy or Delegated Democracy vests voting power in assigned delegates instead of representatives. This enables voters to take an active role and vote on issues directly, or take a passive role and delegate voting power to a trusted party with domain expertise. Through either direct voting or proper delegation, people with domain knowledge of the topic are able to better influence the outcome of decisions, which in turn leads to an overall better governance of

the state. Because of this, a Liquid Democracy naturally evolves into a system where decisions are mainly made by those who have the expertise required to make well-informed decisions on issues.

Introduction - Calamity on the Blockchain

In May 2016, the DAO, or "Decentralized Autonomous Organization" launched the largest crowdfunding campaign in history.[^1] Not just on the Ethereum Blockchain – but **ever**. They raised 150 million dollars worth of Ether by the end of 28 days. But, their success was short lived: on June 17th, 2016, we saw what happens when the intention behind a "Smart Contract" diverges from its codified implementation. Several errors inside the smart contract code written by the DAO team allowed a single bad actor to drain 50 million dollars worth of Ether from the DAO wallets overnight. The remainder of the funds were saved only because a group of "white hat" hackers moved them to a friendly wallet via the same exploit.

The breach was significant enough to drastically undermine investor confidence in Ether. Immediately following the DAO's theft, Ether's price cratered and lost nearly 63% of its value. Beyond just a price drop, the impact of the DAO was forceful enough to crack Ethereum into two entire separate blockchains: Ethereum, on which the DAO transactions were erased, and Ethereum Classic, where they were not. The split took place because this "hack" wasn't strictly illegal, or even really a hack. These bad actors didn't break anything; they noticed errors and exploited them to make the contract function in a way other than intended. The community was split on how to handle this: should they stick to the "four corners" of the contract terms, or stick to the intent of the smart contract code? After much debate there was a "Hard Fork" of the Ethereum Blockchain[^2]. The fork happened because the Ethereum Foundation decided to honor the intent of the contract over the literal code written. This type of dispute is not new. **This is contract law.**

Had the set of smart contracts that constituted the DAO been constructed with an adjudication platform available as insurance (in the way court systems safeguard ink and paper contracts) the events that unfolded, ranging from the loss of market cap to the "Hard Fork" of Ethereum, may have been preventable. It is to avoid catastrophes like these, and engender a better confidence in smart contracts at large, that we propose **Juris**: a decentralized adjudication platform for blockchain smart contracts.

The Juris Token (JRS)

The Juris Protocol will use a proprietary blockchain based security token (JRS) to incentivize developers and Jurists to be involved and to improve the system. The use of this "tokenization" of resources allows us to provide the Protocol

as an open source project. The goal of the JRS token is to capture the value inherent in a dispute resolution system, and to concretely distribute that value to the builders, the jurists, and the Juris community. With such a system in place The Juris Foundation will be able to focus on its mission to provide fair and just dispute resolution to the world... and not on profit motives.

A Note on Regulation

The conversation about how to treat new models of incentivisation and collective ownership is ongoing. In response, the goal of this portion of the paper is to lay out the intended philosophy and functionality of our Juris system tokenization and incentivisation. Early stages of Juris Protocol development, including token offerings, will strive to attain these goals within established U.S. securities law. We will not address regulation directly, or token offering details directly, as this is an ever shifting target, and will continue to be this way for years.

Tokenization

> "It's not about Bitcoin, it's about blockchain"

Tokenization is not a new concept. "Shares" of a company are simply tokens representing fractional ownership of that company. You give the company money, they give you "shares." And those shares come with certain rights – voting, profit sharing, etc. Your shares used to be literal pieces of paper in a folder somewhere. Now all the stock markets are digital. We've already tokenized the world.

The Bitcoin whitepaper, and the currency it spawned, brought us the first prominent example of blockchain technology in use. Regardless of one's feeling about Bitcoin as a currency or project, it has proved that blockchain technology is – at the very least – aptly used to build a functional *value* layer. Using tokens as "shares" to distribute the value captured in a system. Again, nothing new, I've just describe stocks. Which capture the value in a company, and redistribute.

The confusion increases because blockchain is *so* good at digitizing this kind of system that it allows a fluidity of shares that the stock market system does not allow. When this happens tokens begin to feel more like money than like stocks. Blockchain projects already exist in which we can use tokens to "pay" for things. This has given rise to the debate among founders, investors, and regulating bodies alike regarding the notion of a "utility token." A token that is more akin to frequent flier miles, or cash, than a stock. Some tokens are clearly utility tokens. Some are clearly stocks. Most, including JRS, will be hybrids.

Incentivisation

Within a company, money is the single most concrete form of incentivisation. Everyone goes to work because they need to make money. They take that money into the world to pay for food, shelter, and so on.

