

# Graph-Powered Legal Knowledge: An Open, Distributed, and GenAI-Assisted Roadmap

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## Abstract

Legal systems around the world are growing in complexity and volume, yet the data of law is often trapped in static documents and siloed systems. This paper presents a roadmap for a **graph-powered legal knowledge framework** that addresses these challenges through an open, distributed, and GenAI-assisted approach. Building on an existing white paper by Dinis Cruz, we expand and elaborate the vision: a collaborative knowledge graph of legal information that serves as a canonical source of laws and regulations, with full version history and point-in-time views. We outline how such a system can resolve amendments into consolidated snapshots of the law, uphold strong provenance and explainability, and remain deterministic in its outputs. We advocate for **distributed, domain-specific ontologies** rather than a single monolithic taxonomy, enabling different legal domains and jurisdictions to capture nuances without sacrificing interoperability. In early stages, GenAI (Large Language Models) can assist humans by bootstrapping the graph—extracting structure from texts, aligning schemas, and visualizing relationships—under strict human oversight. Over time, as the knowledge schemas stabilize, reliance on GenAI can be minimized in favor of deterministic processes. The governance of this legal knowledge graph is envisioned as a community-driven effort: stakeholders such as legislative bodies, legal experts, and civic technologists collectively maintain “shards” of the graph that matter to them. We discuss incentives, including compensating subject matter experts for curation work, to ensure data quality and sustainability. Finally, we explore the transformative potential of graph-based legal data for society: lowering the cost of accessing the law, enabling advanced tools for justice and compliance, supporting policy simulations, and driving legal automation. Throughout, we draw analogies to successful open collaborations like Wikipedia and Git, and emphasize the importance of open data standards and protocols in making legal knowledge universally accessible and computable.

# Introduction

Modern societies depend on vast bodies of legislation, regulations, and case law. However, the way this legal knowledge is published and managed remains antiquated. Government gazettes and legal publishers typically release laws as **static text** – PDF files, Word documents, or basic HTML pages. While legally authoritative, these formats are **opaque to machines** and cumbersome for humans to navigate. The result is a legal ecosystem where answering even straightforward questions (e.g. "What is the law on this issue as of today?") requires labor-intensive manual research or expensive proprietary databases. The **societal cost** of this status quo is high: citizens and businesses struggle to understand their obligations, innovators face hurdles accessing legal data, and the law itself becomes less transparent and accountable.

Traditional attempts to manage legal information with databases or XML repositories have exposed limitations. Relational databases and isolated document systems struggle to represent the rich interconnections in law—such as cross-references, amendments, and precedents—which hinders efficient knowledge discovery ([An LLM-assisted ETL pipeline to build a high-quality knowledge graph of the Italian legislation](#)). Even specialized semantic web efforts using RDF faced challenges scaling to the complexity of real legislation ([Modelling Legislative Systems into Property Graphs to Enable Advanced Pattern Detection](#)). As a result, legal practitioners often rely on brute force: manually comparing different versions of statutes or regulations and painstakingly tracking changes over time. For example, one legal technologist described *"needlessly having to waste time by manually comparing the existing and proposed text"* of laws, a process that fails when major reordering or renumbering occurs ([Detailed legislation version tracking? - Open Legislation - Open Knowledge Forums](#)). Such manual workflows are error-prone and cannot keep up with the pace of legal change.

This paper argues that we can do better by treating **legal knowledge as a connected, living graph**. Instead of static documents, imagine a **legal knowledge graph** where each law, section, and amendment is a node, and relationships (citations, modifications, repeals, etc.) are explicit links. In this graph, one can traverse from an amended section to the amending act, from a regulation to its enabling statute, or from a court decision to the statutes it interprets. The graph becomes the canonical source of truth for legal content and its evolution over time. Crucially, this vision is **open and distributed**: no single company or government silos the data. Instead, the structure is maintained collaboratively by stakeholders and domain experts, much like a legal "Wikipedia," and versioned and validated in a manner akin to open-source code on Git. Before detailing this vision, we explore the core problems with current legal data and why a graph-based solution is so compelling.

## The Problem: Static Legal Data and Its Societal Costs

Most official legal information today is published in **static, document-centric formats**, which poses several problems. First, static publications (like PDFs or plain text) lack **machine-readable structure**. Critical information—section headers, definitions, cross-references—is embedded in unstructured text. This makes it difficult for software to parse or for researchers to automate analyses. As a consequence, answering complex questions about the law can be impractical without human effort. Studies of legislative informatics note that the *“textual nature of laws presents a significant challenge when it comes to extracting or processing the content in a structured manner for automated analysis”*. Important connections between legal provisions remain implicit, and potential insights stay buried in volumes of text.

Second, laws continuously evolve, but static publications provide no easy mechanism to track these **changes over time**. When a new amendment is passed, it is often published as a separate document describing changes (e.g. “in section 5, delete paragraph (a) and insert a new paragraph...”). To know the law in force on a given day, one must gather the original act and all subsequent amendments, then mentally (or manually) **resolve all those amendments** into a consolidated version. This process is tedious and error-prone. In practice, even government websites struggle with version control. For instance, Italy’s official legislative portal allows selecting a date to see if a law was in force, but requires retrieving all laws again for each date of interest. Without an integrated version history, legal researchers and drafters wind up performing their own comparisons or relying on expensive commercial consolidations. In an online forum, one practitioner lamented having to manually “diff” PDF files to compare legislation, only to be thwarted when sections get renumbered or moved around. Such inefficiencies translate into real costs: lawyers spend billable hours on clerical updates, courts risk applying outdated texts, and citizens cannot easily find the current law.

Third, static siloed data undermines **transparency and accountability**. If understanding the interplay of laws requires herculean effort, then effectively only a select few (those with resources or expertise) can navigate the legal system. This asymmetry harms access to justice and democratic oversight. By contrast, when legal data is structured and connected, it *“contribute[s] to increasing transparency by facilitating the understanding of interconnections”* among laws. For example, a network of legal provisions could reveal which regulations implement a statute, or how a particular amendment cascaded through various codes, allowing both experts and the public to better grasp the impact of legislation. The **societal cost** of opaque law is measured in avoidable lawsuits, compliance errors, and missed opportunities for reform. In sum, publishing laws as static text might satisfy minimum publication requirements, but it fails to leverage modern technology to serve society’s broader need for accessible, navigable legal knowledge.

