Geo Web Protocol Suite: A decentralized system for a geolocation-driven web experience

Draft 1

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ABSTRACT

Smartphones have revolutionized our world by putting the Internet into our pockets–making it accessible everywhere that we go. As smart devices shrink to fit on our wrists, on our eyeglasses, and eventually embedded inside of us, the time we spend on the Internet transitions from discrete, conscious interactions to a continuous, immersive experience. The Geo Web is a novel web experience proposed for this future. Using geolocation as its primary navigation mechanism, it can create an orderly, frictionless, and valuable user experience that blends our physical and digital worlds..

As proposed, the Geo Web is based on an authoritative geographic namespace maintained in an Ethereum smart contract. The Geo Web can utilize a Harberger Tax structure to help achieve allocative efficiency of "digital land" and to promote egalitarian values. The Geo Web can be an open, decentralized, and efficient alternative to proprietary systems that will power applications on the next generation of smart devices.

1. INTRODUCTION

The Internet and World Wide Web's minimalist protocol designs were key to scaling the networks to billions of devices and across years of hardware, software, and use case innovation. The protocols had contemporary competitors that were more opinionated, had more features, and/or had proprietary backing. Yet the open, free, and decentralized approaches became the de facto standards.

The emergent properties of these networks turned out not to necessarily reflect their founding principles. Big Tech has successfully accrued almost unimaginable value and power. Massive corporations have become gatekeepers of ecosystems designed to be permissionless and democratizing. Smartphone app stores embody the problems with centralization: rent seeking, innovation suppression, and censorship. There are an estimated 4.6 billion internet users as of 2020.[1] They are largely beholden to decisions made by few. Users' participation in the value distribution and governance of the world's driving economic and social forces is limited.

It is with this two-part lesson in mind that the technical and governing structure for this new web experience are proposed.

The Geo Web's core protocol is a geographic namespace table and lookup. It is analogous to the Web's DNS. Its design is deliberately minimalist. It enables powerful, frictionless user experiences that can augment life rather

[1] Internet World Stats. May 31, 2020. https://www.internetworldstats.com/stats.htm

than pull attention away from it as smartphone usage so often does today. It can scale to billions of devices and across currently unimaginable use cases. It provides an alternative application model to app stores or proprietary AI assistants that monopolize power and personal data.

The Geo Web could become more pervasive than the World Wide Web is today. It is important that the network benefits and empowers the individual user. This proposal looks to integrate with and draw inspiration from breakthroughs in the Web 3.0[2] space: distributed infrastructure, user-owned data, decentralized governance, and egalitarian market mechanisms. With this approach, we can build a new, open, and distributed network to benefit all.

2. DIGITAL LAND

The Geo Web's core enabling component is *digital land*. Practically speaking, digital land can be used to map digital content to real world locations. Content can be anchored to specified points or span areas. Ownership of a digital land parcel confers the exclusive right to place Geo Web content within its boundaries. This differs from a traditional system of geotagging. The link between geolocation and content is one-to-one and unambiguous.

Digital land parcels are the unique identifiers of the Geo Web's global geographic namespace. They are mapped as non-overlapping polyhedrons[3] with a standardized coordinate system. Together they define boundaries on the Geo Web and create a digital layer that spans Earth.[4]

The digital land registry is maintained in a smart contract similar to that of the Ethereum Name Service.[5] Instead of maintaining an authoritative list of human-readable domain name mappings, the *Geo Web Property Registry* (GWPR) will maintain the spatial and non-spatial attributes of digital land.

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[2] Web 3.0 is used here to refer collectively to the various efforts in cryptography, blockchains, and related technologies that aim to distribute power and value of networks to their users.

[3] Digital land includes the vertical space above land (or water). It can be defined with geo coordinates (creating polygons) plus optional height/altitude fields (creating polyhedrons). This would enable digital land parcels to be "stacked" and to align with multi-story building ownership/tenantantship. Alternative land definition methods such as Geohash, Plus Codes, & H3 may offer desirable technical and performance attributes that will be explored as well.

[4] Unlimited digital land layers are technically possible. Think of these like the different top-level domains of the World Wide Web and DNS. Network effects should limit excessive proliferation. Defined use-case implementations may provide user motivation sufficient to overcome switching costs. Governments and entities hostile to this project's open and free values may implement their own closed versions.