Slightly less concrete is the idea of stock, which is frequently given to employees at a company, particularly if they are involved early. This stock, representing a stake in the company itself, is a different kind of incentive. Here value is gained not by working and receiving money. Here value is gained by working for the success of the company as a whole. This means that the behavior this has the potential to promote is different. Here the incentive is not only to do your job, but it is to help others, and to make choices that will benefit the company at large... so your stock will go up.

As stock based incentivisation systems scale upward, regulations and transactional friction make it impractical to offer more fluid (or public) stock until there is enough value in the company for a small percentage of shares to be worth holding. If the average person owns stock in Apple it is a minute share of the company as a whole, but the company's overall value is so high that it is worth owning such a small share. "Going public" is a landmark in any company's growth. It represents reaching such a scale (such a value to the world) that the only way to grow is to share that value with any member of the public willing to purchase stock. In fact, until this decade "going public" was the *only* way to capture value at such scale.

Digital tokenization and blockchain infrastructure allow us to rethink this dynamic. They introduce the ability to incorporate stock-like incentivisation mechanisms at the very core of a protocol. They introduce the ability to capture the value of a system, and bake in a way to share that value with everyone responsible for creating it. These systems can work hand in hand with traditional "payment for services" models to drive a depth of platform use, trust in the protocol, platform growth, and value distribution previously reserved for public companies – or more aptly – public governments.

In the development of the JRS token model it is our consideration that the establishment of any sort of judicially compliant dispute resolution system must hew closer to that of a public court system, than a private company. The value captured by the system and any associated power in governance must be re-distributed to all members of the system who provide value.

Token Functions

While a utility token functions in a manner more akin to that of money, a security token makes no bones about being a share of stock. A utility token makes the promise that a holder will be able to use it for a specific function. A security represents ownership of a portion of a company, project, protocol, or piece of property and often includes voting rights, or profit sharing.

Guided by the above definitions, **JRS tokens will be a hybrid model.**

JRS Utility Functions

CDK users who wish to avail themselves of the ability to trigger binding dispute resolution will be required to stake JRS on their contract. JRS will be available on open trading markets, and we will offer additional ways to acquire JRS as the technology landscape and regulation evolve. The minimum amount of Juris required to trigger the Juris protocol will be calculated based on a fiat conversion, and priced to provide wide access to the protocol.

When a dispute is triggered and Jurists are called in, the staked JRS will be allocated to the Jurists providing services. – Additional fees, paid in native crypto or fiat currency, may additionally be layer on top of this transaction to represent payment for Jurist services.

Invitations to take part in SNAP judgements as a Jurist are open to all registered JRS holders worldwide. This ensures the possibility of a wide Jurist pool, and the involvement of only those users with a stake in the protocol. As a utility function the protocol will occasionally check a Jurist's wallet for a non-zero JRS token balance in order to allow certain actions or transactions to proceed.

JRS Security Functions

As a Jurist, an investor, or a community member, the JRS token will represent your share of the value captured by the Juris Protocol, and your "stake" in that system. In this way JRS is most like a share of stock, earned by being part of the company.

JRS function as security will be of increasing importance and value as Juris Protocol, and Juris Foundation governance evolves to a "Proof of Stake" model for community input on future development and policy. More in the "Governance" section.

Looking forward

Defensibility

Before you decide to commit your time to working on an open source project, or commit to stockpiling a utility token behind that project, it is certainly worth discussing the long term prospects. In the blockchain space, every good idea has lots clones and forking iterations. So, why is Juris going to win in the long term?

First Mover Advantage

First, there is great strength in the "first mover" advantage, and only more-so in the context of the creation of the associated Jurist network. Bitcoin remained the dominant medium-of-exchange crypto currency despite thousands of competitors, many of which are technically superior. If all of the interested parties commit to the first mover, everyone has more of an incentive to improve the first mover, than

to jump (alone) to an upstart platform. Juris has this advantage. Arbitration companies like JAMS persist because they have organized a registry of certified arbitrators. Juris intends not only to begin by partnering with such companies before launch, but to increase our pool through the Repchain protocol, which will allow the onboard of new Jurists.

The Jurist Repchain

In this context, the Repchain is potentially more important for the persistence of the Juris Protocol, and the Juris Platform, than simply being the first to move. Stack Overflow was not the first place to talk about software, and Github was not the first place to distribute source code. But they are the dominant platforms today because they were a good place to develop, exhibit, and leverage a good reputation. And that reputation is only tangentially portable to other networks. This is the Juris Platform's long term strength. Though most of the utility will be derived from open source software, the Juris Foundation's implementation will continue to thrive because of the power of the Proof of Judgement-based reputation system – a novel innovation.

Jurists

Potential (non-developer) Jurists will want to commit to Juris Tokens quickly because holding JRS lets them move to accrue reputation sooner. This will allow them to advance more quickly to placement on the more lucrative PANELs. While the ability to fork the protocol is inherently simple, Jurists will be reluctant to leave JRS for alternatives because they cannot take the associated reputation with them. Better to stay and improve the system in which they are invested by taking part in governance functions also afforded by the holding of JRS and associated reputation.

