

AIB

Atoms, Institutions, Blockchains



Josh Stark

0x4aa9

April 13th, 2022

0.

What do a book, a radio broadcast, and the human voice all have in common?

Today the answer is easy: they all contain information.

But if you asked someone the same question 100 years ago, they would struggle. They would not have easily identified that these different things all share an abstract property like “information”.

The modern idea of information is a recent invention. It was not until the 1940s that new communications technologies pushed [people working on the cutting edge](#) to articulate that there was something universal underlying sound, electromagnetic waves, symbols on paper, and much more.

Although humans have been creating and using information technologies like writing, printing, and telegrams for hundreds or thousands of years, it was only in the last century that we articulated clearly what all of these things have in common, and realized that they can be understood as a category.

In the decades since, the idea of information has spread into mass culture. Today, it is intuitive to most people that speech, images, films, writing, DNA, and software are all just *different kinds of information*.

I believe that a similar situation exists today with respect to blockchains. A new technology has forced us to reconsider things we thought we understood. But instead of books, telephones, and voices, this time it is money, law, and government. We can sense the outline of a category that unites these seemingly disparate things.

Perhaps there is an analog to *information* hidden in the foundations of our civilization. An abstract property that once revealed, might help remake our understanding of the world, and help us answer plainly what problem blockchains are supposed to solve.

1.

Call this property **hardness**.

Human civilization depends in part on our ability to make the future more certain in specific ways.

Fixed, hard points across time that let us make the world more predictable.

We need these hard points because it is impossible to coordinate at scale without them. Money doesn't work unless there is a degree of certainty it will still be valuable in the future. Trade is very risky if there isn't confidence that parties will follow their commitments.

The bonds of social and family ties can only reach so far through space and time, and so we have found other means of creating certainty and stability in relationships stretching far across the social graph. Throughout history we have found ways to make the future more certain, creating constants that are stable enough to rely upon.

One source of hardness has been physical stuff - **atoms** - in the natural world around us. We found objects and systems that had some convenient properties which, we learned through experience, were quite hard to change. We picked up shells, rocks, and metals from our environment, possessed and defended them, and used them as a basis for commerce.

Over time we learned to create our own hardness, and not just borrow it from nature. We built **institutions** - groups of humans who work together, who behave in predictable ways over long periods of time. We learned to *design* these institutions to become very reliable - so that we could give an instruction to an institution, and be sure that those instructions would be followed - even years, decades, or centuries later.

Recently, we've invented a new way to create hardness: **blockchains**. Using an elegant combination of cryptography, networked software, and commoditized human incentives, we are able to create software and digital records that have a degree of permanence.

If law, money, and government are the infrastructure of our civilization, then Atoms, Institutions, and Blockchains are some of the raw materials this infrastructure is built with.

Just as an architect must carefully plan not only the design of a building, but the materials used to construct that design, so must we carefully consider the materials for our civilization's infrastructure.

But the civilization we are trying to build is stretching the limits of what those materials can do. It is becoming increasingly obvious that Atoms and Institutions alone cannot support the global digital civilization we strive towards.

This is the problem that blockchains solve. They are a new source of hardness, with new strengths and weaknesses, which make them a suitable complement to address the limitations of Atoms and Institutions.

2.

Speaking clearly about hardness is challenging because we do not have pre-existing terminology.

We are very accustomed to talking about certain sources of hardness, like institution-hardness. But the language we use there - terms like *trustworthy* or *enforceable* or *promise* - are too intertwined with ideas about relying on *people*, and the types of relationships that people can have with one another.

If we are going to speak precisely, we need terminology that sheds these meanings, and refers only to a more narrow concept that unites atom, institutional, and blockchains.

"Hardness" is defined as the capacity of a system to make something very likely to be true in the future. Hardness is most useful where it is customizable or programmable - where humans can *choose* something specific we want to be true in the future.

When speaking about hardness, there are three things we need to consider:

1. **What is the hardness about?** What is the "something" which is being made very likely to be true in the future?
2. **What is the source of that hardness?** What is the *reason* it is very likely to be true?
3. **How hard is it?** How can we measure the degree of hardness?

First, what is the hardness about? What is its informational content?

I will call this the "**cast**". The cast is the "thing that is hard", and it always takes the form of a statement or claim about the future. I'm coining a term here because I do not think there is a suitable existing word for the concept. I use the word "cast" for its dual connotations in English of *a thing we throw ahead of us* and *a thing which hardens to protect or shape*.