## Canonical and Versioned Laws as a Knowledge Graph

To address these problems, we propose a **canonical graph representation of laws**, in which every legal provision and its versions over time are captured in a network of nodes and relationships. In this model, a law (or regulation, code, etc.) is not a single static document but a **persistent entity** in the graph that accumulates modifications through time. Each amendment, repeal, or insertion is recorded as a relationship (edge) pointing to a new node representing the changed content. This approach treats the evolution of a legal text similarly to how software source code is version-controlled: each change is tracked, and the history of changes is preserved. Researchers in legislative informatics have recognized the value of this approach, noting that *“a law can evolve; for instance, it can be amended or partially repealed, leading to multiple versions of the same law”*. By tracking the original text and then layering changes as connected nodes/edges, we maintain a **single source of truth** for that law, with branches for each amendment and the ability to query any point in time.

One key process enabled by this graph is **flattening** – the ability to resolve all amendments and produce a **point-in-time snapshot** of the law’s text. Flattening is essentially asking the graph: “What would the text of Law X look like on date Y?” The graph can answer by following all relevant modification edges up to date Y and assembling the consolidated text. This is analogous to checking out a specific commit of a file in Git, reconstructing the file content at that revision. By storing modifications as first-class data, the system can generate a fully up-to-date version of any statute or code on demand. This removes the need for separate “official compilations” of amended law; the graph itself is the dynamic compilation. As an example of the benefits, researchers using a legislative graph for Italy demonstrated that instead of manually retrieving static files for each date, one can simply query the graph’s *“abrogate”* (repeal) relationships to determine which provisions were in force at a given time. The result is a **drastically improved ability to navigate legal timelines**: attorneys can instantly obtain the historical text of a regulation as it was when a contract was signed, or policymakers can trace how an act has evolved through successive amendments.

The graph-based approach also inherently captures **canonical references**. Citations in legal texts (e.g., “as per Section 10 of Law Y”) are transformed from mere textual pointers into actual graph links. Each reference becomes a relationship connecting the citing node to the cited node. This means that from any article of a law, one can traverse outwards to see all other laws or regulations that reference it, and vice versa, one can see what authorities that article cites. In a traditional setting, finding all references to a particular section requires full-text search or proprietary annotation; in the graph, it is a simple traversal. Moreover, because references and changes are explicitly typed edges (such as *“amends”*, *“repeals”*, *“cites”*), it becomes possible to ask nuanced questions. For instance: “Show me all sections of environmental law that were modified by the climate act of 2025” or “Find any law that cites a section which has since been repealed.” In fact, a graph approach has been used to detect **errors and inconsistencies** in legislation—one study found 144 cases where laws continued to cite provisions that had been abrogated, a mistake exposed by tracing citation links in the graph. This exemplifies how a canonical knowledge graph of law can improve not only access but the quality and integrity of legal systems themselves.

In building a canonical legal graph, we take inspiration from the success of version control in software. **Git**, the ubiquitous tool for managing code, provides a mental model: it identifies each file by content and tracks every change as a commit with an author and timestamp. We envision a similar “*Git for Laws*” where each amendment is like a commit, tied to an official source (e.g., the amending act and section) and metadata (date, enacting authority, etc.). Indeed, commentators have proposed using version control systems directly for legislation, and experimental projects have put entire legal codes into Git repositories. Our approach extends that idea with the richer semantics of a knowledge graph: not only versioning the text, but encoding the relationships and context of those changes. Every node (whether a whole law or an individual provision) carries **provenance** information—where it originated, which official gazette or database it came from, who curated it in the graph—and is connected to explanatory notes or interpretations as needed. By assembling law into a graph with robust versioning, we lay a foundation where the law is no longer a maze of documents but a **connected, temporal dataset** that stakeholders can query, audit, and build upon.

## Distributed, Domain-Specific Ontologies (Not One-Size-Fits-All)

A crucial design decision in this roadmap is to avoid imposing a single universal ontology or taxonomy for all legal knowledge. The legal domain is extraordinarily diverse: it spans constitutional text, statutes, administrative regulations, case law, contracts, scholarly commentary, and more. Within each of these categories, further specialization occurs (e.g., tax law versus criminal law, or federal statutes versus municipal ordinances). Past efforts to create an all-encompassing ontology for “the law” have struggled with over-generalization and inflexibility. We advocate a **federation of ontologies** – a distributed approach where each legal sub-domain or jurisdiction can develop its own schema of concepts and relationships, appropriate to its needs, while remaining interoperable with others through shared standards.

This approach acknowledges that **context matters**. For example, an ontology for intellectual property law might include entities like “Patent” and “Trademark” with relationships defining their filing, approval, and expiration processes. In contrast, an ontology for legislation drafting might focus on entities like “Bill”, “Amendment”, “Section”, “Clause”, with relationships like *has\_subsection* or *amends\_section*. Attempting to force these into one master hierarchy would either oversimplify distinctions or become unwieldy. Instead, we allow multiple **domain-specific ontologies** to coexist, each capturing rich detail in its domain. They can still link to each other—much as different Wikipedia articles link across topics—using bridging concepts or alignment ontologies where overlap exists. For instance, a contract ontology might link to statutory concepts when a contract clause references a statute. This way, the overall knowledge graph is polyglot: unified by graph technology and common protocols, but not dependent on a single rigid schema.

Distributed ontologies also promote **community ownership** of different parts of the graph. One group of experts (say, environmental law scholars) might steward the ontology and data for environmental regulations, ensuring that domain-specific terminology and relationships are properly represented. Another group (judicial clerks or legal GenAI developers) might maintain the ontology for court judgments and how they cite precedents. Because each group can extend or refine the graph in the ways that make sense for their domain, the system remains flexible and extensible. This is akin to modular design in software or the way different scientific disciplines maintain their own taxonomies but agree on certain cross-discipline terms. Notably, even the widely adopted Akoma Ntoso (AKN) XML standard for legislation incorporates flexibility for different jurisdictions, recognizing the need to represent “fundamental aspects of laws shared across different legislations” while allowing extensions for local specifics. Our proposal builds on that lesson: **no one-size-fits-all ontology** will suit every purpose, so we must enable many ontologies to flourish in a coordinated ecosystem.

