Multi-level Architecture for Separation of Powers in Legislative Process*

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Abstract

Contemporary democracies are based on three founding principles: i) separation of powers, which balances against excessive centralisation through checks and balances; ii) institutional representation of the people, ensuring an active role for minorities and opposition; iii) citizen participation and transparency in legislative, judicial and administrative processes. Within this framework, this work proposes a multilevel DLT architecture to ensure: a) separation of powers between institutions involved in the legislative process, providing autonomy to various actors (e.g., Chamber, Senate, Government, Ministers); b) active stakeholder participation (e.g., associations, municipalities, regions); c) transparent and public decision-making. A blockchain architecture with three interconnected yet autonomous levels is designed to respect the constitutional separation of powers. This system implements these three principles whilst leveraging blockchain characteristics to ensure traceability, authority, integrity, and selective transparency for publishable information only.

The project involves the implementation of three levels of DLT (Private Institutional Blockchain, Inter-Institutional Coordination Blockchain, Public Legislative Blockchain) and the use of the MOVE language to model smart contracts that regulate legislative procedures between institutions. Akoma Ntoso XML OASIS standard will also be used to model legislative documents and track changes introduced by different institutions. Finally, Decentralized Self-Sovereign Identity (SSI) implemented through the IOTA Identity framework will be used for permissioned access in the private blockchain.

Keywords

Deliberative Democracy, Multi-level DLT, Legislative Process, CEUR-WS

1. Introduction

Constitutional democratic governance is grounded in three essential principles:

1. the institutional separation of powers to prevent the concentration of authority (legislative, judiciary, government);
2. the representational inclusion of diverse societal voices, including minorities and opposition groups; and
3. the promotion of civic engagement alongside transparency in governmental functions.

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One of the most important powers is the legislative competence, which is held by the Parliament, and by limited delegation, to the government with some countermeasure (e.g., veto) to avoid frustrating the dialogic debate between majority parties and minor parties. In many countries, like Italy or in the European dimension, the legislative process is governed by different institutions with different roles (e.g, EU Parliament and Council of the EU [1]; Senate and Chamber of Deputies [2]; Lords and Commons [3]). Many other actors enter into the legislative process to contribute (e.g., Ministries) or to monitor (e.g., consumer associations, watchdogs bodies [4])[1]. Each of these actors should follow precise procedures (e.g., Regulation of the Parliament) and rule of law, in the meantime, they should operate applying the separation of the powers in order to activate the mutual checking on the others. Finally, each institution should publish in given steps of the procedure the output of their activities to permit other bodies to verify the correctness of the operations, the respect of the rule of law, to intervene in case of violation of constitutional principles, and to monitor the good application of the regulation. In parallel, the publication of some given output and actions is fundamental to inform the citizens, to apply the principles of transparency, accountability, and neutrality. When the digital transition transforms the legislative process steps, the design of the informatics system should take into consideration the peculiarities of this critical function, which is a key point of democracy. Consequently, the design and implementation of legislative information systems require careful consideration to prevent any single branch from gaining or exerting excessive control over joint resources. Additionally, legislative documents, which include drafts, amendments, and ratified laws, form the foundation of the legal framework of any rule of law. The integrity, security, and accessibility of these documents are crucial for maintaining transparent and effective governance and also to support the participation of the citizen in the legislative process.

Our research designs and theoretically validates a three-tier blockchain system to manage legislative documents. We use Italy's constitutional framework as our main case study whilst ensuring our approach works for other parliamentary democracies. We do not cover implementation details or testing. Instead, we focus on the basic architectural principles and how they comply with constitutional requirements.

We believe that we can model a multi-level DLT for managing the interactions between multiple actors, not defined in sequence manner, who have to respect different rules and workflows, mutable over time and dynamics. This multi-level DLT also guarantees the subdivision of the powers, the transparency in front of the citizens of those steps that are mandatory for publicity, and to preserve the integrity of the legitimacy of the documents from alterations.

This paper introduces the first multi-level blockchain system designed to protect separation of powers in government whilst digitalising law-making processes. Unlike current single-layer systems that work only within one institution, our approach maintains the independence of different government bodies. Previous blockchain prototype systems failed to respect the autonomy that each institution needs when working together digitally.