For example, one important "cast" about gold is that its supply will remain predictable in the future. We could express this precisely as "between X and Y kilograms of gold will enter the

market each year for the next 20 years”.

Or, consider a loan agreement. The cast here might be something like “If Alice does not pay Bob back \$100 before July 1, then the legal institutions of my jurisdiction will use increasingly severe threats and actions to force her to pay Bob”.

In the case of a digital asset on Ethereum, one cast might be “this asset can only be transferred if a transaction is signed using the private key that corresponds to the public key X”.

Casts are descriptions of some future state of the world. A cast is *hard* if that future state of the world is very likely to turn out to be true. These casts might be claims about something *not* changing (“the object in my security deposit box will still be there in 10 years”), or something changing at a certain rate (“The supply of Bitcoin will inflate predictably for the next 100 years”), or something that is conditional on other actions or events (“If we get divorced, we will divide our assets in the following way”).

In practice, we are usually interacting with bundles of interrelated casts, which woven together, create stability and predictability in our affairs. For instance, if you own gold but store it in a bank, there are many interlocking casts that matter to you: casts about gold’s supply in the future, the integrity of the institution holding your gold for you, the physical properties of the vault where it is stored, the strength of the legal agreement between you and that institution, the reliability of the legal system in the jurisdiction where you live, and many others.

Second, there is the *source of hardness*. This is the *reason* that the cast can be hard in the first place. It is what the cast is *made out of*: atoms, institutions, or blockchains.

Sometimes the properties of our physical universe are the source of hardness. There just *is* a certain amount of gold contained within the earth, and only a portion of it is accessible to us with our current technology. That simple physical truth is the *reason* casts about the supply of gold are hard.

In other cases, the source of hardness might be an institution. A contract is only hard if there is an institution that makes it so. Groups of people - lawyers, judges, police officers - who share a common understanding of how to work together, and who have proven over decades that they are likely to behave in a predictable fashion.

Or, the source of hardness might be a blockchain. The *reason* a smart contract will operate the way it was programmed is that blockchains provide very high assurances that this will happen, by creating incentives for people to maintain the network and making it extraordinarily expensive to censor or stop its function.

With these first two components identified, we can ask the third question: how *hard* is a particular *cast*? Hardness is always measurable in theory, even if it is difficult to do so in practice.

For example, take the example of gold. How *hard* is the cast “between X and Y kilograms of gold will enter the market each year for the next 20 years”.

This is something we (as a species) know a lot about. People spend a lot of time and money trying to predict how much gold will be mined every year, based on what we know about the properties of our planet, the technology available, and the industry built to extract gold from the earth.

One way to measure the *hardness* of a cast is to estimate probabilities. If you had all the relevant data, you might come to a conclusion that there is an 80% likelihood that “between X and Y kilograms of gold will enter the market each year for the next 20 years”.

Another way to measure hardness is to estimate *how much it would cost* to create a world where the cast turns out to be false. Is there a price that someone could pay to create a world where less than X, or more than Y kilograms of gold enter the market? What does it cost to *break* the cast?

There is a price of course, though it is probably very high. Someone with the resources of a nation state could disrupt global gold production over an extended period to bring it below X. And it is also conceivable that in the next 20 years, someone could obtain a near-earth asteroid that contains a large amount of gold, causing the production to exceed Y.

In the example of a legal contract, we can also measure the *hardness* in terms of probabilities and costs. If Alice does not pay Bob back, and Bob sues her for breach of contract, Bob’s lawyer might advise him that there is a certain chance of success. Because the final outcome is at the discretion of a person (like a judge), these probabilities can be very hard to estimate.

As with the gold example, we might also express this in terms of cost. what would Alice have to *pay* to change the outcome? She could flee the jurisdiction, or she could spend a large sum on expensive lawyers that diminish Bob’s chances of success.

It’s important to keep in mind here that the *content of the contract* is not the *content of the cast*. A legal contract is a tool used within a broader institutional context, but it does not contain or express all of our implicit expectations about the future state of the world we are trying to create using this tool. The *cast* is about how the whole system will behave in the future, and the words of a contract are just one part of that system. The contract itself cannot tell you if you can afford a lawyer to enforce it, or whether the legal system will behave in a corrupt fashion.