The challenge with multiple ontologies is ensuring they can interoperate and that the overall knowledge graph doesn't fragment into isolated silos. Here, the graph platform and shared **open standards** play a mediating role. We establish common reference points—such as unique identifiers for the same real-world entities (e.g. a specific law or court) and core properties like dates, titles, jurisdictions—that all ontologies must use when relevant. Ontology alignment becomes an ongoing process, one that can even be assisted by GenAI initially (as we discuss later). The benefit of this pluralistic approach is a system that can evolve organically and **adapt to new domains of law or new countries' legal systems** without a central authority having to pre-design every possible structure. Just as the internet grew through open protocols rather than a single central database, the legal knowledge graph grows through open ontologies that communities contribute to. This stands in contrast to proprietary legal taxonomy projects that attempted to catalog every legal concept universally, only to become too rigid. Instead, by embracing diversity in ontologies, we combine the strengths of specialization with the **power of a connected open network**.

## Provenance, Explainability, and Determinism by Design

In an GenAI-assisted legal system, **trust** is paramount. Lawyers, judges, and citizens will rightly question any automated output about the law: *Where did this information come from? How was this conclusion reached?* Our roadmap places **provenance, explainability, and determinism** as core design principles to ensure the system's integrity and trustworthiness.

**Provenance** means that every piece of data in the knowledge graph is traceable to its source. If a node represents Section 15 of a certain Act, there should be a clear link to the official publication of that Act (such as a URL to the government gazette or legislation database). If a relationship says that Act A amended Act B, that too should point to the amending instrument and clause that enacted the change. The graph thus serves not as an oracle of

truth on its own, but as a **well-organized map to authoritative sources**. Users of the system can always drill down to the original texts, verifying that the graph's representation matches the source. Moreover, as the data is updated by contributors, every change in the graph should carry metadata about who made the change and when, analogous to a commit history. This audit trail is vital in the legal domain: it must be possible to identify errors or outdated information and correct them while understanding how they entered the system. In practice, this could mean each node/edge stores references like *"sourced from Official Gazette No. X, page Y"*, and each contribution is logged. Strong provenance not only builds trust, it also aids **maintainers** – if something is contentious or unclear, they know exactly where to look in the source material for clarification.

**Explainability** goes one step further. Beyond sourcing the raw facts, the system should be able to explain how it derived any answers or analytics it provides. For example, if the graph is asked, *"What regulations are currently in force regarding water quality?"*, and it produces a list, it should be able to show the chain of reasoning: which laws it considered "water quality" related (perhaps via an ontology tag or keyword), how it checked their in-force status (following amendment/repeal edges up to the current date), and how it filtered the results. Each step corresponds to a transparent operation on the graph or data, as opposed to a black-box guess. This transparency is essential for legal uses. It allows users to **challenge and verify** the system's answers. If a relevant regulation was omitted, one can trace whether the ontology failed to tag it as water-related, or if an outdated repeal status was not updated, etc. The goal is that the system's conclusions are *reproducible*: given the same input data and queries, any independent party should get the same result. This is what we mean by **determinism** in outputs. Unlike a free-form GenAI that might answer slightly differently each time or cannot fully justify a specific phrasing, the graph operations yield consistent outcomes grounded in the data. Deterministic behavior is especially critical in legal automation—imagine an GenAI assistant giving a different interpretation of a statute on different days; such inconsistency would erode confidence and could have legal consequences.

By baking explainability and determinism into the architecture, we ensure the system aligns with legal norms of reasoning. Legal reasoning often requires citing sources and precedent for every assertion; our knowledge graph, with its provenance links and clear traversal logic, analogously provides citations for its answers. Furthermore, determinism supports **predictability**: if a law is updated, we know exactly how that update will propagate through the graph and affect queries (no mysterious "retraining" effects as in some GenAI models). This makes the framework reliable infrastructure for others to build upon. For instance, a startup could build a legal Q&A service on top of the graph, confident that if they test a query today, it will behave the same tomorrow unless new data (like a new law) is added, in which case the change is traceable and explainable. We recognize that achieving perfect explainability can be challenging, especially in early stages where GenAI might assist in data curation (GenAI decisions can be opaque). However, a core requirement is that **anything contributed by GenAI must be validated or re-expressed in human-comprehensible, rule-based form** before becoming part of the official graph. In other words, GenAI can draft or suggest, but the final accepted knowledge in the graph should always reduce to

deterministic content. This ensures the end product—an open legal knowledge base—earns the trust of its users by design, much as a well-edited legal treatise does, with footnotes for every statement.

## GenAI-Assisted Bootstrapping and Alignment

While the long-term vision is to minimize reliance on GenAI inference in day-to-day operations, **GenAI and other GenAI tools play a vital bootstrapping role** in this roadmap. The volume of legal text and the complexity of aligning diverse ontologies are simply too great to build the graph entirely by manual effort. Early on, Large Language Models (LLMs) and related GenAI techniques can act as force-multipliers for human experts, rapidly processing texts and suggesting structure which experts can then refine and verify.

One major application is **extracting structured data from unstructured legal texts**. Laws and court decisions need to be ingested into the knowledge graph, but they often come as plain text. GenAI models can assist by identifying key elements: titles, section headings, definitions, references to other laws, etc. For example, an LLM could take the text of a new bill and propose a breakdown into a graph format: “This section amends that other law; this paragraph defines a term; these clauses list obligations.” Generative models are adept at picking up patterns and could handle the initial parse and classification of each piece of text. Similarly, GenAI can help in **resolving references and alignments**. If one document refers to “the Act of 1999 on water resources,” the GenAI can link that to the specific law in the graph (assuming it exists or prompting a new node if not). This is akin to named-entity recognition and disambiguation, tasks well-suited for NLP technology. Indeed, recent research on building legislative graphs used fine-tuned language models (like BERT and others) to enrich and augment the graph’s quality, indicating that careful use of GenAI can significantly speed up obtaining a high-quality knowledge base.

Another area where GenAI shines is in **ontology alignment and schema mapping**. As we promote multiple ontologies for different domains, we need to ensure they can talk to each other. GenAI can compare the schemas and suggest correspondences: for instance, it might infer that one ontology’s concept of “statutory instrument” is equivalent to another’s “regulation” concept, or that a “legal case” in one schema is similar to “court decision” in another. By analyzing definitions and usage contexts, an LLM could propose mappings or even create a higher-level ontology that links the two. These suggestions would then be reviewed by humans (to avoid misalignment or false equivalents) but would accelerate the integration of ontologies. GenAI can also help identify **gaps or inconsistencies** in the data. For example, if an amendment refers to inserting a paragraph that is already present (perhaps due to a drafting error), an GenAI reading the consolidated version could flag this anomaly for a human to resolve.