This is achieved by decentralizing data storage and management, thereby reinforcing the security and integrity of the data and aligning with the democratic ideals of balanced and equitable power distribution among governmental branches. The specific case of Italy provides a pertinent example of how these principles are operationalized within a national context. Building upon these foundational ideals, this study introduces a multilevel architecture based on Distributed Ledger Technology (DLT) intended to structurally reinforce democratic integrity within legislative processes. The proposed model delineates a layered blockchain framework that upholds institutional autonomy, enhances participatory governance, and ensures procedural transparency. The design envisions a system where legislative bodies, such as parliaments, governmental entities, and ministries, operate independently yet remain interconnected through a secure, traceable infrastructure. This system also provides mechanisms

[1] www.europarl.europa.eu/infographic/legislative-procedure/index_en.html
[2] https://en.camera.it/4?scheda_informazioni=15
[3] https://www.gov.uk/guidance/legislative-process-taking-a-bill-through-parliament
[4] https://www.ucl.ac.uk/constitution-unit/sites/constitution_unit/files/10.pdf, https://www.ucl.ac.uk/constitution-unit/research-areas/constitutional-watchdogs/parliaments-watchdogs

for stakeholder involvement, encompassing local and regional authorities as well as civil society organizations, thereby broadening democratic input. To achieve this, the architecture comprises three distinct but interoperable DLT layers: a Private Institutional Blockchain for internal governance, an Inter-Institutional Coordination Blockchain to manage inter-agency procedures, and a Public Legislative Blockchain to facilitate citizen oversight and accountability. The MOVE [2] programming language is employed to develop smart contracts that encode legislative protocols and inter-institutional interactions. Legislative content will be modeled using the Akoma Ntoso standard, enabling structured documentation and version control of legal texts across institutional actors. Furthermore, access control and identity verification within the private network will be managed through a Decentralized Self-Sovereign Identity (SSI) solution built on the IOTA Identity framework, ensuring secure, permissioned participation[5]. It is important to note that the Akoma Ntoso XML standard is a cornerstone technology for digital legislative processes. Established as an OASIS standard, it provides a structured markup language specifically designed for parliamentary, legislative, and judiciary documents. Akoma Ntoso enables machine-readable representation of legal documents whilst preserving their semantic richness, supporting features like point-in-time versioning, automated consolidation, and sophisticated document referencing through URNs (Uniform Resource Names). This standardisation facilitates interoperability between different legal systems and technological platforms.

Most studies on blockchain in governance only look at single institutions or general e-government uses. These approaches ignore the constitutional complexities when multiple government bodies must work together on laws. Our paper fills this gap by showing how blockchain technology can support the constitutional need for separate, independent institutions in democratic systems.

2. Italian Use Case for Legislative Process Management

2.1. Bicameralism, Transparency and Participation

The Italian Constitutional Court's ruling no. 235/2015 explicitly reinforces the constitutional necessity to prevent any form of centralization that could infringe upon the separation of powers. In accordance with its constitutional obligations, Italy maintains a decentralized system for managing legislative data, a model that adheres closely to the principles of separation of powers and ensures that no single entity holds undue control over this sensitive information. This approach is commendable as it aligns with both democratic ideals and constitutional mandates, promoting a balanced distribution of power among the various branches of government. This decentralization is fundamentally designed to uphold the integrity of the legislative process, ensuring that each governmental branch can operate independently without interference from a centralized authority. However, while this system significantly contributes to the robustness of Italy's democratic structure, it also introduces certain inefficiencies. For instance, the processing of legislation can be protracted, as evidenced during the last legislatures, in which decree laws were often used to speed up the process[3], and where the average time for deliberating government-initiated and parliamentary laws was notably extended. These delays can be attributed to the logistical complexities inherent in a decentralized system, where the coordination and exchange of documents across multiple independent entities take more time than a centralized system might. Therefore, while the decentralized approach is constitutionally vital and beneficial for maintaining democratic safeguards, it also poses challenges that could impact the timeliness and efficiency of legislative processes. The Blockchain technology, with its decentralized, transparent, and immutable ledger capabilities, presents a promising solution. It offers a way to streamline the exchange and verification of legislative documents while maintaining the independence and integrity required by the separation of powers doctrine. Blockchain could potentially enhance the efficiency of legislative processes, fostering quicker legislative responses and more robust governance while firmly upholding the rule of law and the essential democratic principle of distributed governmental power. Democratic participation, another important democratic principle, is essential for the legitimacy and accountability of governance, and its