Having explained the basics of what “hardness” is, we should offer a few clarifications and nuances:

- Hardness is **not** the only way we create durable relationships and coordinate with each other. Family or social relationships, culture, religious or political beliefs, and many other more diffuse or “informal institutions” influence human behaviour and help us coordinate. These are important, but they are distinct from the kind of durability provided by AIB.
- There is a very wide range of “how hard” something needs to be, depending on our use-case and the social context. In many cases we are able to get by with a minimum level of certainty about the future for certain kinds of relationships, like a handshake business deal.
- Talking about hardness is also **not** a claim that something, once made hard, should never be changed or adapted. Hardness is just a tool, not an end in itself. But there is no contradiction

in believing both that hardness is an essential characteristic of some systems, and that sometimes it is overridden by other factors. To make an analogy: apartment buildings must be able to stand firmly in place for decades for them to be useful, but that does not mean we shouldn't sometimes tear them down to build something better.

- Hardness is also not a claim that the systems and mechanisms we use to create hardness should themselves be static or unchanging. The thing that is being made hard is the cast, the claim about the future. In many cases the only way to make that cast *hard* is for the thing that makes it so - like an institution or a blockchain - to be adaptive and flexible. Democracies, for instance, are often a better institutional source of hardness for political casts, even though they are constantly changing and re-inventing themselves.
- Hardness is related to legitimacy, but they are distinct ideas. Legitimacy is about how human beings react to or perceive some state of affairs. But hardness is just a dry, abstract property of some system to make something more likely to be true in the future. This property might contribute to legitimacy - a legal system is perhaps more likely to be legitimate if it is predictable - but it is not the only or even most important factor in many cases.

3.

Atoms, Institutions, and Blockchains are all different from each other. As a species we have been very opportunistic, and creative, in how to find or create hardness that enables human coordination. Over time, the balance between sources of hardness has shifted, often without our realizing this has happened. This has created structural weaknesses in the infrastructure of our civilization.

Atoms

"Atom" hardness refers to hardness that is sourced from the physical properties of our universe. This includes more than literal atoms (i.e. matter, physical stuff), but all other properties of nature like physical laws and constants. "Atom" is just a convenient shorthand.

The easiest example is early money. Humans found objects in our environment - shells, gems, rocks, metals - that had a collection of useful features.

One feature was that they were scarce. This meant that there was a better chance that these objects would retain their value over time. The cast "shells of this type appear on the beach at a consistent rate of X" was *hard*, because of a predictable natural process in the local ecosystem of a society.

Another feature is that these objects were small enough to be easily possessed, transferred, and defended. By exchanging these objects, and placing them in the possession of different people, we could in effect record information about a social relationship relating to money, value, or social status. The ability to possess and defend those objects conferred *hardness* to those relationships. The universe stores information, and we can manipulate that information by manipulating our environment.

We have so far relied on examples of casts about the supply of objects - gold, shells, etc - but atom-hardness includes all of the ways that we use physical reality to create hardness about casts that are socially important to us. We create walls, barriers, homes, and other secure structures to increase the hardness of casts about ownership of physical things and other social relationships.

Atom-hardness has advantages and disadvantages. One great virtue of atom-hardness is that it is *automatic*. To state the obvious, a wall just *is*. You do not need to depend on some other party to enforce the wall, or enforce the supply of gold within the earth. Another virtue is that atom-hardness is not subject to human discretion. There is no person you can bribe or corrupt to subvert physics.

But atom-hardness is limited in frustrating ways, making it increasingly unreliable as a source of hardness for human civilization.

First, we are limited to what nature provides: we can only *find* properties in nature, and use them where those properties happen, by accident, to fit some social need. We cannot say to the universe “we’d like another type of shiny rock, with a supply curve a bit different than gold, spread more evenly across the following nation states”.

Second, atom-hardness doesn’t allow for very expressive or customizable hardness. Over time, humans have developed a need for complex casts, like “if Alice and Bob divorce, the rule for splitting their assets shall be...”. We can’t give nature specific instructions about complex and subtle human relationships.

Third, atom-hardness relies on implicit limitations of human capabilities. But as human technology has improved, we have overcome many of these limits, undermining the hardness of some atom-casts.

Using shells for money works for a while, until your society expands into an ecosystem where those shells are plentiful. Once a civilization expands outside of a certain ecosystem, the assumptions they made about what is *hard* might change. Humanity might someday face that problem with gold, whose supply is limited on earth, but abundant throughout our solar system.

New technology sometimes undermines atom-hardness completely, dissolving casts that we took for granted. Often, we then use institution-hardness as a substitute.

For instance, limitations on the speed of travel and communications were once relied on as a source of hardness for casts that shaped our political systems.