Visualization and user interaction are yet another facet: GenAI could be used to create **natural language summaries or visual diagrams** from the graph. Early in the project, before end-users are comfortable querying graphs, an GenAI layer can translate a user's question ("Has law X been amended recently?") into a structured query on the graph, or conversely, take a set of graph results and generate a concise explanation. By doing so, GenAI acts as a friendly interface, helping to demonstrate the value of the system even to those who are not technical. These uses of GenAI, however, remain **assistive**. The GenAI's output is not taken as truth until vetted. We foresee an iterative workflow: the GenAI proposes a draft graph extraction or alignment; human experts review, correct, or approve it; then the vetted result enters the knowledge graph. This human-in-the-loop approach mitigates the risk of GenAI errors propagating into legal data. It also provides training data to improve the GenAI over time on legal-specific tasks, ideally using open-source models fine-tuned for legal text to avoid black-box proprietary systems.

By leveraging GenAI in the early stages, we **bootstrap the knowledge graph significantly faster and more cheaply** than a purely manual effort. For example, instead of a team of lawyers spending months reading thousands of pages to codify a body of regulations, an GenAI system could draft a first cut of that codification in hours, which the team can then validate and publish incrementally. There are promising signs that this approach works: an ETL (Extract-Transform-Load) pipeline for Italian legislation recently achieved high-quality results by employing large language models to enrich the graph with metadata and derived insights. It demonstrates that when carefully applied, GenAI can enhance the depth and utility of a legal knowledge graph beyond what simple parsing can do. Our roadmap embraces such techniques not as a replacement for human judgment, but as powerful **augmentation tools** that help surmount the initial obstacles of scale and complexity in constructing the system.

## Minimizing LLM Reliance as the System Matures

While GenAI is invaluable for kick-starting the graph and performing heavy-lift integrations, a key goal of this roadmap is that the **day-to-day operation and querying of the legal knowledge graph should not rely on opaque GenAI reasoning**. Once the schemas, ontologies, and data pipelines stabilize, the system transitions into a more deterministic, maintainable phase. In essence, as the graph "learns" the structure of the legal domain (through human curation and GenAI-assisted import), the need for further GenAI intervention declines. This is both for practical reasons (cost, performance) and for trust reasons as discussed earlier.

One reason to minimize reliance on LLMs is **consistency and reliability**. Deterministic code and queries will behave predictably, whereas large language models can exhibit variability or require continuous tuning. For example, if the graph is fully populated with up-to-date laws and their relations, answering a question like *"What laws cite this section?"* can be done by a straightforward graph traversal that will always yield the correct, complete set

of results. Using an LLM to answer the same question might introduce unnecessary uncertainty (it might omit some references or hallucinate an extra one if not carefully constrained). By structuring the problem such that a normal database or graph query engine can handle it, we effectively **eliminate error where possible**. In the mature system, the role of GenAI might be reduced to edge cases—such as processing a novel type of document we haven’t seen before, or interpreting a user query in natural language into a formal query language. Even in those cases, as patterns emerge, they can often be turned into deterministic processes (for instance, if users frequently ask certain types of questions in plain English, we can develop a template-based translation to graph queries rather than invoking a full LLM every time).

Another reason is **performance and scalability**. A fully realized legal knowledge graph will be massive and frequently updated. If every update or query had to pass through an GenAI model, it could become a bottleneck. Instead, after initial loading, updates to the graph (like a new law being added) can follow a repeatable procedure. For instance, if the jurisdiction publishes laws in a known XML format (say, Akoma Ntoso or another), we might develop a direct parser to graph pipeline from that format once we understand it thoroughly, obviating the need for GenAI parsing. In fact, part of the maturity process is identifying where one can replace an GenAI-driven step with a **rule-based or algorithmic step** reliably. Many tasks that were ambiguous early on become clearer as the ontologies solidify. For example, aligning two ontologies might initially need GenAI to suggest mappings, but once those mappings are established, new data can be automatically classified under the correct ontology by following the existing map.

Minimizing LLM reliance also encourages **community trust and adoption**. Legal practitioners may be wary of a system that feels like a black box GenAI, but much more welcoming of one that feels like a database or reference tool—albeit a very smart and connected one. By highlighting that the system’s answers come from explicit data relationships and not mysterious neural nets, we make it easier for law firms, courts, and government agencies to integrate the tool into their workflows. It can be positioned as an authoritative reference (because of provenance and determinism) rather than an advisory GenAI that might be wrong. The ultimate aim is for the knowledge graph to become part of the legal information infrastructure, like an official but open repository, and that status would be jeopardized if it were perpetually dependent on proprietary or inscrutable GenAI processes running in the background.

This is not to say GenAI becomes irrelevant—in a steady state, GenAI might still be used for **advanced analytics** or to propose major structural changes (e.g., “we noticed a new pattern in case law references, here’s a suggested new link”), but the day-to-day operations—adding a new amendment, querying relationships, checking consistency—should run on well-tested code and human governance. Paradoxically, by planning to *remove* GenAI from the routine loop, we actually guide our initial use of GenAI: we focus on using GenAI to reach the point where it’s no longer needed for known tasks. In short, **use GenAI to automate yourself out of dependence on GenAI** for those tasks. The long-term maintenance of the legal knowledge graph will then rely on stable tooling, open-source algorithms, and an engaged community, rather than constantly chasing the state-of-the-art in GenAI. This makes the

project sustainable. It ensures that the knowledge graph, once built, can persist and improve for decades (much like Wikipedia has) without being tied to a specific vendor or model. We envision that after the initial GenAI-assisted bootstrap, the graph enters a phase of **continuous community-driven refinement**—somewhat like an encyclopedia that after being initially populated, grows at a slower, steady rate through human contributions, with occasional GenAI aid to suggest improvements but not to control content.

## Stakeholder Ownership and Collaborative Maintenance

A graph-powered legal knowledge system is not just a technical project; it is a **socio-technical endeavor** that requires buy-in and participation from a broad range of stakeholders in the legal domain. Key stakeholders include legislative bodies and government publishers of law, courts and judicial administrations, law libraries and archives, universities and researchers, law firms, and even civic tech communities and the general public. For the system to thrive and remain up-to-date, these stakeholders should not merely be end-users but **active contributors and custodians** of the knowledge graph.