[5] https://wiki.iota.org/identity.rs/welcome/

functionality ensures the effective operation of democratic systems. It encompasses the mechanisms through which citizens engage in the political process, influence decision-making, and hold public officials accountable. This principle is strongly linked to transparency, which ensures that governmental actions and decisions are conducted in an open manner, allowing citizens to be informed and actively participate in public affairs. In Italy, the principles of transparency and the right to participate in the democratic process are enshrined in law No. 241 of 1990 , which regulates administrative procedures and the right of access to administrative documents. Granting citizens access to administrative documents, the law facilitates informed public participation in governmental processes and decision making. It is also reinforced by the FOIA (d.lgs. 33/2013) that introduces the right to access to the data and information of public administration without a legitimate interest. Democratic participation empowers citizens to influence and oversee governmental actions, reinforcing the system's accountability and legitimacy. Judicial justice ensures laws are applied fairly and protects individual rights, upholding the rule of law and preventing arbitrary governance. This balance is fundamental to the functioning of democratic societies.

2.2. xLegs System

The current state of the art in Italy is linked to the xLeges project [4], an innovative initiative under the auspices of the Italian government's Normattiva program. This project, launched with the objective of addressing and mitigating inefficiencies inherent in the legislative process, utilized a sophisticated peer-to-peer (P2P) architecture specifically designed for the electronic transmission of legislative documents. The xLeges project, operational since 2014, embraced principles of decentralization and inviolability, leveraging Certified Email (Posta Elettronica Certificata - PEC) and ensuring traceability through the implementation of Uniform Resource Names (URN). Despite not incorporating blockchain technology, the xLeges project mirrored several decentralizing functions that blockchain could potentially enhance, offering a robust foundational model for future innovations. The xLeges project distinguished itself by integrating URN and XML standards. This was mandated by the Autorità per l'Informatica nella Pubblica Amministrazione (AIPA) circulars no. 35/2001 and no. 40/2002, along with their subsequent extensions. The report defines that the study phase of these development options will conclude by December 31, 2024, after which the project's future will be determined based on the involvement of relevant institutional actors. The xLeges system represents a new approach to the digital management of legislative documents in Italy. Although it does not integrate blockchain, it provides an interesting precursor to its application in regulatory use. It functions as a peer-to-peer network that enables the secure transmission of legislative documents between government institutions. Unlike blockchain-based systems, the xLeges technology, already implemented, relies on Certified Electronic Mail (PEC) for the exchange and validation of documents, while using Uniform Resource Names (URNs) for document identification and traceability. The system operates through a network of independent nodes within each participating institution, maintaining institutional autonomy while facilitating the necessary coordination through standardized document formats and communication protocols.

3. Decentralized legislative process

As previously stated, one of the most significant challenges within the existing legislative framework is the absence of a unified document repository, due to regulatory requirements and the legal structure, which exacerbates inefficiencies in document exchange processes. This lack of a centralized repository promotes redundant procedures, increases the risk of delays in legislative workflows, and necessitates manual reconciliation of documents across disparate platforms. The manual reconciliation process is not only cumbersome but also prone to errors, further complicating the legislative process. Furthermore, the fragmented nature of the current system makes it difficult to trace the progression and historical trajectory of legislative measures. This lack of traceability undermines transparency and poses significant challenges in the review and analytical examination of legislative evolution. The ability to accurately track and analyze the legislative process is crucial for ensuring accountability, transparency,

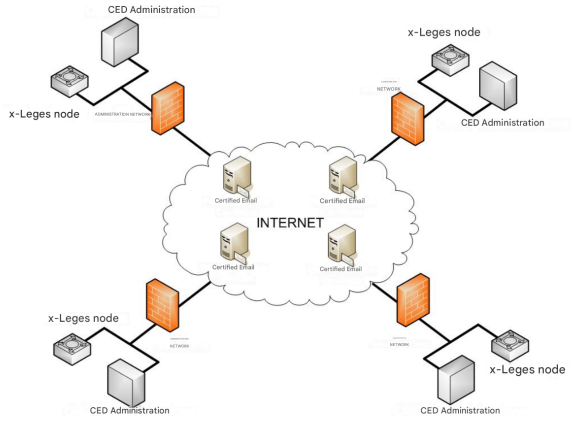

Figure 1: The xLeges system: a peer-to-peer distributed architecture connecting Italy's key legislative institutions (Senate, Chamber of Deputies, Prime Minister's Office, and Ministry of Justice) through secure certified email (PEC) transmission over the Internet. Each institution maintains its independent x-Leges node whilst communicating legislative documents and metadata through encrypted channels, ensuring institutional autonomy whilst enabling seamless document exchange and legislative process tracking across the entire parliamentary workflow.

and informed decision making within the legislative framework. Additionally, the current infrastructure presents significant challenges in terms of accessibility and transparency of regulatory information. An attempt to resolve this issue was made by Normattiva, which proposed and subsequently provided a system to identify the legislation in force as of a user-defined date and to uniquely identify each version. For both institutional operators and citizens, accessing regulatory information remains a daunting task, complicating engagement and transparency. The difficulty in accessing this information limits the ability of stakeholders to participate effectively in the legislative process, undermining the democratic principles of inclusivity and transparency.