Developers

Developers involved with the project will be incentivized through JRS rewards for codebase commits and bug bounties, and the value of tokens received for this effort will only be amplified by the above non-developer token use. Additionally, this allocation to developers will incentivize the developer community to use the Juris Protocol in their own smart contracts, spread the word to other developers, and to take part in future governance mechanisms to improve the protocol on an ongoing basis.

AI Arbitration

While the Juris Foundation has no specific plans at this time, we would be remiss were we not to address a frequent corollary to blockchain technology conversations: artificial intelligence and machine learning.

Activity on the Juris protocol, and associated reputation chains, would amount to a source of judicial, dispute, and smart contract related data like the world has never seen. Anyone who knows AI/ML knows that data is an important crux of their application. Things learned from Juris Protocol data, with applied AI/ML, could have an impact on justice, dispute resolution, and judicial practice beyond current comprehension.

Beyond Arbitration

In preparation for a trial, lawyers will often 'war game' a case. The art of trial law is less in the details and the evidence, and more in the way a story is presented to a jury – there's a reason that "courtroom drama" is a consistently popular television and movie genre. And it's not because evidence is so interesting. Mock trial and jury selection companies make a pretty penny providing services to aid in this version of trial preparation. Lawyers do their best to use these tools to test different variables in their story, and how to best select a jury to hear that story. Yet these "war games" are often slow, expensive, inaccessible to weaker parties, and still provide data of limited statistical relevance.

In this context, with minimal repurposing, the Juris Platform could provide a solution. The SNAP could be used to test different arguments and possible presentation of trial facts on a scale larger by factors when compared to what a mock trail company might provide. And at a greatly reduced price. What's more, the system could, by filtering for novice Jurists with no previous qualifications, approximate the input of an uninformed jury. This would create increased opportunity for novices to gain reputation in the system, while providing trial lawyers with a testing ground providing data from both professionals (other lawyers), and novices (those peers that would make up a jury.)

The Juris Mission

To make "smart contracts" on all blockchains safe, robust, and human.

To create a protocol, token, and reputation system for fair dispute resolution, justice, and judgement.

To make justice as efficient, effective, and accessible as the Internet.

Notes

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1. https://en.wikipedia.org/wiki/The_DAO_%28organization%29ethereum
2. https://www.coindesk.com/ethereum-executes-blockchain-hard-fork-return-dao-investor-fun

3. https://en.wikipedia.org/wiki/Alternative_dispute_resolution
4. https://en.wikipedia.org/wiki/Bitcoin
5. https://en.wikipedia.org/wiki/M-Pesa
6. http://www.uncitral.org/uncitral/en/uncitral_texts/arbitration/NYConvention_status.html
7. https://en.wikipedia.org/wiki/Convention_on_the_Recognition_and_Enforcement_of_Foreign_Arbitral_Awards
8. https://www.uncitral.org/pdf/english/texts/arbitration/arb-rules/arb-rules.pdf
9. https://www.tricentis.com/resource-assets/software-fail-watch-2016/
10. https://ujomusic.com
11. https://www.coinlancer.io
12. https://github.com/thirdkey-solutions/damn/blob/master/proposal.asciidoc
13. https://dao.consider.it/decentralized-arbitration-and-mediation-network?results=true
14. https://medium.com/kleros/kleros-a-decentralized-justice-protocol-for-the-internet-38d596a6300d
15. https://en.wikipedia.org/wiki/Delphi_method
16. https://www.uncitral.org/pdf/english/texts/arbitration/arb-rules/arb-rules.pdf
17. https://link.springer.com/article/10.1007/s10796-005-4807-3
18. https://en.wikipedia.org/wiki/Bar_association

Non-Technical Overview

The Protocol

A smart contract is protected by the Juris Protocol when the Juris CDK code is included in the contract, and backed by the attachment of a small quantity of Juris Token (JRS). The CDK provides for a minimum subset of "just in case" contract terms in the form of code to be included in the smart contract. The CDK and Juris Dashboard help make sure that the party writing the contract has outlined the necessary terms of possible dispute resolution, or is aware of default CDK settings. It also makes sure that any other parties accessing the smart contract are aware of these terms as well. The necessary terms include details like the amount of time the parties will have to dispute a transaction

following the smart contract's execution, time for default in arbitration, and other specifics The Jurist Foundation or the United Nations recommend.

Once the contract is written, the minimum JRS is attached, and the smart contract is live on a blockchain, that contract is protected by the Juris Protocol. For the life of the contract the JRS will remain attached, and the CDK terms will remain incorporated, unless otherwise specified to expire in the code. If the smart contract runs without dispute, and the time for a challenge expires, all attached JRS will be returned.