In the early 1800s in North America, there was a hard cast with the content “the fastest information can travel is roughly at the speed of a pigeon”. This cast was *hard* because the physical properties of our universe seemed to prevent, as far as we knew at the time, communication traveling any faster than this.

One way this cast was socially useful related to elections. The results of voting on the east coast of North America could not be reported fast enough to influence voting on the west coast, ensuring that later voting periods were not influenced by this information.

But eventually, we had technology that undermined this hardness and broke the cast. But we wanted to keep the cast, so we just remade it by substituting institution-hardness where atom-hardness had failed us. In Canada, there are now laws that prevent reporting election results or exit polls before a certain time. In the United States, there is a long-standing convention about the same among media organizations (not law, but a different form of institutional hardness with similar effects).

This has been a common pattern over time. As our control over nature increases, things we once believed were hard have crumbled away, and we have patched the holes using institution-hardness.

Institutions

Over time, humans developed a need for a different kind of hardness. Hardness that could be used for casts that were specific, complex, and conditional. To do this, we used institutions: groups of human beings who together act in sufficiently predictable ways to be a source of hardness themselves.

“Institution” here is an extremely broad category, including:

- Legal systems
- Legislatures
- Police forces
- Governments
- Central banks and other monetary authorities
- Private banks
- Corporations
- Startups
- Religious institutions

The details of every case are different, and different institutions within this very broad category vary in how exactly they create hardness. But all of them share the basic property of using organized human behaviour as a foundation for sufficiently hard casts that enable social, political, and economic activity. Groups of humans who are motivated and organized to behave in a certain way, such that the institution itself outlives the participation of any particular individual person.

One key advantage of institutional hardness is that it is extremely *customizable*. The design space of possible casts built with atom hardness is very limited. But the design space of possible casts built with institutional hardness is limited only by what rules you can convince people to enforce.

When we needed hardness that could create more complex casts, we created what we needed out of what we had: people.

Thus we built institutions, and they provided sufficiently customizable casts to enable grander and more complex forms of human activity and coordination. We created casts that gave order to our societies, punishing antisocial behaviour (“if you harm others, retribution will be taken”). We created flexible all-purpose systems that let anybody create casts related to commerce (“if you write down your promises in a certain format, we will force your counterparty to abide by these terms”). We created casts that spawned new assets, and provided sources of credit to growing economies (“this piece of paper is backed by the full force of the United States”). Using institutions, we built the hard foundations on which human civilization has grown and expanded.

This category extends to institutions who we might not always think of as rule-making bodies. Today, many private American corporations act as institutional sources of hardness that govern massive amounts of human activity. Facebook (now Meta) is an institution that controls and defines casts that apply to anyone using its platform, and is capable of enforcing those casts. This is also true of Twitter, Google, Apple, and other companies.

But institutional hardness has its limitations. Some of these have become more apparent, as the scale of human civilization begins to test them:

- Most institutions, and the things that they can make hard, are bounded by nation-state borders. There is one set of rules in one place, and another set of rules in another place. This introduces complexity and cost for a civilization and economy that spans many international borders. Relying only on institutions for hardness means access to that hardness is demarcated along nation-state boundaries.
- Many institutions depend on a central state of some kind. In some cases this means that the institution’s function as a source of hardness can be undermined by the state that controls it. A judiciary that serves only as a function of political interests loses its *hardness*, because it can no longer reliably or predictably enforce consistent rules. Or worse, people *believe* these systems remain hard, and the state can exploit individuals’ reliance and expectations when it chooses. And if the state falls, it might bring down all of the institutional sources of hardness that enable other parts of society to function, like commerce.
- Institutions are often very opaque. This makes it hard to tell how hard a cast actually is. It is very difficult for any person to predict precisely how a legal rule will be applied, and also very hard to predict how expensive it is to break an institution-made cast. We have built entire professions (lawyers) whose function is, in part, simply to guess at these things, and they are often wrong.
- Institutions are made of people and people are fallible. They are cruel, evil, stupid, and prejudiced. In most places, in most times, consistently throughout our history, institutions have only been reliable sources of hardness for some people, and not for others. Using institutions as a source of hardness for critical social infrastructure often turns that infrastructure into a tool of oppression wielded by those who control the institution.
- Institutions are extremely expensive and difficult to create. The institutions that we rely most on for institutional hardness have today evolved over centuries and millennia. We cannot

easily experiment, invent, or test new institutions, which means the rate of innovation proceeds slowly, over decades.

Over time, a greater and greater share of the systems that are socially important to us have become grounded in institution-hardness, rather than atom-hardness.