4. Interoperability and Authonomy

The infrastructure often leads to the creation of isolated data silos, which impedes effective communication between systems. These silos result in critical information oversight or significant data loss, further complicating the legislative process. The lack of interoperability between different systems presents substantial risks to the continuity and consistency of legislative activities and records, highlighting the necessity for integrated solutions that can bridge these gaps and enhance the overall efficiency and transparency of the legislative process. The Interoperability Act of the EU [6] now requires assessing the level of interoperability within the public administrations to reduce the burden and improve services. In the case of the legislative process, also necessary to improve democracy.

5. Benefits of the Multi-level DLT Approach

The incorporation of blockchain technology into legislative systems has the potential to significantly enhance the interoperability, security, and traceability of legislative documents. Due to its foundational characteristics—immutability, transparency, and decentralization—blockchain provides a secure and verifiable framework for managing legislative amendments. Each modification to a document is permanently recorded, thus reducing risks of tampering and fostering institutional trust through a transparent legislative record accessible to both policymakers and the public. Integrating blockchain with established legislative standards such as Akoma Ntoso (AKN-URI and AKN-XML) improves document structure, authenticity and machine readability. This synergy enhances document provenance and data

[6] http://data.europa.eu/eli/reg/2024/903/oj

integrity whilst streamlining information flow between institutions and reducing transmission latency. This combined architecture ensures a consistent and standardized representation of legal texts, essential for modern legislative governance. Blockchain contributes to legislative transparency by enabling full traceability of document changes. Every revision is visible and verifiable, safeguarding the integrity of laws and amendments. This visibility supports democratic accountability and provides a foundation for more efficient oversight and judicial interpretation, while simultaneously reducing administrative complexity. Moreover, blockchain facilitates greater interoperability in legislative environments. The creation of a decentralized yet unified document repository it simplifies the exchange and management of legal texts across various institutional bodies. Such a system reduces redundancy, accelerates workflows, and mitigates risks related to procedural delays, thereby enhancing overall legislative efficiency and resilience [5].

6. Challenges of the Multi-level DLT Approach

Despite its advantages, the adoption of blockchain in legislative systems presents notable challenges. Technological frameworks must uphold national sovereignty, particularly regarding the confidentiality and control of sensitive legal data. Permissioned or private blockchains are necessary to ensure secure access management and prevent unauthorized external exposure, aligning the technology with institutional legal requirements and constitutional protections. Additionally, avoiding technological lock-in is essential. Legislative institutions must retain the ability to migrate between platforms and providers without compromising operational continuity. The adoption of open standards and modular architectures ensures system portability, supports long-term technological independence, and prevents dependency on proprietary infrastructures that may limit institutional autonomy. Furthermore, the lack of user interfaces in DLT domain make these solutions a niche for technical experts, with an ineffective user experience (UX), especially if it should be applied to institutions and the legal domain. Finally, blockchain implementations must respect the constitutional separation of powers. Legislative bodies, such as the Italian Chamber and Senate, must retain exclusive control over their systems in accordance with Article 64 of the Italian Constitution. Ensuring this autonomy requires that blockchain platforms be specifically designed for secure, flexible, and legally coherent use within sovereign legislative frameworks, preserving institutional independence and legislative authority. It is not easy to maintain control of these requirements in the DLT domain, which was designed to disintermediate the centrality of the powers [6].