We propose an **open collaborative model** for maintaining the legal graph, inspired by the success of Wikipedia in crowd-sourcing knowledge and open-source communities in managing large codebases. In this model, different groups can take responsibility for different “shards” or segments of the graph. For instance, the national parliament’s IT department might manage the nodes and edges for all statutes in the national jurisdiction (since they have the authoritative feed of that data), while a court administration might maintain the portion of the graph dealing with court decisions and how they cite laws. Academic volunteers or non-profits might curate thematic sub-graphs—for example, an environmental law NGO could curate all environmental regulations, adding rich metadata and cross-links to policies or scientific data. Crucially, **no single centralized authority owns the entire graph**; ownership is distributed but coordinated. This federated ownership aligns with the earlier idea of domain-specific ontologies: those who know the domain best maintain its representation in the graph. It also distributes the workload of data curation. The legal domain is far too large for any one team to manage comprehensively, but by dividing it, we make the task feasible.

To coordinate this multi-party collaboration, the project would establish clear governance protocols. These would cover how new contributions are proposed and reviewed, how conflicts or overlaps between different domains are resolved, and how the integrity of the graph is protected. Borrowing from open-source practices, one could imagine a system of “**maintainers**” for each section of the graph, and a version-controlled workflow for edits (just as code changes are submitted and reviewed). Tools for comparison and diffing of graph changes become important, so contributors can see what a proposed edit would do—this is analogous to legislative markups but in a graph context. By making the maintenance process open and

transparent, we ensure that stakeholders trust the data: they can see the community processes behind every entry. In effect, the legal knowledge graph becomes a **commons**—an infrastructure maintained by and for its users.

One might worry that open collaboration could introduce errors or inconsistencies. However, legal data has a self-correcting community: lawyers and judges are quick to spot when something is off, because errors have direct consequences. Additionally, the provenance and explainability features of the graph help here: if someone were to introduce an edit that's not backed by an official source, it would be flagged as lacking provenance and likely not approved by maintainers. Over time, active communities will emerge around areas of law that are heavily used, similar to how Wikipedia has active editors for popular topics. Less trafficked areas might lag, but part of the roadmap is to identify **incentive structures** to encourage broad coverage, which we will discuss next.

Critically, this collaborative model also means stakeholders have **agency and control** over the representation of “their” laws. Instead of feeling subject to a black-box system created by technologists, they become co-creators. A regulatory agency, for example, could directly ensure that its regulations are correctly linked to enabling statutes and updated promptly when new rules come into force. This sense of ownership can drive adoption: organizations will be more willing to use the graph if they had a hand in building it and can ensure its accuracy for their domain. Moreover, collaboration opens the door to **community-driven extensions**. People can attach commentary, interpretations, or practical notes to the graph (perhaps in a separate layer or as annotations), building a richer ecosystem of knowledge around the bare bones of legal texts. This echoes how legal commentaries and case annotations accompany statutes in traditional law books, but now it can be done in an open digital medium.

In summary, stakeholder ownership turns the knowledge graph from a static product into a living, community-driven project. It harnesses the distributed expertise in the legal field. By treating maintenance as a shared responsibility, we increase the graph's resilience (no single point of failure or neglect) and ensure it keeps pace with the law as it changes. This collaborative aspect is not just a nice add-on; it is fundamental to the **open and distributed ethos** of our roadmap. The law belongs to everyone, and so should the map of legal knowledge.

## Incentivizing Domain Experts and Sustaining the Effort

For the open, collaborative model to work in practice, especially in highly specialized domains, we must consider how to **incentivize domain experts** to contribute their time and knowledge. While many legal professionals and academics are passionate about open access to law, their contributions

cannot be taken for granted—after all, curating data can be time-consuming. We outline a few strategies to attract and reward the people whose expertise is vital to maintaining high-quality data.

One approach is through **institutional support and recognition**. Contributions to the legal knowledge graph can be recognized as a form of public service or scholarly output. For example, a law professor who curates a segment of the graph on constitutional law could receive academic credit or citations much like authoring a law review article. Professional organizations (bar associations, legal tech groups) might formally encourage members to participate, perhaps by issuing acknowledgments, certificates, or awards for significant contributions. This creates reputational incentives. If the platform publicly credits contributors on a leaderboard or hall of fame, individuals and teams gain recognition for their effort, which can be a powerful motivator in communities of practice.

Another crucial incentive is **financial or material support**. Wherever possible, funding should be allocated to compensate experts, especially for the initial heavy lifting of data entry and ontology creation. Governments could justify funding this as it ultimately improves public access and administrative efficiency. Grants from foundations interested in legal empowerment or digital infrastructure could sponsor portions of the work (for instance, a grant to integrate all labor laws into the graph with expert oversight). In the corporate context, companies that rely on certain legal data might sponsor work—imagine a consortium of banks funding the curation of financial regulations in the graph, because they all benefit from better compliance tools. We could even explore *bounty models*: specific gaps in the graph (say, missing case law connections in a particular field) can have bounties that researchers or firms compete to fill for a reward. The concept of **paying legal SMEs (Subject Matter Experts) to maintain shards** of the graph is not far-fetched, given that today law firms pay for costly databases; redirecting some of those funds to an open effort could both save costs and improve quality long-term.

A sustainable incentive model might blend volunteerism with paid work. For instance, volunteers could handle routine updates (with the motivation of contributing to the public good), whereas paid experts could be tasked with complex restructuring or initial seeding of difficult domains. It's analogous to open source software: many contributors volunteer, but core maintainers in key projects are often funded by companies or donations because their continuous involvement is critical. By making it possible for someone to have, say, a part-time job maintaining the environmental law ontology, we ensure that at least a minimum level of attention is always given to that domain.

We should also create a **feedback loop of value** to incentivize contributions. As the graph-based system becomes useful in practice (through tools and applications built on it), those who contribute will likely be users themselves or see the benefit for their organizations. For example, a judge who ensures that new court decisions are promptly linked in the graph will directly benefit when researching related cases or when the graph helps generate

a report on citation patterns in her court. Likewise, a government agency that feeds its regulations into the graph will benefit from improved compliance monitoring applications that use the graph's data. When stakeholders see tangible improvements in efficiency or decision-making due to the knowledge graph, they have a self-interest in keeping it accurate and comprehensive. Over time, what starts as an initiative might evolve into a norm: just as publishing laws online is now a given, maintaining them in the open graph could become an expected part of the legislative process.