[5] N. Johnson. *EIP 137: Ethereum Domain Name Service - Specification*

Sample Data in the Geo Web Property Registry

Digital land[6] can be bought, sold, and utilized independent of surface land. In this way, digital land is similar to mineral, water, and airspace rights in the United States. Surface landowners may own their land's digital counterpart, but not necessarily.

3. BROWSING

The Geo Web can be the constant digital complement to everyday lived experience. It's intended to augment life experiences rather than pull attention away from them. Initially it can be accessed in discrete experiences through smartphones and smartwatches. As smart device screens disappear, browsing the Geo Web can become coincident to experiencing the physical world.

The World Wide Web has effectively infinite "space" between hyperlinks and subdomains. Abundance is an undoubtedly valuable concept for the Web, but it comes with tradeoffs. Browsing the Web requires active participation and filtering to find valuable content: typing a URL, switching between apps, and/or searching Google. These incremental actions may not seem like much, but they add up. This model isn't feasible for a ubiquitous web experience.

The Geo Web offers a finite, contiguous navigation space. Content discovery is orderly, natural, and frictionless–mirroring how we navigate and experience our physical world. It can use place and time to present relevant digital content rather than relying on active user interaction and filtering. Content creators can tailor content for a known user environment without knowing a thing about the individual users.

The user interface for the Geo Web may resemble a web browser (without a URL bar) initially. Using GPS or another suitable navigation system[7], an active browser continuously references the GWPR and resolves content. Look-ups should be encrypted and leverage appropriate methods to quickly find the appropriate digital land

[6] Digital land can be implemented as a non-fungible token compliant with EIP 721: ERC-721 Non-Fungible Token Standard or a suitable alternative.

[7] GPS is subject to spoofing, interference, and technical limitations indoors. FOAM is an example of a Web 3.0 project that aims to overcome these challenges. The Geo Web architecture should remain agnostic to the navigation system used.

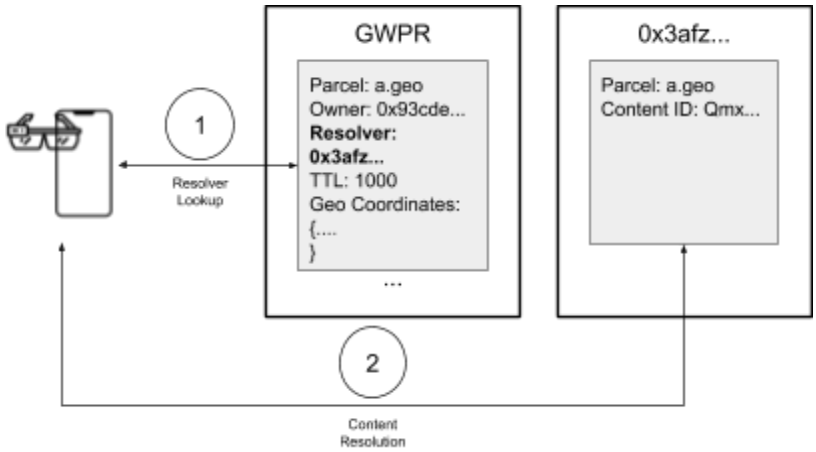
parcels. While geolocation is the driving navigation method, it is not intended to serve as a security measure. Alternative security practices should be implemented for private data on the Geo Web.

As the dominant browsing device transitions from smart devices with a screen (e.g. phones) to those without one (e.g. glasses), Geo Web browsers can take on a different format. The canvas for content can become transparent and gain depth. A field of view will define the content displayed on the Geo Web rather than just a set of geo coordinates. The field of view browsing experience can leverage rich user context including angle of viewing, altitude, and velocity to create immersive experiences.

The GWPR itself will not have the ability to filter, algorithmically promote, or censor content. It will remain neutral. Publishers retain the right to free speech. Users retain all power to control what they do and do not see. Scarcity of digital land (opposed to effectively infinite URLs & IP addresses) and identity can make content filtering and blocking more manageable. Requiring unique identity[8] to register digital land ownership increases friction for bad actors. User-defined blacklists of locations and publishers should be implemented and shared across browsers. The digital land market structure (see *Section 6 - Implementation*) combined with user-empowered blocking should effectively disadvantage spammers versus those providing value to users.