7. Multi-level DLT Functionalities

Multi-level interoperability is essential for the effective integration of blockchain technology into public administration. It enables controlled data exchange between distinct blockchains, such as those used by different legislative bodies or committees, promoting cooperation while maintaining necessary information boundaries. This system permits selective visibility. It ensures that sensitive processes, such as those protected under Article 82 of the Italian Constitution, remain confidential. Meanwhile, public acts retain the necessary transparency and immutability. Hierarchical scalability further improves the applicability of blockchain in legislative contexts by organizing information across multiple blockchain layers based on its formality and institutional relevance. The main blockchain records formal legislative acts, while secondary chains handle informal proceedings like discussions and amendments. This structure improves efficiency, reduces system congestion, and optimizes resource allocation. In addition to performance gains, this model bolsters data security. By relegating non-critical or evolving information to lower tiers, the risk of compromising official records is diminished. This layered architecture thus aligns with cybersecurity best practices, preserving both the integrity and confidentiality of legislative data. The Akoma Ntoso standard [7] reinforces this model by distinguishing legislative texts from their annotations. It promotes semantic clarity by maintaining a separation between legal content and interpretive metadata, thereby ensuring that opinions or analyses do not

interfere with the authoritative legal corpus. This differentiation is crucial for upholding the separation of powers, as it preserves the neutrality of legislative texts. Annotations, often influenced by subjective perspectives, are kept distinct from the core legal content, safeguarding the impartiality of the legislative process. By integrating hierarchical blockchain architecture with Akoma Ntoso's document structuring, the system fosters transparency, legal traceability, and inter-institutional collaboration. It ensures that each type of legislative input—whether official or interpretive—is appropriately recorded and governed, maintaining both procedural integrity and democratic accountability.

8. Multi-level DLT Specifications

8.1. The three levels of DLT

1. Each legislative institution (e.g., parliamentary committees, ministries, legislative offices) operates on its own permissioned blockchain - Private Institutional Blockchains (Level 1) with the following characteristics:
    a) Governance: Proof of Authority with validator nodes managed by the institution itself.
    b) Content: Working documents, draft bills, introductory reports, agendas, amendments, confidential minutes. Possibly in AKN-XML.
    c) Access: Restricted to authorized institutional members.
    d) Function: To support internal deliberative processes and procedures using smart contract while maintaining confidentiality.

    This structure is designed to preserve the deliberative autonomy of parliamentary committees. As articulated: "Committees require a confidential space for preliminary discussions, where even controversial proposals can be debated before reaching a mature stage suitable for public discussion."

2. Inter-Institutional Coordination Blockchain (Level 2) that implement the shared blockchain between institutions to handle the official transmission of documents:
    a) Governance: Federated permissioned model with validator nodes distributed among participating institutions.
    b) Content: Official documents exchanged between institutions, including metadata regarding the legislative process.
    c) Access: Restricted to institutions involved in the legislative process.
    d) Function: To formally trace inter-institutional exchanges (e.g., from the Chamber of Deputies to the Senate).

    This intermediate blockchain is essential for replicating the formal institutional steps of the Italian legislative process. Each transfer between the Chamber and Senate, assignment to a committee, or transmission to the Government is recorded here, thereby creating an immutable ledger of institutional transactions.

3. Public Legislative Blockchain (Level 3) that is a public DLT and implement the final repository of legislative acts for publicity requirement:
    a) Governance: Public-permissioned with institutional validator nodes and public read-only access
    b) Content: Official and final versions of legislative documents
    c) Access: Public for reading; restricted for writing to authorized institutions (potentially automated at the moment of promulgation)
    d) Function: To ensure transparency and public access to definitive legislative acts

This public blockchain embodies the constitutionally guaranteed principle of transparency in legislative acts. Only documents ready for official publication are included, potentially making this blockchain the digital equivalent of the Gazzetta Ufficiale.

8.2. Selective Disclosure Mechanisms

The architecture's core lies in mechanisms for selective data transfer across blockchains because not all the information is sharable between all the partners:

Cross-Chain Notarization When a document moves from one blockchain to another:

1. The full hash of the original document is always transferred (ensuring verifiability)
2. Only sections designated for disclosure are transferred in full
3. Smart contracts validate compliance prior to transfer

This method balances verifiability with confidentiality, ensuring that even if the full content remains private, the document's existence and integrity are publicly verifiable.

Hash-Based Reference Each document on the public blockchain includes references to the hashes of source documents from private blockchains, thereby creating a verifiable provenance chain while preserving necessary confidentiality.

Zero-Knowledge Verification For particularly sensitive verifications, zero-knowledge proofs may be implemented to confirm properties of a document without revealing its content.