Consider the privacy of your personal communications. For most of human history, people had a strong expectation that their private communications could not be easily monitored (cast: “If I criticize the government while speaking to my family, the state will not learn about it”).

Until very recently, casts about your personal privacy had a strong foundation in atom-hardness. A private conversation in a home could not be easily monitored, assuming a listener was not physically present in your home. As technology enabled new kinds of communication, more and more of our private communications passed through a wire that was controlled by an institution.

But even then, the simple physics of it made it extremely expensive to do this at scale. J. Edgar Hoover did not spy on every American in the 1950s not because he didn’t want to, or because he wouldn’t have been able to get away with it, but because it was *simply impossible to do*. There were not enough FBI agents in America to spy on the private communications of every American. The cost of breaking the cast was too high.

But new technologies, and the architectures of control we built on top of those technologies, have radically reduced this cost. Today, the material costs of mass surveillance are cheap. The US government, and others, already conduct surveillance on a mass scale. Today, casts about your personal privacy are made *only* of institutional hardness, and they are broken constantly.

The rapid development of internet and software technologies have increased our dependence on institutional hardness - and made us more exposed to its failures. The problem with software eating the world, is that behind most software is an institution. We are hollowing out the infrastructure of civilization, and replacing it with forms of hardness that may not be up to the task.

The internet has let us build the early stages of a global, digital civilization. But today it is built on weak foundations. The internet we have reflects the shortcomings of institutional hardness. It is increasingly balkanized, carved up along nation-state boundaries. It is a fragile and unstable foundation, as the individual companies that control it rise and fall. And most of it is owned by a handful of companies, controlled by a small group of people, who live in one country.

Blockchains

Satoshi’s invention was a new source of hardness. It was the first *new source* of hardness that humans have invented in thousands of years.

Satoshi will not be remembered primarily as the inventor of Bitcoin. What Satoshi gave us was a kernel of something grander. It is the insight that through clever design, we can create systems bounded by cryptography, and fueled by simple human incentives, which together provide a

source of natively digital hardness. Satoshi used this new source of hardness to create the first blockchain application: Bitcoin.

The same design that makes Bitcoin possible was extended and expanded into a broader design space, giving rise to the first and most widely adopted programmable blockchain, Ethereum. Just as institutions let us create hard casts with any arbitrary content that can be interpreted and executed by humans, Ethereum lets us create hard casts with arbitrary content that can be interpreted and executed by a computer.

Like Atoms and Institutions, Blockchains have strengths and weaknesses that make them appropriate for certain use-cases but not others:

- Blockchains are natively digital. They create hardness about software, data, and programs. Anyone with an internet connection can access, and interact with, a blockchain. This is also a limitation, because blockchain hardness depends on a sufficiently technological civilization that can maintain the internet and other infrastructure.
- Blockchains do not depend on any institutions, even if they do require human *maintenance*. Blockchain hardened casts will remain hard if a government fails, a judiciary succumbs to corruption, or a police force refuses to enforce the law. Blockchains do depend, to some degree, on the behaviour of groups of humans - for instance, to maintain client software that facilitates the protocol, or wallet software that lets humans interact with it. But these services can be performed by anyone, anywhere, anonymously - a loose, decentralized community of engineers. And it is not an exclusive right - anyone can create and maintain an Ethereum client.
- Measuring Blockchain *hardness* is extremely transparent. The specific cryptographic tools used by blockchains are public and available for study, and generally their properties are very well understood. The cost of attacking the system to subvert it - i.e. through a so-called "51% attack" - is known, and we can estimate it accurately.
- Blockchain casts are made using software. Software can be poorly written, include errors, and most people cannot read software or write it themselves. Without the convenience of human discretion (as exists in institutions), small mistakes that differ from our intent can be severe. On the other hand, the opportunity to learn to write and read software is available to anyone on earth. Anyone can upload a contract to Ethereum, virtually no one can write a law.
- Blockchains let us create new casts that, if they were grounded in institutional hardness, would require creating entirely new institutions. Anyone can create an asset, and define the parameters of that asset, in a way that would be impossible through any other means.

Armed with the idea of hardness, it is easy to explain what blockchains are for and why they matter. Blockchains, like institutions, are a source of hardness. We need hardness because it is what makes it possible for us to build complex global coordination tools like law, governance, and money.

Blockchains have a different set of tradeoffs than institutions, making them suitable for some purposes but not others. They can go places and do things that institutions cannot, and they are

more resistant than institutions to certain kinds of failure. Maybe they can even enable new types of coordination mechanisms that were never possible until now.