In the event of a dispute, the challenging party accesses the contract through the Juris Dashboard, or via the command line, and initiates the Juris Protocol. The system freezes further activity within the smart contract, creates an individual address as a holding account for any funds, takes the details of their grievance, attaches them to the disputed smart contract along with any and all associated logs, and then notifies the other parties involved. They are immediately moved to the mediation and arbitration process with the following steps:

1. **SELF Mediation:** Through the Juris Dashboard the parties have access to a range of popular mediation tools and techniques intended to facilitation resolution of any conflicts. The CDK gives the parties the ability, with mutual agreement, to cause the contract to proceed as written, to return all parties back to their positions before the contract was executed, or any resolution in-between deemed fair by all parties, and implemented.

2. **SNAP Judgement:** If the parties are not able to work the conflict out themselves, they can escalate to a SNAP Judgement. This will cost JRS: at minimum the JRS attached already, with the option to add more to incentivize Jurist participation. The SNAP will arm the conversation with data on a possible outcome. When a dispute is escalated to a SNAP, the Juris protocol will facilitate a polling and discussion process among all available Jurists. They will have a limited amount of time to review the details of the case, each side's story, and provide their judgement on an equitable solution via anonymous vote. The parties will be provided with a breakdown of poll results, and a brief opinion from the group. The JRS put up for the SNAP will be split among all Jurists who take part in the SNAP process. Armed with this new information, the disputing parties will still have the option to resolve the dispute on their own using the Juris CDK tools.

3. **Binding PANEL Judgement:** If the parties are unable to resolve their conflict to the satisfaction of all, one or more of the parties may choose to escalate further, through The Protocol, to a Juris PANEL judgement. Again, this will come at the cost of additional JRS, but will provide a binding judgement. As a bonus, enforceable by UN treaty in most of the world if legal followup is needed. When a case is escalated, the Juris system will facilitate the selection of a panel of three High Jurists: those at the highest level of reputation, classified by domain experience and any

other factors outlined initially via CDK. This panel will be selected by UN mandated rules, and convene virtually through the Jurist Platform. They will have a pre-determined amount of time to hear additional arguments from the parties, request, collect, and review additional evidence, consider arguments, etc. Once this panel has made their decision, the presiding High Jurist will have the power via the CDK to execute the decision by immediately running the modified contract instructions. The dispute is marked resolved, and the additional JRS allocated for escalation is paid out evenly to the High Jurists who made up the panel.

Jurists

Jurists are classified by their rank in The Juris Reputation System, and by their areas of demonstrated expertise. The reputation system is a blockchain based means of storing and representing the following: proof of certification, merit, competence, and engagement. This pool will initially be seeded by The Juris Foundation from existing, certified, arbitrators and legal professionals. But, anyone is welcome to sign up to start earning (or losing) reputation by voting on cases, taking part in discussion, and helping with opinions. Classified by expertise if specified, all Jurists are notified when there is a new case. If they take part in an initial SNAP vote they will be required to take part in the final vote, and are encouraged to take part in discussion.

Reputation bleeds over time, and may be docked for bad behavior, and anyone is subject to rank demotion. All Jurist signups require proof of identity, and proof of certification if applicable. There are three reputation ranks:

High Jurists: are pre-certified and Juris Foundation vetted. They are arbitration professionals, and those who have earned advancement and maintained standing through the system. High Jurists are eligible for the more lucrative, but time consuming PANEL Judgements.

Good Standing Jurists: have continued to contribute fruitfully to decisions and discussions on the Juris platform. They are able to vote in SNAP Judgements, and the outcome of their anonymous votes will be included in the case files and reports to involved parties. They are able to advance to High Jurist by gaining reputation. Good Standing level reputation may be automatically obtained by providing proof of a law degree.

Novice Jurists: are new signups not able to demonstrate any prior experience. They are allowed to take part in SNAP judgements and discussions, contribute to opinions, and earn reputation to advance to Good Standing.Their votes are not included in case files or reports to the parties involved in a dispute. (They may also be invited to take part in mock trials, more in the "Beyond Arbitration" Section).

The Reputation System

Background

The Juris Reputation Blockchain is an evolution of existing systems with significant prior art:

In the digital realm, the problem of reputation has been tackled from many angles, and effective execution has contributed to the success of such platforms as Reddit and Stack Overflow. In real world academic and professional context, we handle the notion of reputation by issuing credentials like degrees or certificates. We track notable publications, awards, or recommendations, and we award higher degrees. In the context of justice and the law, there already exists a well worn hierarchy of certification, experience, and reputation. There are certain bars to be cleared before the practice of law is allowed, with even further hurdles to become a judge and progress from there. Because of this pre-existing system, legal reputation is an ideal first case scenario for a bespoke reputation chain implementation. We will be able to use observations regarding the movement of participants through the legal hierarchy to craft our own system, taking into account the inevitable real world variables like certification.

Proof of Judgement

If Juris is to be the go-to adjudication mechanism for smart contracts, parties must have confidence that their cases are arbitrated fairly by reputable and experienced individuals. The system must allow for the on-boarding and advancement of new Jurists. But, inexperienced input on cases must not result in an unfair outcome. Additionally, in order to resist attack, the system must require a minimum demonstration of experience for a Jurist to have material impact on case outcome.