4. CONTENT RESOLUTION

A second type of smart contract can be used to resolve content on the Geo Web (using the Ethereum Name Service as a model).[9] Each GWPR entry consists of basic digital land parcel information and a link to a Resolver smart contract. It is the Resolver, controlled by the landowner, that resolves the digital land to its content.



The Geo Web's two part content resolution approach

[8] While public identity is not envisioned as a requirement for the GWPR, tying a pseudonymous identity to a validated, unique real world person can be a powerful tool in the fight against malicious actions on the network. While they can't be eliminated, this can introduce strong friction for spammers, hackers attempting to use digital land as a vector, and other abusive actors that degrade utility of the network. Privacy and user-owned data are equally important considerations. Decentralized identity integrations and zero-knowledge proof methods should be explored.

[9] Ethereum Name Service Documentation. *Writing a Resolver*

Different Resolvers can be implemented to accommodate different transmission methods (client-server and peer-to-peer) and content types without changes to the GWPR's structure. This two-part architecture provides flexibility in content resolution and stability for the GWPR.

In the early days of the Geo Web, it will be valuable to support legacy websites. The most straightforward implementation for a new publisher on the Geo Web will be to link an existing website (through a specified server) to their digital land parcel. In practice, Geo Web users could find a store's website by simply being inside the store and opening their Geo Web browser rather than knowing the URL or searching Google.

Content addressing and P2P transmission of content is attractive on the Geo Web for many of the ideological reasons that Web 3.0 projects like IPFS and Dat cite[10]–openness, decentralization of power, etc. The technical case for the Geo Web and P2P transmission is even stronger. The characteristics of the Geo Web can make the hypothetical efficiency, speed, and robustness gains of P2P networks a reality.

Geo Web users seeking the same content should be geographically clustered. This is an optimal environment for P2P transmission: reduced search radius for peers, shorter transmission distance, and redundant connections. As media on the Geo Web grows in volume and fidelity (especially with augmented reality), leveraging P2P transmission can significantly improve performance and network scalability.

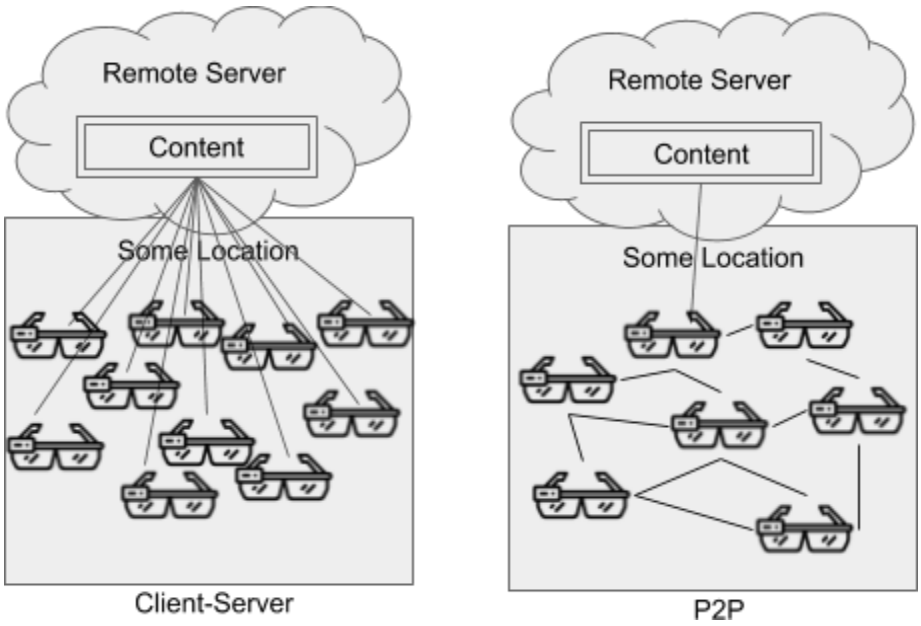


Illustration of client-server and P2P architectures on the Geo Web

5. APPLICATIONS

Geo Web applications can primarily benefit by utilizing user location in two ways: 1) as a primitive on which to build a unique experience and/or 2) as a frictionless discovery mechanism. The Geo Web can offer a flexible model that supports application types and leverage technologies not yet invented. As hardware, software,