It is also worth noting that this third type of hardness I am referring to as “blockchains” will very likely grow to include things that are not, technically, chains of blocks. Recent and emerging innovations in cryptography like secure multi-party computation and homomorphic encryption may have equally significant contributions to humanity’s toolkit for creating hardness. But Satoshi’s invention marks a zero-to-one moment in our understanding of how cryptography and economic incentives can be used to create hardness, so I use the term blockchain for now.

Understanding blockchains as a source of hardness also helps us make sense of the dizzying array of narratives and buzzwords that have been used to make sense of them over time:

- Blockchains can be [*credibly neutral*](#) because their rules are transparent and verifiable, and casts about those rules are made hard by the blockchain itself.
- Ethereum enables **composability between applications** because applications built on Ethereum can be very hard, with high assurances that they will not change. Applications that are deployed on mainnet will stay there, letting developers build on top of what has already built, with high confidence that those foundations can never crumble beneath them.
- Ethereum enables [*hyperstructures*](#) - protocols that can run forever - because blockchains provide a native source of *hardness* that makes the structures built on top of them extremely likely to persist into the future.
- Ethereum enables **decentralized finance** because it lets us create programmable hardness sufficient to recreate the complex intersecting web of relationships that characterize traditional finance. But whereas traditional finance is built out of institutional hardness (e.g. legal contracts), defi is built out of blockchain hardness.
- Blockchains can be **trustless** in the sense that they create hardness without any reliance on the behaviour of individual people or institutions. People also like to say that blockchains are [*“trust machines”*](#) or that they create trust. The mystery of why we use both these seemingly contradictory explanations is unraveled once we are armed with the concept of hardness: blockchains are *trustless* in the sense that their hardness does not depend on *people*, but they are *trustworthy* in that they are still capable of producing hardness. In the former the speaker is using the word “trust” as a stand-in for institutional-hardness, whereas in the latter “trust” means just “hardness”.
- Ethereum enables **web3**:* an ecosystem of web services, protocols, applications, and communities whose foundations are built primarily on blockchain hardness, rather than institutional hardness. A digital environment where people’s identities, their possessions, their means of commerce, the way they govern themselves collectively, and the way they publish information to the world, all of it grounded primarily in blockchain hardness, rather than institutions.
- Hardness also helps us articulate what is special about some blockchains and not others. Blockchains cease being a novel contribution to humanity’s hardness infrastructure when they collapse into just another institution. In other words, when they become centralized,

dependant on specific groups of people. Digital institutions might still be useful, but they bring with them the same advantages and disadvantages of analog institutions.

Humans have a natural need for hardness in the systems we use to coordinate, the systems we rely on to bring predictability to our civilization. We feel it's absence when it is missing. One underlying reason for the increasing backlash against "big tech" is that it has become clear that the institutions that control the internet today are not suitable sources of hardness, and the casts we try to make with them keep breaking. And across the political spectrum, all over the world, many people are increasingly skeptical of the institutions that, through our reliance on them as a source of hardness, wield great influence over our lives.

We want a strong foundation for the global civilization we are trying to stitch together. One that does not change under our feet with each election, or the rise and fall of individual American companies.



4.

Think about Atoms, Institutions, and Blockchains like a system of checks and balances. Using them together to build our civilization's critical infrastructure makes it more resilient, and less exposed to the limitations of any one of them. They are a set of building materials that, used together in aggregate, make a stronger whole.

But that system of checks and balances is changing beneath our feet. Most of the time, we don't even realize it. The last protections of atom-hardness are crumbling as new technology lowers the cost of rights infringements that were once impossible at scale. The growth of a global digital civilization mediated via the internet has accelerated our reliance on institutions, stretching and testing them past their breaking point.

Blockchains will not replace institutions as our only source of hardness. But they will compete with and complement them. Humans now have options: for the first time, there is a market for hardness that can be used to produce the complex casts necessary for modern civilization. Blockchain-hardness will be used where institutions falter or cannot go, and institution-hardness will fill the gaps where human discretion or intent is necessary to create a system usable by humans. A new dimension of our politics has opened up. We will debate not only which systems to use - what forms of governance, what kinds of markets - but also what sources of hardness should be used to *construct* those systems.

What do we want our civilization to be made out of?

(Thank you to Danny, Luke, Sina, Saffron, Trent, gubsheep, the Farcaster community, and many others who gave feedback on earlier drafts).