Finally, we note that open legal data efforts can tap into **civic enthusiasm and volunteer tech communities**. Projects like Free Law Project in the U.S. or myriads of legal hacking meetups worldwide show that a segment of the population is eager to contribute to making the law more accessible. By providing an appealing platform (with clear tasks, good documentation, and perhaps gamified elements for contributing), we can channel that energy. Imagine law students being able to contribute as part of their training, or civic hackathons focusing on adding a set of municipal ordinances to the graph. With proper guidance from domain experts, even non-lawyers could help, especially on technical tasks like data formatting or writing conversion scripts.

In conclusion, sustaining the legal knowledge graph will require a mix of **carrots** (recognition, direct benefit, possibly payment) and the intrinsic motivation of participating in an important public resource. Our roadmap encourages early planning for these incentives. The goal is to cultivate a vibrant ecosystem where contributing to the graph is seen as professionally and socially rewarding. That way, the system will not stagnate after initial hype, but continue to grow richer and more valuable year after year, supported by a community that has a stake in its success.

## Integrating Public and Private Legal Datasets

Law does not exist in a vacuum; it permeates both the public and private spheres. A comprehensive legal knowledge graph should encompass not only the **public laws and regulations** issued by official bodies, but also allow integration of **private legal datasets** that organizations or individuals might have, all under a shared framework. Bridging these realms under one graph framework can unlock powerful synergies while respecting necessary boundaries (like confidentiality).

On the public side, our system will compile statutes, regulations, case law, administrative rulings, international treaties, and so forth—the whole corpus of “black letter” law and related official materials. These are the backbone of the knowledge graph, broadly accessible to all. On the private side, consider the wealth of legal knowledge embedded in things like corporate policies, contracts, compliance checklists, or legal commentary and analyses. Today, a company's internal compliance database (mapping laws to internal requirements) is usually separate from the actual text of the law.

In our vision, a company could link its internal rules directly to nodes in the public legal graph. For example, a bank's internal policy on data privacy might be linked to the provisions of a data protection law in the graph that justify that policy. This doesn't mean the internal documents become public; rather, they can be integrated in a **permissioned layer** of the graph that only the company (and authorized parties) can see, but still using the same ontology and IDs for the public law concepts. The result is that private and public knowledge "speak the same language." A compliance officer could run a query like "show me all internal policies related to Law X and whether Law X has changed recently" and get an answer because the internal nodes connect to the public nodes representing Law X, and the graph knows Law X was amended last month.

Another example of integration is in legal practice tools: law firms may annotate statutes with internal notes or even predictions about how a court might interpret a clause. Using the graph, these annotations can attach to the exact nodes they concern. If shared under certain conditions (perhaps among firm clients, or publicly if the firm chooses), it enriches the overall ecosystem. Over time, the boundary between public and private data might blur in a controlled way: if a firm decides to open source some of its contract templates and map them to the statutes they comply with, those templates could join a public repository linked to the graph. This creates a continuum of legal knowledge from the very general (the law) to the very specific (individual contracts and cases).

To enable this integration while maintaining appropriate separations, the system would implement **access controls and data partitions**. The core public knowledge graph remains openly accessible. Private extensions of the graph (like a company's nodes or a law firm's annotations) reside in a secure space but reference the public graph's identifiers. Technically, one can imagine it like layering: the base layer is open, and private layers sit on top, visible only to those with permission, but aligning with the base. This is similar to how one might fork a public source code repository for private use but still merge updates from upstream. The public graph is the "upstream" of law; private graphs merge it and add proprietary notes, and if something in the public graph changes (like a law is updated), those with private layers get a notification or can automatically see the updated link.

The value of combining public and private datasets is immense. It encourages **standardization** in how legal information is referenced. If everyone refers to a particular regulation using the same node ID and name from the graph, it reduces confusion and errors (no more mismatched references in different databases). It also fosters **innovation**: entrepreneurs could build apps that, for instance, let individuals input a scenario and then traverse both public law and relevant private knowledge (like common contractual clauses) to give guidance. Policymakers could simulate the impact of a regulatory change on businesses by seeing what internal policies or procedures companies have linked to the affected regulation. In effect, the graph can serve as a *lingua franca* for legal knowledge across society.

Of course, careful governance is needed to handle sensitive data. Private contributions should never inadvertently leak into the public domain via the graph, and the platform must uphold confidentiality and privacy commitments. But those are manageable technical and legal issues (solvable with encryption, sandboxing, and contracts). The strategic vision is that by **embracing both public and private legal knowledge**, the system becomes the single hub where all legal information connects. It's a move away from fragmentation—today one might search a public law database for “what is the law” and then search internal memos for “what do we do about it”; tomorrow, those could be one integrated search with filtered views.

## Applications: Access to Justice, Policy Simulation, and Legal Automation

The true measure of this graph-powered legal knowledge system is in the **concrete improvements** it brings to legal processes and society at large. By transforming static legal texts into a living, queryable network, we unlock numerous applications. Here we highlight how it can enhance access to justice, enable sophisticated policy analysis and simulation, and drive new levels of automation in legal services.

**Enhancing Access to Justice:** One of the most direct benefits of making legal information structured and navigable is empowering individuals and small entities who lack large legal teams. When laws are openly available in an interconnected graph, it becomes easier to build citizen-facing tools. For example, consider a simple web application where a tenant can input a question about eviction and, behind the scenes, the app queries the graph for relevant housing laws and local ordinances, returning an answer with the exact provisions highlighted. In the current world, that tenant might have to wade through dense statutes or pay for advice. With the graph, the heavy lifting is done by the data structure: the app can quickly find all sections related to “eviction” and even see connections (perhaps linking to a court decision that interpreted those sections, or a regulation that provides a form the landlord must give). Knowledge graphs have already been noted for powering advanced legal research tools that *“help lawyers find relevant cases, statutes, and legal concepts more efficiently”* ([What is a knowledge graph? – FOLIO](#)). Extending that to non-lawyers means providing **plain-language interfaces** backed by the graph. Because the graph contains the logic of the law (through its relationships and ontology), it can be used to guide a user step-by-step – for instance, a chatbot that walks someone through eligibility for a benefit by following the criteria laid out in regulations, all of which are represented in the graph's structured data. This dramatically lowers the barrier to understanding legal rights and obligations, thereby improving access to justice. Moreover, legal aid organizations can use the graph to quickly assemble information packets for clients, rather than manually searching various sources.