[10] https://ipfs.io/; https://dat.foundation/

wireless connectivity, and design tools advance, the type of experiences enabled on the Geo Web can become higher fidelity and more immersive.[11] Like the World Wide Web, successful initial use cases will likely be focused and simple, but the possibilities are endless:

Web 2.0 Discovery - Simply copying what was done (successfully) in Web 2.0 doesn't take full advantage of the new paradigm, but existing website and smartphone application functions could be linked to digital land on the Geo Web. This provides a new discovery mechanism that is useful for infrequent and/or high-value interactions. The UX improvement over existing models (no new app downloads or URLs to know and type) can increase engagement and user value.[12] Walk-up reservations and contactless ordering for restaurants are example applications.

Data Feeds & Notifications - Data and notifications are sensitive to the time and place, making the Geo Web potentially valuable delivery mechanism. Useful information can be presented to users based on their environment with minimal distraction and effort. Examples are displaying wait times for lines, public transport arrival times, and changes to schedules.

Games - Scavenger hunts, gamified check-ins, and other location-based games (even screen-based, map ones) can leverage the Geo Web to create open, decentralized, and global experiences. The Geo Web would allow for new integrations and collaborations across experiences that could separate them from existing location-based apps/games that exist in silos. The Geo Web is Web 3.0 native, so naturally Geo Web gaming can leverage concepts like NFTs and user-owned data to further differentiate from comparable Web 2.0 games.

File Sharing - The fact that Geo Web users seeking content can be geographically clustered lends itself to peer-to-peer sharing. This can be leveraged to efficiently and simply share (large) files in places like classrooms (eg data sets), restaurants (menus), and sports/concert venues (photos/videos). This can limit the cost of and reliance on the wide area network (WAN).

Augmented Reality - Augmented reality is a content type that itself has nearly unlimited uses, especially as smart glasses and supporting software advance. The Geo Web offers a way to create shared AR experiences across different hardware without forcing all users to download a separate app or software. The frictionless Geo Web UX means that location-anchored AR begins to function, at least visually, like physical architecture. Atoms can be swapped for bits to create new types of entertainment, art, and experiences that blur the lines between our physical and digital worlds.

6. IMPLEMENTATION

The fact that the Geo Web associates new digital rights with existing physical land presents many challenges around implementation and market structure. The Geo Web is intended to be consumed side-by-side with daily life–an easy-to-imagine starting point for a dystopian future. While early Web enthusiasts saw opportunity in a

[11] As Dani Grant and Nick Grossman argue in The Myth of The Infrastructure Phase, Geo Web applications may beget improved infrastructure and not the other way around. Regardless, the insight to be applied to the development of the Geo Web is that new applications and infrastructure capabilities co-exist in a feedback loop. Futuristic applications may not be entirely practical today, but their creation can help spur the infrastructure innovation that makes them commonplace tomorrow.

[12] Apple announced App Clips as a part of iOS14 on June 22, 2020. App Clips shares UX goals with the Geo Web (streamlined user interaction & discovery), albeit through an extension of Apple's proprietary ecosystem. The Geo Web could be used to replicate similar functionality in an open, extensible ecosystem.

blank slate to build a cyber-utopia, there may be even greater opportunity in a web experience anchored in the real world.

6.1. Initial Digital Land Assignment

Land rights are typically the domain of governments. Different legal regimes for land ownership dot the globe. Differences arise from history, governing/economic models, and cultural norms. Implementation of the Geo Web's digital land ownership model must grapple with these differences, but need not conform. The goal is to establish a globally unified, open, and egalitarian network based in digital land ownership.

To help bootstrap network buy-in, initial digital land ownership will attempt to mirror physical land ownership where possible. From a practical perspective, physical land owners should have higher incentive and ability to leverage digital land to enhance their physical spaces, on average. From a psychological perspective, some may feel entitled to their land's digital rights. This can be channelled to help drive early land claims while the network establishes value.

Mirroring physical land ownership will be a challenge that requires tools for records verification and a centralized authority (initially). Land ownership records in the United States are public. However, they are non-uniform, sometimes analog-only, and held in disparate sources.[13] Some countries have better, more transparent systems. Others don't even have the concept of private land ownership.