This presents a challenge: how do we gauge fairness and reputability in a decentralized, anonymous, autonomous environment, while acknowledging, but not overemphasizing, proof of previous credentials? As a solution to this challenge, we propose a trust framework—a *reputation system*—tightly integrated with the Juris platform. This framework will be executed as its own blockchain, meant to establish and measure a new metric: *Proof of Judgement.*

Reputation Systems

A *reputation system* is a program that enables a community to collaboratively determine the trustworthiness of its members. More formally, a reputation system defines a trust metric, provides the framework for computing that metric, and calls the metric *reputation.*

Trust Metrics

The concept of measurable (or computable) trust has been studied extensively within the contexts of sociology and computer science, and is known as a *trust metric*. Defined simply, a *trust metric* is the quantification of the emotion *Trust*. That is, the extent to which one party expects that any other party will do as they promise. However, Trust, being both abstract and subjective, has no formal or universal identity as a numerical quantity. It follows that trust metrics are proxies; they are numerical quantities that attempt to indicate the magnitude of trust between parties in a given context.

The context dependence of trust metrics means that it's exceedingly difficult to directly map existing trust metrics to new systems, while retaining the original metric's meaning[^17]. Therefore, the details of our trust metric will require a lot of tuning and adjustment to the use case, and as Juris matures. Before giving detailed implementation specifics, we will define our priorities and process.

Priorities for The Juris Repchain

Broadly, the Juris Repchain should have the following qualities:

Useful Proxy

(1) Reputation Score (henceforth, "Rep") must be a useful proxy for the intended trust metric: *an individual's capacity to effectively arbitrate cases.*

In the Juris system, Rep gauges the degree to which a person is capable of effectively and fairly rendering a judgement regarding the outcome of a case when presented with details, arguments, and discussion.

Verifiable

(2) Rep must be readily calculable, deterministic, and open.

Readily calculable: This should not be confused with "computationally or algorithmically simple." Instead, we mean **right-sized for the execution engine**. If the execution engine is Ethereum, then "readily calculable" does translate to "computationally simple" due to the cost of computing on the Ethereum platform.

Deterministic: Repeatable Rep computations. Starting from the same base state, the Rep algorithm will always compute the same Reputation for a given point in the Rep transaction log.

Open: Rep algorithm and log of Rep-changing transactions are both public. If Rep computations are readily calculable and deterministic, the Rep transaction logs available and the algorithm known, then anybody can verify the accuracy of reputation scores quickly and easily.

Achievable When Warranted

(3) Earning Rep legitimately should be straightforward, although difficult.

Straightforward: Knowledge of the repchain's implementation is neither necessary nor advantageous for earning Rep.

Legitimate: An individual who, using a single identity, is committed to resolving smart contract disputes through the fair and impartial application of knowledge and judgement, is **earning Rep legitimately**.

Difficult: Earning Rep requires considerable human action.

Unachievable When Not Warranted

(4) Earning Rep illegitimately should be so difficult as to be effectively impossible.

Illegitimate: (Definition by negation.) An individual using multiple identities, or multiple individuals using a single identity, who manipulate the outcome of contract disputes through unfair and/or biased application of knowledge and judgement, is/are **earning Rep illegitimately**.

Identity-Based

(5) Rep must be non-transferrable and unsusceptible to commodification.

Non-transferrable: down to the smallest denomination, Rep is permanently tied to one identity (account).

Non-commodification: no quid pro quo. The reputation system must have barriers that limit the feasibility of selling an identity/account.

Promotes Cooperation

(6) The system must have a sensible incentive structure. Jurists are rewarded for sound judgement, fruitful contribution, and effective prosecution. Jurists are punished for poor judgement, bad behavior, or extended failure to engage in the system.

Punishment: The system must provide for the increase *and decrease* of reputation.

Quantity of engagement: Continued engagement with system must be rewarded, and lack of engagement punished.

Q_uality of engagement:_ the system will measure not only the amount of engagement, but the quality and efficacy of that engagement via, among other tools, upvote/downvote systems, and peer review of opinions.

Attack-Resistant

(7) The system must be resistant to malicious actors, sybil attacks, and abuse through collusion.

Malicious actors: The system should be decentralized. Both correctness and incorrectness should be provable.

Sybil attacks: Creating many accounts must be extremely difficult. It must always be more effective to concentrate Rep in one account instead of many.

Collusion: Just as one person with many accounts is less effective than same person with one account, many legitimate accounts with low Rep must be *less* impactful than one legitimate account with high Rep.

Self-Perpetuating

(8) After initialization, the system should be fully autonomous and decentralized.

Decentralized: as a blockchain based system it should be able to function on a peer-to-peer basis, without the requirement of a central oracle.