8.3. Smart Contracts for the Italian Legislative Process

The architecture implements smart contracts tailored to the specific characteristics of Italy's legislative procedure:

- Legislative Initiative Bill Drafting: Records the origin of the initiative (government, parliamentary, popular) and assigns a unique identifier based on existing conventions (e.g., S.xxx or C.xxx), ensuring continuity with the current system.
- Committee Assignment Bill: manages the assignment of the Bill to the relevant committees, recording both main and consultative assignments. It does not replace manual assignment by the President of the Chamber/Senate, but registers decisions.
- Text Unification of the Bill: crucial for managing the merging of multiple legislative proposals while preserving traceability and handling composite numbering (e.g., S.108-376-B). This contract reflects the complexity of procedures involving unification, as seen in cases like C.4205-4525-4526-4594-4596-4607-4620-4646-B.
- Inter-Chamber Shuttle of the Bill: it manages transfers between the Chamber and the Senate, automatically updating document identifiers according to existing rules (e.g., appending "-B" for the second reading).
- Promulgation of the Act: Handles the transition to the public blockchain after final approval, generating the immutable, public version of the legal act.

8.4. Specific Legislative Use Cases

We can identify several use-cases. Case 1: Bill with Inter-Chamber Shuttle The Italian inter-chamber shuttle is often physically transported via courier through Rome's traffic, or electronically via xLeges when parties have time to input the metadata into the PEC system. With blockchain technology:

- The bill is registered on the originating Chamber's private blockchain.
- Following committee examination, the approved text moves to the coordination blockchain.
- Upon Chamber approval, it is transferred to the Senate (or the opposite if the initiative starts to the Senate).
- If amended, it returns to the originating institution with a versioning naming convention (in Italy the number is integrated with the "-B" suffix).
- Upon final approval, it is added to the public blockchain.

Case 2: Unified Bills Sometimes two or more bills are integrated or unified because they are similar, or they cover the same topic (e.g., health). This procedure is particularly complex, and our architecture offers a significant simplification.

- Multiple proposals are presented in their respective private blockchains.
- The committee decides to unify them.
- Through the unification smart contract, a new document is generated with references to all originals.
- The identifier preserves links to all components (e.g., S.2923-2991-B).
- The process proceeds as a single unified text.

Case 3: Decree-Law

- The government submits the decree on its private blockchain.
- After approval by the Council of Ministers, it is sent to the coordination blockchain.
- Due to urgency, a provisional version may enter the public blockchain immediately.
- Simultaneously, it is transmitted to Parliament for conversion in Act.
- After conversion, the definitive version replaces the provisional one on the public blockchain.

9. Multi-level DLT System Architecture

9.1. Level 1: Institutional Private Blockchain Architecture

This proposal advocates for the implementation of an Institutional Private Blockchain tailored to each legislative institution. Each institution would thus operate its own private, permissioned blockchain, accessible exclusively to authorized individuals—specifically, members of relevant legislative committees.

9.1.1. Off-Chain Interface Layer

Authorized users interact with an off-chain system that serves as an interface to the blockchain. Through this interface, users can view a catalog of existing documents, request access to specific on-chain documents, edit their content, and subsequently save updated versions back onto the blockchain. The communication between the user interface and the blockchain is possible via Programmable Transaction Blocks (PTBs), which are required by the Move language to interact with the smart contracts on the blockchain. Indeed, one of the main advantages of using a blockchain system based on Move, compared to "classic" Solidity smart contracts architectures, is that a PTB is a temporary sequence of operations, orchestrated and executed atomically in a single transaction, which can be built dynamically on the