Initial Geo Web land claims could be rolled out country by country. In countries with verifiable public records, physical land owners can submit digital land claims for a nominal verification fee. Systems used for Know-Your-Customer compliance and partnerships with entities like real estate brokerages can be leveraged to validate identity, ownership, and parcel boundaries at scale. This validation will be done on a "best effort" basis. It is reliant on the accuracy of third-party data and not impervious to fraud, so validated land claims will be submitted to an interim GWPR.

Matching current physical land ownership is not the ultimate goal. This would tend to reinforce existing inequality and not align with the Geo Web's broader social values. This interim phase provides a logical onramp for digital land ownership and helps establish network buy-in. It creates time and space to validate the technologies and methodologies proposed for the Geo Web before transitioning to the permanent GWPR.

6.2. Ongoing Digital Land Rights[14]

The land assignment model described in *Section 6.1 - Initial Digital Land Assignment* works only under certain conditions: (1) in jurisdictions with verifiable land records, (2) with a centralized authority validating claims, (3) maintaining the status quo of land ownership, and (4) only with private property. The system suffers from challenges of reach, sustainability, efficiency, and fairness.

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[13] Ideally, this project would avoid extensive data cleansing required to produce a national data set and partner/license with a 3rd-party data aggregator (e.g. Landgrid, CoreLogic) or directly with governments under favorable conditions.
[14] This section relies heavily on ideas presented in Eric Posner and Glen Weyl's book *Radical Markets*.

A digital land rights regime based on the concept of a Harberger Tax[15] offers an elegant, decentralized solution that can be implemented universally. A Harberger Tax aims to reduce monopoly power of private property and allocate resources more efficiently (i.e. use scarce resources for more productive activities). Proponents believe it can produce significant economic and social benefits across markets.[16] The Geo Web is an ideal test ground for this idea that could have tremendous real world impact.

A Harberger Tax system is comprised of two basic rules:

1. owners of property pay a tax based on the self-assessed value of the property
2. anyone can force a sale by paying the self-assessed value for the property

These simple, enforceable-in-code rules can create a powerful market structure for the Geo Web. Ownership of digital land can be administered with limited central authority. No government land records verification is required. The *wrong* digital land claimant cannot simply squat on digital land in perpetuity holding out for a big payday. The tax mechanism enforces unavoidable cost to this. The *right* digital land owners (the ones that can best put it to economic use) can always buy a parcel if they don't own it. All pay an on-going fee[17] proportional to the self-assessed economic benefit that they receive from the digital land. Those that reap the greatest economic benefits from the Geo Web will pay the most in fees. These fees can be used to support initial network development and eventually higher social aims (see *Section 7.3 - The Future)*.

Before committing to a global Harberger-based digital land ownership model, it can be tested with certain land parcels in the interim phase. As the GWPR is rolled out to new countries, digital land corresponding to public land can be put up for auction. Winning bidders receive the rights to utilize digital land and agree to pay the ongoing fee based on their public, self-assessed economic value of the land.[18] At any time, the digital land may be purchased by another party willing to pay the published price.

The percentage used to assess this fee will have a direct impact on market characteristics. As Posner and Weyl note, a lower rate inflates self-assessed asset prices (it's less expensive to carry an inflated self-assessed price) and reduces turnover (forced sales are more expensive). The rate used for the Geo Web should be studied and set to balance healthy turnover and market efficiency. Additional considerations should be taken and implemented to address ownership transition mechanics, limits on combining/splitting digital land parcels, and discouraging malicious actors.

The rules of the Harberger market can be implemented via an Etherum smart contract. The Harberger smart contract will maintain the owner-assessed value for appropriate digital land parcels and carry out two basic

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[15] The Harberger Tax is named for economist Arnold Harberger who outlined the basic scheme. It was formally proposed by Nobel Prize-winning economist, Maurice Allais.
[16] See Posner & Weyl's *Property Is Only Another Name for Monopoly* for an in-depth exploration of the topic.
[17] The Geo Web isn't run by a government entity, so collected revenues are referred to as fees rather than taxes.
[18] Rights holders should be able to change their self-assessed value of the property at any time, including immediately after the auction. The auction methods (open, sealed, Vickery, Dutch, etc.) should be explored to optimize the auction. Efficiency of the auction would be measured by comparing the price paid to the self-assessed value immediately following the auction.

functions. It will administer automated fee collection (staking, calculation, debiting, and crediting) and facilitate purchases of land parcels (auctions, transfer payments, and modification of the GWPR).