Autonomous: Rep is awarded only based on system parameters. There is no way to earn Rep *other* than taking part in the system, or through providing proof of previous credentials.

Earning and Computing Juris Reputation

Earning Rep keeps a Jurist in good standing and earning a lot of Rep makes a Jurist eligible to participate in PANELs.

SNAP is structured to provide numerous opportunity for:

(1) Jurists to demonstrate good judgement, and
(2) Jurists to implicitly or explicitly endorse the judgement of other Jurists.

Accounting for the Basics

It is important to take into account a subset of standard best practices, which may have little to do with judgement. Finish what you start. Be polite. Report conflicts of interest. These practices do not really prove that one has good judgement, but failing to do them impacts trustworthiness. So, if a Jurist makes an opening vote, and does not make a final vote, or endorse an opinion, they will lose Rep. If a Jurist is reported for bad, abusive, or clearly biased behavior, they will lose Rep.

Contributing to Discussions and Opinions

The structure of measurement in this space will take shape over time, but can begin simply with an upvote/downvote dynamic for comments and questions during SNAP proceedings. As opinions are moved to increasingly collaborative writing processes, the reputation systems can become increasingly fluid. Contributions can be quantified and rated similarly to GitHub repo contributions, with Rep awarded accordingly at the close of the SNAP. Points may be awarded for popular forks, and for merges back into the master. Implicit endorsements can be deduced from the persistence of changes to documents, which can be attributed to the party which committed those changes for the purpose of Rep awards.

PANEL Peer Review

PANEL's don't have as many inherent structured opportunities for Jurists to demonstrate their good judgement. They are, by their nature, much more freeform. Therefore in a PANEL, Jurists will endorse each other much more explicitly using peer review following PANEL proceedings. These peer reviews will be structured to elicit meaningful measures of endorsement, as well as feedback for the most skilled of the Jurist pool, allowing them to improve and maintain standing.

Graph Analysis

All of these implicit or explicit "endorsements" can be used as the raw data for a directed weighted graph (DWG). By applying graph analytical techniques to these DWGs we can infer our _Trust Metric. _All of the endorsements produced during dispute mediation will be modeled as a weighted, directed graph. Rep earned will slowly 'rot' over time, ensuring that the graph remains current, and promotes ongoing engagement. By using various graph analytical techniques (PageRank, AvoGatoTrust, EigenTrust, etc.), we will be able to infer Jurists' Rep within the network. There is extensive academic literature on using graph analysis to infer 'trust' and 'reputation' within distributed systems. By drawing on this literature, and balancing different graph analytical techniques, we'll be able to achieve the goals set above.

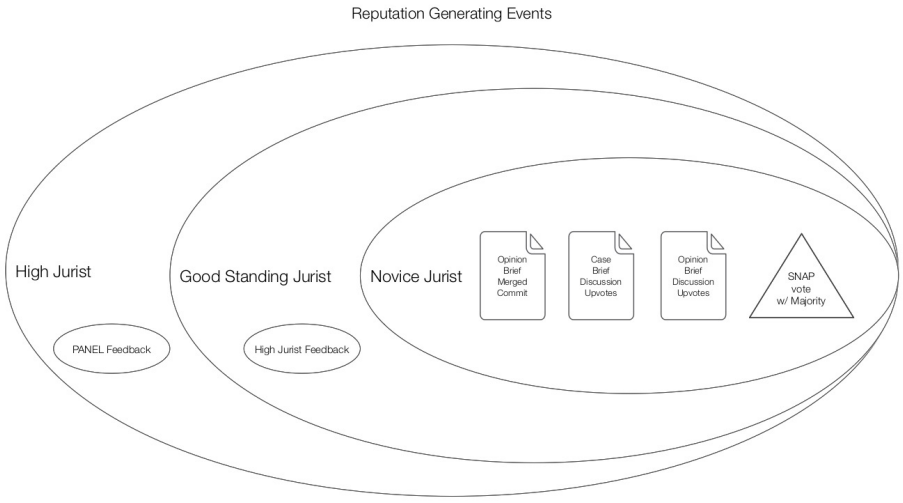

Figure 11.1

Repchain Attack Resistance

Simple point-based karma systems are vulnerable to many classes of attack. For example, it would be trivial to attack the Repchain by submitting fraudulent low stakes contracts and using sibyl accounts to mediate them. But, by using a graph based Rep score these fraudulent methods can be detected and factored out of the Rep calculation. A linear increase in fraudulent graph-based Rep would require an exponential increase in the size of the attack.

Nodes mining the Repchain would preform this graph analyses as part of their Proof-of-Work. It's much easier to check the result of a graph analysis, O(n), than it is to preform the analysis, O(n^3). This makes it a good fit for distributed proof of work.