**Policy Simulation and Impact Analysis:** Lawmakers and policy analysts stand to gain a powerful new toolkit. With a fully versioned knowledge graph, one can perform **what-if analysis** on the legal code. For instance, before introducing an amendment, a legislator could query: “What sections of other



laws cite the section I plan to amend?” and instantly get a map of dependencies. This is akin to how engineers analyze the impact of changing a piece of code by seeing what calls it. Our graph makes the web of legal interdependencies explicit. It could enable simulations such as: *“If we repeal Law X, what related regulations or subsequent laws become irrelevant or orphaned?”* or *“If we tighten the definition of ‘employee’ in the labor code, how might that affect references in tax or social security law?”*. Because the graph can be queried for all points of connection, these analyses, which are currently done via tedious manual cross-reference checks, can happen in seconds. Additionally, the data can feed into quantitative models. For example, one might combine the legal graph with economic or demographic data to simulate outcomes: *“There are 200k people affected by Regulation Y; if we change threshold Z in that regulation (as seen in the graph), our linked economic model predicts X change in compliance costs.”* Think of it as **policy prototyping** with real data. Governments could also monitor the health of the legal system via the graph: metrics like the number of amendments, the average age of laws, or the network centrality of certain regulations could signal areas of complexity or over-regulation. Researchers demonstrated how graph analysis of legislation can reveal patterns and even errors (like the citation mistakes found by tracking abrogation links. This kind of insight can guide evidence-based reforms.

**Legal Automation and Smart Contracts:** By having the law in a computable form, we open the door to automating various legal processes. One burgeoning area is the idea of *“smart contracts”* and computational law, where legal obligations are executed by software. While not all laws can be converted into code, many well-defined rules (tax formulas, benefit eligibility criteria, procedural deadlines) could be directly **queried and applied** via the graph. For instance, a startup could create a service that automatically monitors changes in employment law and updates a company’s HR policies accordingly – the graph triggers alerts when a relevant node changes (due to a new amendment or a court ruling), and the service knows exactly which policy documents (in the private layer) map to those nodes to update. In contract management, as another example, a platform like *Legislate* has leveraged knowledge graphs to extract key information from contracts and even compute metrics like a company’s total obligations ([RDFox and Legislate: The Legal Knowledge Graph | 3 min read | Feb 12, 2024](#)). With an open legal graph, such a platform could link contract clauses to statutory requirements, ensuring that all contracts in a portfolio remain compliant with the latest law. Furthermore, compliance checking – say, verifying if a business procedure meets all regulatory requirements – becomes more straightforward: the requirements are nodes in the graph, which can be programmatically checked off against the company’s documented processes. This reduces the need for manual legal checklists and periodic audits, potentially moving towards **continuous compliance monitoring**.

Another aspect of automation is in the courts. Imagine a judge or clerk getting a “graph view” of a case: all cited authorities are pulled in from the graph, any subsequent history of those cases or statutes is flagged (e.g., “this precedent was recently overruled, which the attorneys did not mention”), and even suggestions from the graph’s knowledge base of similar cases or outcomes. Some of these features are emerging in legal research systems, but

an open graph makes it universally available rather than behind a paywall. Over time, one could integrate GenAI to propose draft judgments or documents by drawing on the structured knowledge – indeed, if the graph knows the logical structure of legal arguments and the pertinent facts, an GenAI could assemble first drafts for human refinement.

Lastly, the graph and automation can help in **regulatory compliance for emerging technology**. For example, consider GenAI systems that need to be law-aware (self-driving cars following traffic laws, or content platforms complying with a maze of content regulations). These systems could query the legal graph in real-time to ensure actions are within legal bounds. While that is a futuristic scenario, having a machine-readable law graph is a necessary foundation for it.

In all these applications, the common thread is **empowerment through structured legal knowledge**. What was once the sole province of trained experts spending hours can be accelerated or even handed off to software. Importantly, this doesn't eliminate the need for lawyers or policymakers – it elevates their role. Lawyers can focus on strategy and advocacy rather than document assembly or citation-checking; policymakers can focus on the substance of policy rather than cross-referencing laws. Meanwhile, the public gets more direct access to information that affects their lives. The legal knowledge graph thus acts as an enabler of justice, efficiency, and innovation.

## Real-World Analogies: Wikipedia and Git for Law, and the Power of Open Protocols

To better envision our proposal, it helps to compare it with analogous successes in the digital realm. Two analogies stand out: **Wikipedia** for collaborative knowledge curation, and **Git (version control)** for managing revisions. Additionally, the story of the internet's open protocols underlines why openness is crucial.

**Wikipedia as a Model for Collaborative Legal Knowledge:** Just as Wikipedia turned the traditional encyclopedia model on its head by allowing a distributed community to build and maintain an ever-growing body of knowledge, our legal knowledge graph invites a community of contributors to collaboratively curate the law. Wikipedia's strengths – open access, rapid updates, broad contributor base, and citation to sources – are exactly what we seek to emulate. In our context, each legal provision is like a Wikipedia article, maintained by those who care about it, complete with citations (provenance) to official sources. Vandalism or inaccuracies are deterred by the community and the transparency of changes. Notably, Wikipedia has shown that a complex, interlinked knowledge system can scale without a central authority dictating each entry; instead, norms and quality control processes emerge. We anticipate a similar evolution: an ecology of editors ranging from official bodies (who might keep certain pages current) to

hobbyists and experts who add detail and connections. Wikipedia also demonstrates the value of **iterative improvement** – a page can start as a stub and grow over time. Likewise, our graph might not be perfect on day one, but with open contribution, it will steadily fill out and refine. The end result is not just data, but a **shared understanding** of law, much as Wikipedia has become a collective understanding of general knowledge.