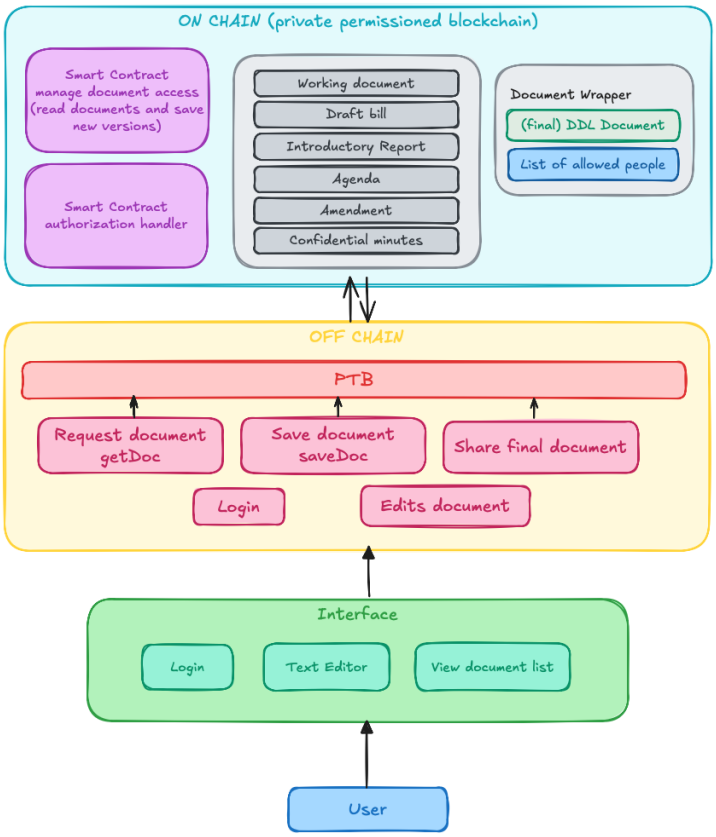

Figure 2: Architecture of the first level of DLT)

client side, without the need to write and deploy a dedicated smart contract. A PTB can also interact with existing smart contracts, enabling the creation of complex orchestrations across multiple modules. Thus, functionally, the use of PTBs allows to build an interface that acts as a document editor, where modifiable legislative documents are managed in accordance with the specifications outlined herein.

Access requests for specific on-chain documents are facilitated by smart contracts implementing a Zero Trust Authority paradigm. This approach employs an authority that scrutinises each user's identity and security posture through a Zero Trust model—one that never assumes trust by default. The framework incorporates a secondary authentication step to guarantee secure and properly validated authorisation procedures.

9.1.2. On-Chain Logic and Document Management

Within each private blockchain, smart contracts govern document-related operations, including the ability to view contents, create new documents, and upload revised versions of existing documents. Version control is achieved by referencing a "parent" document—defined as the prior on-chain version.

Additional smart contracts manage access control, adhering to the AAA security framework (Authentication, Authorization, Accounting) and the Zero Trust model. These contracts verify that the transaction initiator is properly authenticated and authorized to execute specific actions.

Documents stored and versioned on-chain include institutional work documents, legislative drafts, introductory reports, agendas, amendments, and confidential minutes. Among these, legislative proposals (referred to as "DDL Documents") are modeled with embedded metadata such as the source of legislative initiative, unique identifiers, and references to previous versions.

These documents are encapsulated within a Document object, which itself is contained in a DocumentWrapper. This wrapper structure stores both the document and a list of users authorised to interact with it. The MOVE language (in the IOTA framework) ensures that the DocumentWrapper

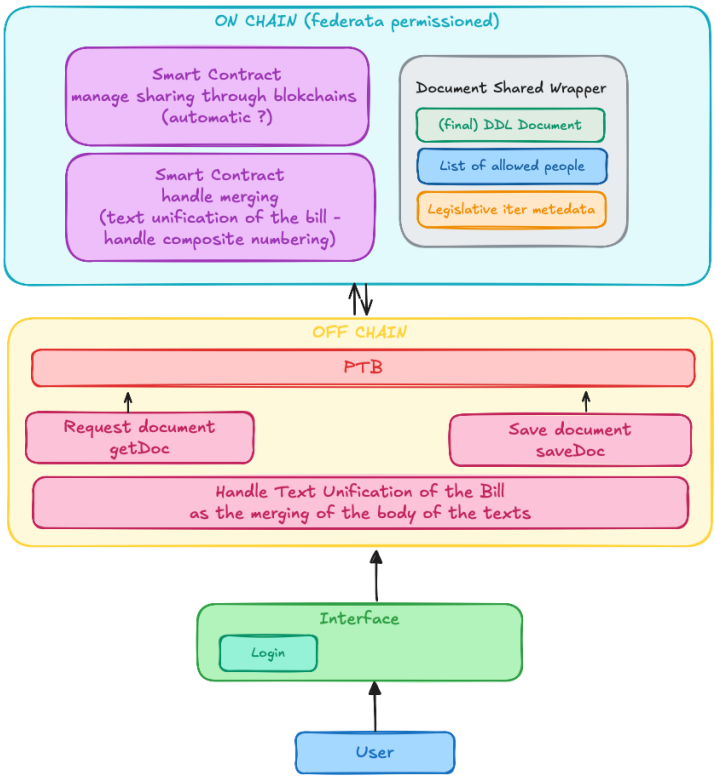

Figure 3: Architecture of the second level of DLT)

abstraction prevents direct access to the document as an independent on-chain object. Access is only possible via the smart contract governing that document, thereby introducing an additional layer of security. Furthermore, the wrapper structure enables a logical association between the list of authorised users and the corresponding document entity.