Real World Juris Use

To illustrate how Juris will work in the real world, here are a few stories:

Ziggy Stardust

Ziggy plays guitar. He's an independent singer and songwriter who puts out music with his band The Spiders from Mars. He wants to sell his tunes, but he's sick of dealing with iTunes and the streaming options. He only makes 30% of the purchase price there. He thought about selling his music direct, and taking payments through PayPal, but those transaction fees are pretty high as well. To compete he needs to offer his tracks at $.99, $1.50 max, and he's losing

$.30-.50 of that on each transaction. But Ziggy has been watching the evolution of blockchain tech, so he thinks he can do even better. He finds a service built on Ethereum called Ujo[^10] that helps him set up a store with Ethereum smart contracts. The contract sends an attached Mp3 file directly to anyone that sends in $1 worth of Ether. Easy, and he gets to keep way more of that dollar than he would have with any alternative.

Ziggy drops his first single using his new smart contract system. He teases the track on Twitter and his fans are excited. David, a huge fan, immediately sends in his ETH, and he gets the mp3 he expected. But when he listens, he finds out the file is nothing but static. This also happened to a thousand other fans. It seems the file Ziggy uploaded was corrupted on export or delivery. Luckily Ujo had incorporated the Juris CDK. The company hasn't collected any money yet, as it's in a Juris CDK created holding wallet for the contracted two days clearance before they pass it to Ziggy. On David's receipt he has a button that says "Request Refund or Report Problem." He hits it, and fills out the details on the problem with his Mp3 file.

The platform operators and Ziggy get a notification right away that the smart contract outcome has been flagged, and the contract (and funds) are frozen. On their Juris Dashboard they can see that 800 other flags have come in for this issue. Ziggy immediately checks the file and sees what happened, realizes this is an obvious screw up, and they'll need to make good. Ziggy exported the wrong track in his recording session, and Ujo didn't catch it.

Ziggy outputs the right track and lets the service know. They send the fixed Mp3 file to David and all of the other fans who have placed an order so far. David gets a ping that Ujo and Ziggy have marked the dispute as resolved. He agrees, so he marks the conflict as resolved via the Juris Dashboard as well. The funds are unlocked, and the contract is able to run. In 2 days Ziggy's ETH is delivered. In that time, the service has fixed the smart contract for Ziggy's track so this won't happen to the next buyer. As buzz grows, 50,000 more tracks are sold in the next day, all smooth transactions. The CDK just saved Ziggy, Ujo, and thousands of fans a headache – and possibly avoided some lawsuits.

100k Twitter Followers?

Alfred, an aspiring London comedian, is looking to drastically grow his small presence on Twitter to reach new audiences. He currently has around 20k followers and dreams of hitting the low six figures. On CoinLancer[^11], a popular Ethereum-based freelancing marketplace, he finds Barbara: a self-proclaimed social media guru in Chicago. Barbara advertises that for 4 ETH she can grow anyone's Twitter follower count by 100k followers within 30 days. Alfred's sold: the price per follower sounds much better than any other offer he's seen. CoinLancer's system helps Alfred enter into a smart contract with Barbara, set to programmatically test Alfred's follower count in 30 days.

30 days later, Alfred's follower count is at 125k - and rising. The test clause of the smart contract becomes active, and confirms that his follower count has surpassed the success criteria to pay out to Barbara.

To Alfred's horror, 3 days later, he receives an email from Twitter notifying him that 80k of Alfred's 125k Followers were deactivated. His Follower count now falls drastically short of Barbara's promise. As far as he's concerned, this isn't what he paid for. He contacts Barbara. As far as she's concerned, she's fulfilled the contract as it was written and has rendered her services as agreed: she got him his 100k followers.

Relieved that CoinLancer suggested he include Juris CDK in the smart contract, Alfred activates the adjudication function in his Juris dashboard. All the Ether in the contract is temporarily frozen, and a request is sent to Juris to begin arbitration. He and Barbara have already talked about their disagreement, and they're getting nowhere, so Alfred decides to escalate to a SNAP Judgement.

Worldwide, holders of JRS receive notification of a new contract in need of arbitration. As they enter their online Juris dashboard and examine the ticket, they're presented with case details provided by Alfred and Barbara, as well as a copy of the smart contract in question and any associated logs. Deng, a JRS holder in Singapore, reviews the initial case brief. He's unfamiliar with bot protocols and Twitter, and he's not confident that he will be able to contribute to the discussion. He decides this case isn't for him. But Juan, a social media manager in Acapulco, has dealt with this before - personally. He, and thousands of other token holders, accept the ticket. He reviews the case and contract, and swiftly casts his first vote. Within a few days, thousands of votes have been cast worldwide, discussions have taken place, and short opinions have been written and submitted.

Alfred awakes the next day and, to his delight, the SNAP has already rendered a judgement. His dashboard reports back that 64% of the High Jurists sided with him, 73% of the Good Standing Jurists. As a token holder - and occasional Jurist himself - he knows that's a very positive outcome for him. He is also able to see a record of discussion, and the opinions submitted along with rounds of voting. He knows Barbara will also see the same.