**Git and Version Control as Inspiration:** Git's influence on our approach is profound. In software development, Git enables collaborative editing, branching and merging of changes, and an immutable history of every change. Law is, in a sense, a form of code (often called “legal code”) that could benefit from the same rigor in tracking changes. By modeling amendments as something like Git commits, we get both clarity and accountability. Git also shows how **distributed governance** can work: thousands of developers can work on a codebase simultaneously, branching off to experiment (like drafting a new bill) and later merging (enacting it into law) after review. Conflicts are resolved through careful merging, similar to how contradictory amendments or overlapping jurisdictions need reconciliation in law. In fact, technologists have experimented with putting laws in Git repositories, finding that it handles versioning well (one project turned the French civil code into a git repository to track changes. We are taking that concept further by adding semantics and a user-friendly interface, but the foundational idea is the same: **transparent, trackable change management**. When a law changes, stakeholders can see a “diff” – effectively, before and after in the graph – and understand exactly what was altered. Moreover, multiple proposals to change the law (like different draft bills) can coexist as branches in the graph, useful for scenario planning. Git also underpins platforms like GitHub which manage large, open collaborations, combining issue tracking, discussion, and integration. Our platform could offer analogous features for legal data: a change proposal (e.g., “Add new regulation node with these properties”) can be discussed and vetted just as a pull request on GitHub is. In short, we leverage the proven paradigm of distributed version control to impose **order on the evolution of law**, treating legal amendments with the same methodical care as software patches.

**Open Data Protocols and the Internet Analogy:** The success of the internet and the web is often attributed to open standards and protocols (like TCP/IP, HTTP, HTML) that anyone could implement and build on. These protocols allowed diverse contributors to create the rich online ecosystem we have today. In contrast, areas where closed or proprietary standards prevailed often saw slower growth and innovation. Our knowledge graph must be built on **open protocols for legal data**. This means using and extending standards such as Akoma Ntoso for legislative documents, RDF/OWL or other graph standards for data interchange, and APIs that are openly documented for querying the graph. By being open, we encourage third parties to integrate with our system – whether it's a local court building a portal that pulls data from the graph, or a civic hacker group creating a visualization of the connections in the tax code. Open data also ensures longevity: if no one entity controls the data format, the information can outlive the original platform (just as one can still parse HTML from the 1990s with today's browsers). Imagine if each country or state adopted an open protocol to publish

its laws as structured data feeds; our system could subscribe to them, and conversely, our consolidated graph could feed others. This network effect only works when the interfaces are open.

There are already movements in this direction. Governments have started open data portals and initiatives (e.g., the U.S. **OPEN Government Data Act** requires agencies to publish data in open, machine-readable formats). In the legal arena, projects like the **Open Legal Data** and some forward-thinking legislatures provide APIs for statutes and bills. Our roadmap both benefits from and reinforces these trends. We will advocate for law to be published “by default” in structured form and to contribute to an open knowledge network. The **SCALES Open Knowledge Network** for judicial opinions, for example, is an GenAI-powered platform aiming to connect case law ([Release 2.0 - MIT Computational Law Report](#)). By aligning with such efforts and ensuring everything uses open standards, we collectively build an **ecosystem instead of isolated systems**.

In essence, the analogies of Wikipedia, Git, and open protocols are guiding stars. They remind us that **distributed collaboration can outperform centralized siloed work**, that **tracking changes is essential for complex knowledge**, and that **open systems win out in the long run**. By learning from these real-world successes, we can navigate the challenges of creating a graph-powered legal knowledge base and increase the odds that it will flourish and truly transform how we manage legal information.

## Conclusion

The law is often described as society’s operating system, but until now we have lacked the tools to collaboratively manage and query that system with the efficiency and transparency that modern life demands. **Graph-powered legal knowledge**, as outlined in this paper, offers a transformative path forward. By converting legal texts into a connected, versioned graph of knowledge, we reconcile the dynamic nature of law with the need for stability and clarity. We can have, at once, the authoritative past (what the law was), the knowable present (what the law is now), and a blueprint for the future (how the law could change and what effects that would entail).

We began by identifying the deep shortcomings in how legal data is currently published and the very real costs imposed on society when laws are hard to find, hard to understand, and hard to track. We then proposed a roadmap that is at once technical and communal: using graph databases, ontologies, and GenAI to build the platform, and using open collaboration, expert engagement, and clever incentives to build the content. Each key idea from the initial vision—canonical versions of laws, amendment flattening, distributed ontologies, provenance and determinism, judicious use of GenAI, stakeholder ownership, and integration of datasets—has been expanded and grounded in practical rationale.

What emerges is a picture of a **legal ecosystem re-engineered**: no longer a labyrinth of documents, but an accessible network where anyone (with permission, if needed) can traverse from a problem or question to the precise legal answer, seeing the connections and context along the way. It is an ecosystem where changes in law ripple through in a controlled, observable manner, allowing all stakeholders to adapt quickly. Where today legal research might involve hours of reading and cross-referencing, tomorrow it could involve interacting with a smart, explorable graph that yields answers with evidence in seconds. Where today policy-making can be a shot in the dark in terms of side-effects, tomorrow it can be informed by simulations on a digital twin of the legal code.

The journey to this future will not be without challenges. It requires cross-disciplinary cooperation: lawyers, judges, technologists, and data scientists will need to learn each other's languages. It requires policy support: governments must embrace openness and invest in the infrastructure of legal data much as they do in roads and bridges. It requires cultural change: a willingness in the legal profession to trust (and verify) machines as partners in handling the law's complexity. But none of these challenges are insurmountable—we have seen analogous shifts happen in other domains. The open-source software movement overcame skepticism about quality to now run the backbone of the internet. Open data in fields like genomics accelerated research in ways that siloed projects never could.

The roadmap presented is admittedly ambitious, but it is also modular. Progress can be incremental. We can start by piloting a legal graph for a single domain or jurisdiction, demonstrating value, and then scaling outwards. Early successes—say an open graph for privacy laws that tech companies and regulators both use—will build momentum and confidence. At each step, maintaining the open, distributed, and accountable ethos will be crucial, as that is what differentiates this vision from proprietary attempts that have come before.

In closing, **Graph-Powered Legal Knowledge** is more than a technical proposal; it is a call to reimagine the relationship between law and society. An open legal knowledge graph has the potential to democratize access to justice, turning the lights on in the dark corners of legal codes. It can make lawmaking more informed and responsive, as each decision is grounded in a rich awareness of the legal landscape. It can empower innovators to create new tools and services that make compliance and rights comprehension almost frictionless. In short, it can help fulfill the promise of the rule of law in the digital age: that law is not just words in books, but knowledge in action, accessible to all.

By embracing the roadmap herein, we take a decisive step toward a future where **legal information is a public utility** – open, intelligent, and in service of the people it governs. The task now is to gather the community, secure the resources, and begin building this future one node, one relationship at a time. The complexity of law will not vanish, but it will finally become navigable by anyone with curiosity and need.