With experience in administering public lands, the Geo Web can transition into a universal Harberger structure and the permanent GWPR. Verified private landowners should maintain their initial rights to digital land (avoiding the cost of initial auction), but begin self-assessing their property value and paying the associated fees at a to-be-determined date. Auctions and Harberger fees would establish an orderly process for bringing new counties onto the Geo Web that lack records or property basis to otherwise do so.

This model can establish an efficient, decentralized method of digital land allocation. It can help neutralize questions of "rightful" ownership for this novel asset (digital land) that will produce strong associations to a zealously protected real world asset (land).

7. GOVERNANCE

The Geo Web is enabled by a type of bottom-up, permissionless network innovation that wouldn't have been feasible until a few years ago. There is no government or corporate stamp of approval establishing its credibility. Satoshi Nakamoto's 2009 Bitcoin whitepaper ushered in a new era in which networks could be built on trust in math rather than trust in third parties (whose interests may or may not diverge from the network at large). The Geo Web network will harness this concept, but also acknowledge its limits. The Geo Web will start with minimal, necessary centralization and responsibly transition to more decentralized governance as the network and supporting mechanisms mature.

7.1. Multi-Signature Authority

The initial authority of the Geo Web will be a multi-signature group. They will hold root keys for the GWPR, Harberger smart contract, and associated depository wallets. The keyholders will be publicly identified. They will be trusted, leading members of the distributed web community and related academic or technical fields.

The multi-sig authority is intended to have four core responsibilities to the network:

1. Oversee mechanisms implemented for identity and land parcel boundary verification
2. Facilitate planned upgrades and changes to Geo Web smart contracts
3. Authorize fund distribution to support network development, adoption, and social impact
4. Take actions in the interest of the network in extraordinary circumstances

The multi-sig authority is intended to remain in place until decentralized mechanisms are designed, tested, and implemented to address these four areas of responsibility.

7.2. The Future

The potential proceeds from land auctions and the Harberger fees are significant. With moderate adoption, they can far exceed the needs of the maintaining organization. Security and robustness of the Geo Web's infrastructure will always remain the priority of the organization, but with time the code should stabilize. The

organization's new challenges will be optimally distributing funds and shepherding the network to a decentralized means of governance.

As the network matures, the scope of use of funds should expand: internal development, external grants for ecosystem projects, and funding for global issues outside of the network. The Geo Web straddles our physical and digital worlds. Its Harberger fees are based on theories for taxes and societal good. Use of proceeds shouldn't be limited to funding software development. The Geo Web could eventually fund advancements that benefit all of its global constituents: climate change, health, education, food/water security, science/technology ethics, and human rights.

When imagining the impact that the Geo Web can have in the real world, it becomes even more apparent that decentralization of governance and decision making is paramount. In the last several years, there has been tremendous progress in the technology and mechanisms that enable decentralized governance: decentralized autonomous organizations (DAOs), quadratic voting/funding, etc. The multi-sig authority should explore incremental and wholesale methods for responsibly relinquishing their power to the network at-large.

8. CONCLUSION

The Geo Web combines concepts from the World Wide Web, the Web 3.0 community, and innovative economists to create a novel geolocation-based web experience. Its straightforward, authoritative geographic namespace can enable a frictionless user experience that can blend our digital and physical worlds. The proposed implementation attempts to anticipate the macro implications of this next era of the Internet and smart devices. The Geo Web will be transparently governed as a public good with a path to true decentralization of power. The Harberger-inspired digital land market can not only elegantly and efficiently allocate resources, but it can help address economic inequality rather than exacerbate it. The Geo Web is an undoubtedly ambitious project—not just in terms of technical implications, but for its social aims. The latter aspirations are at least as important as the former given current economic and political realities we face at the end of the Web 2.0 era.

9. ACKNOWLEDGEMENTS

The Geo Web combines numerous breakthrough ideas and technology that came before it. Just citing the creators doesn't seem to be enough. So, thank you to all of these innovators for the powerful ideas and inspiration. Thank you to Cody Hatfield for the hours of stimulating conversation and constructive feedback, especially the introduction to Harberger Taxes. Thank you also to Apoorv Lathey and Mike De'Shazer for helping make the first prototype of the Geo Web come to life.

10. HIGH-LEVEL ARCHITECTURE