9.1.3. Identity and Access Control

In terms of authentication, user identity is managed through Decentralized or Self-Sovereign Identity (SSI), implemented via the IOTA Identity framework. The current code structure has been designed to allow for future integration with the Intelligible Decentralized Identity system developed in [8]. Work is also underway to integrate URI-based document referencing in compliance with the Akoma Ntoso standard. The use of Move on IOTA is fundamental in our proposal for enabling safe access control. This smart contract language was designed with security and resource management as core principles, treating data, such as tokens or access rights, as resources that cannot be copied or accidentally lost and ensuring precise control over ownership and access [2].

9.2. Level 2: Inter-Institutional Coordination Blockchain

Once a legislative proposal has completed internal institutional review, it may be transferred to another institution via a second blockchain layer: the Inter-Institutional Coordination Blockchain. This federated, permissioned blockchain facilitates coordination among authorized institutional entities.

Permitted operations in this environment focus on managing and integrating unified legislative texts, particularly when harmonizing multiple draft versions. On-chain smart contracts handle the unification of document identifiers and references, as well as the migration of content across private institutional blockchains.

In this context, the DocumentWrapper is transformed into a DocumentSharedWrapper, which retains the core document and the updated list of authorized users but also includes legislative process metadata.

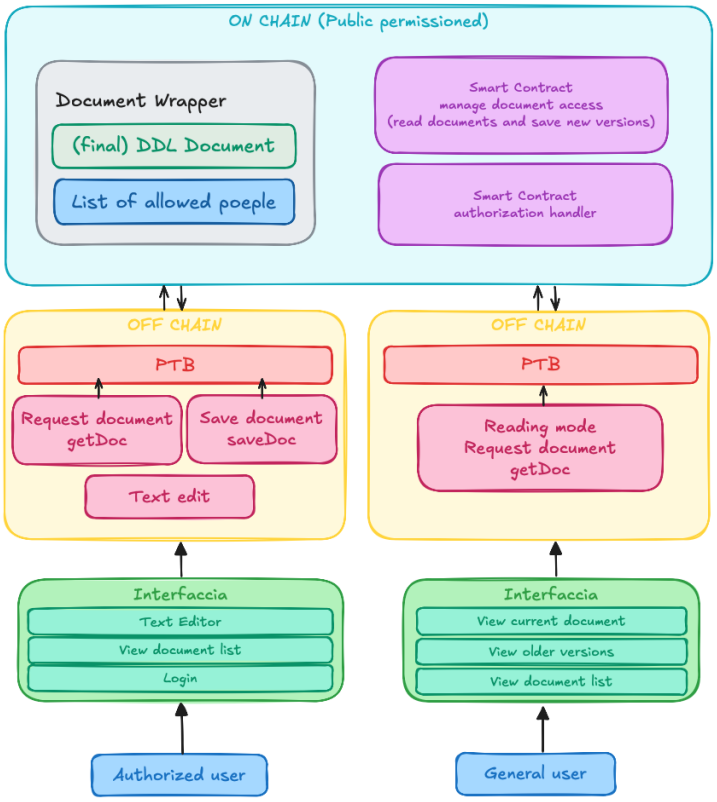

Figure 4: Architecture of the third level of DLT)

This enhanced wrapper ensures an immutable on-chain record of the document's legislative journey.

9.3. Level 3: Public Legislative Blockchain

The third and final layer involves a Public Legislative Blockchain, implemented as a public permissioned network. This system is designed to function analogously to an official government gazette, hosting the authoritative versions of legislative texts.

This blockchain supports two categories of users:

- General users, who lack specific digital identities and are restricted to read-only access.
- Authorized users, who have permission to submit updates by creating new document versions.

The document versioning procedures mirror those of the first institutional layer. As in previous layers, the DocumentWrapper structure is employed to maintain privacy and access control. It continues to serve as the core mechanism for secure, transparent, and traceable document management across the entire legislative system.

10. Conclusions

In this work, we have proposed a multi-level DLT system for managing the legislative process between different undefined institutions, playing different roles, with different levels of confidentiality to share the information, with different rules to apply. Three strong features must be respected:

1. separation of powers;
2. interoperability, transparency, accountability;

3. participation of the citizens.

We have analyzed first the legal requirements, then we have designed the specifications, and finally we have designed and implemented a possible solution. It is a preliminary prototype that needs to be refined, but based on some pillars:

1. Multi-level DLT;
2. Self-sovereignty identity;
3. MOVE language to represent the Smart contract.

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Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

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