He submits to assent to the favorable opinion cast by the SNAP Jurists. If Barbara assents also, the case will be marked resolved and he'll be refunded his Ether. He and Barbara can part ways. He knows that if she doesn't, a second round of arbitration, this time binding, may happen. Seeing thousands of votes rendered in Alfred's favor, Barbara concedes and assents to the decision. The Ether tied up in the contract is returned to Alfred, and the JRS used to power the arbitration function in the contract is divided equally amongst all the arbiters who took part in the SNAP.

Crowdfunding (Equity or Otherwise)

By now, the general public is aware of the idea of crowdfunding. US law has caught up to the extent that regulations have been rolled out allowing a restricted version of crowdfunding in exchange for equity. Nearly all securities contracts use an arbitration clause, or agreement. We already looked at how things worked with Ziggy, described above. It isn't difficult to extrapolate the implications for a Kickstarter- like platform, built via blockchain to maximize efficiency. But because ICOs are all the rage, lets take a look at that type of crowdfunding.

The Simple Agreement for Future Tokens (SAFT) has quickly become a popular funding mechanism for pre-sale Token Generation Events. Sometimes they're also called Initial Coin Offerings, or ICOs. They are a tool for the early sale of the tokens that will be generated and used by technology protocols for which funding is needed. They require a certain degree of interpersonal trust between founders and investors, as they are essentially a promise to produce and deliver something at a future date. But what if you want to fund a Cambodian team with a promising idea, and you can't do a background check? What about an anonymous, distributed team? Because of this trust component, the SAFT is a less effective device for unproven teams or inexperienced investors. Luckily the system is already primed for a trust-less solution, a SAFT built via smart contract, a **SCAFT: Smart Contract for Future Tokens**.

But like we've already covered, even smart contracts can't always be perfect. Let's take a look:

Ten investors would each like to pre-purchase 10,000 ETH of AwesomeCoin. Each puts their ETH in to a smart contract which has the following expected behavior: it will release .5% of its contents every day until it receives [the correct number of tokens] from [specific wallet address] at which point it will dump all of the remaining funds into the company's account.

Due to a technical problem while preparing for the token generation, the AwesomeCoin developers lose access to [specific wallet address]. This means the smart contracts will never trigger as specified in the SCAFT code. Without intervention, AwesomeCoin will never receive the full balance of their funds, and the investors will never receive their tokens. AwesomeCoin does not want to disrupt their timeline, so they push ahead, issue the tokens and distribute tokens manually from their new address, as promised, to the investors. Using the Juris self mediation tools, the developers propose that the money be transferred to their account even through the technical terms of the smart contract were not satisfied. Using the same tools, seven of the investor's signal their assent; the developers signal their assent, and the transfer executes. Two of the investors invoke the SCAFT's cancellation terms. Those contracts are frozen, and all of the money left in those accounts is moved into a Juris CDK generated holding account. The parties are unable to talk it out, and they trigger a SNAP Judgement, after which point one of the investors signals their willingness to release funds. Both parties sign off, and the funds are released.

The remaining investors choose to escalate the case further. This signals Juris

to begin formation of a panel. The smart contract doesn't detail what kind of mediation they would like, so default settings are used. The system guides the parties through the process to select a panel of three High Jurists. This panel hears arguments and examines evidence. At the end of that period, the judges find 2-to-1 for the entrepreneurs. Using their dispute mediation tools, without the consent of the investors, they transfer the remaining funds to the entrepreneurs' account. The panel members split the mediation fee, and rate each other's performance (those ratings are used to update their reputation scores).

Value Proposition

We are not building a full featured consumer facing dApp. We are building a pick-and-shovel tool that nearly every consumer-facing dApp will need.

Value to Decentralized App (dApp) Publishers_ _

Dispute resolution is not the core focus of any dApp publisher, but is a vital component of dApp functionality, especially when tokens are changing hands in the case of e-commerce, freelancing, crowdfunding, or financial securities. Transaction disputes can be a sincere source of legal liability and thus existential risk for a fledgling application. By integrating Juris as their default dispute resolution mechanism, publishers can offload this risk – for free.

Value to Contract Parties & Developers

The Juris platform will provide Protocol users to add a layer of human-powered risk mitigation to their smart contracts at minimal expense. Developers will be able to make JRS by contributing to the open source protocol.

Value to Jurists

Jurist will be able to monetize adjudication experience and legal knowledge. They are the users that make our judgement system run. Any one can become a Jurist, and earn JRS by doing so. Users with legal training will have a head start on other Jurists, but the ultimate measure of a Jurist's quality is the platform's **reputation score**. The reputation score is calculated using machine learning and graph analysis (like google's pagerank.) This score ranks Jurists using their implicit, and explicit, endorsements of one another, which are generated through the normal activity of producing judgements. Being able to prove their good judgement, by advertising their Jurist rep-score, may prove to be more valuable to jurists than the JRS they can earn.