

Zero Trust Architecture for Legal Entities

Erwin Nieuwlaar

Distributed Systems EEMCS
Delft University of Technology
nieuwlaar@gmail.com

Abstract—The European Commission is developing a European Digital Identity. The upcoming revised eIDAS will be the legal framework for the forthcoming European Digital Identity. The commercial closed implementation of the EU reference wallet is expected to be delivered only in 2023. In this thesis, an open standard with open-source reference implementation is developed to showcase the impact of the European Digital Identity. We argue that pre-competitive open standard development and reference implementation in an open model will provide superior quality, deliver results faster, and at a lowered cost. Our open standard and open source reference implementation focuses on creating a peer-to-peer Power-of-Attorney protocol while integrating the legal Dutch database Company Register to provide the root of trust. The reference implementation with the Netherlands Vehicle Registry as a verifier demonstrates the potential of the peer-to-peer framework. This thesis achieves a rigorous system change regarding the currently outdated Powers of Attorney by providing a framework that enables portable trust which is cross-border decentralized, can be verified, has revocation, and enables management of legal delegation of authority. Accomplishing a legally binding delegation in a matter of seconds instead of weeks. Our Zero Trust Architecture will change the way we represent and delegate Legal Entities.

Index Terms—Power of Attorney, European Blockchain Services Infrastructure (EBSI), Decentralized Zero Trust Architecture, Self-Sovereign Identity, IPv8, Legal Entities

I. INTRODUCTION

Citizens must be able to comprehend their digital world, select how they want to interact with it, and act autonomously. At the moment, this is not obvious in the digital realm. Although technology is getting simpler to use, it is becoming more difficult to comprehend precisely how it operates and how data, whether personal or not, is used. This may be enhanced by, among other measures, reducing data-collecting. In order to reduce the current data economy, the European Union, and accordingly, the Dutch government is striving to develop an alternative [1]. The Data Act [2] the Data Governance Act [3] the European Commission is pushing a data economy in which users are controlling their data. Reducing the dependence on organizations that do not adhere to European principles. With the European Data Act, the European Union is developing standards for fair access to and use of non-personal data, including the right to access data and the ability to readily transfer data to other parties. The new Data Act addresses genuine rights to access and use data. A new, more privacy-friendly method of processing data, in which people are given actual options, does not spontaneously appear. European citizens will obtain

a digital identity that is widely used so that they may securely identify themselves in the digital world and have more control over their own data - similar to using a passport in the physical world [4]. These means of identification enable us to establish our identity. By using digital identification, we can streamline interactions and save time. Although the EU wants a digital identity, a potential issue of a digital European identity is the adoption, especially in times when trust in the local government is at its lowest level since at least 5 years [5].

Digital identity tools are presently available from a variety of private and public suppliers, for instance enabling consumers to utilize online banking or various public services. There are several levels of security and reliability offered by digital IDs, the most universal European standard is the Level of Assurance provided in the eIDAS regulation [6]. At the moment, large platforms allow their users to login to a variety of online services, like shopping and reading the news, but these logins do not provide consumers with complete choice over the information they submit to identify themselves with online services. These means of identification provided by Big Tech control most of the market share [7] and induce privacy issues [8]. Although the European Commission has not set a strict release date for the new European digital identity, the first toolbox to experiment with implementation should be released by 30 October 2022 [9]. The most innovative aspect of the new regulation with regard to the new European digital passport is that everyone will be entitled to a European Digital Identity Wallet that is recognized by all Member States. However, there will not be any obligation either. The European Digital Identity Wallet will be designed as a Self-Sovereign Identity wallet where users choose to disclose their personal information with online services, enabling people to digitally identify themselves, as well as store and manage identity data and official documents in an electronic format. These may include a driver's license, a prescription, or educational certification. With the wallet, users will be able to access internet services, transfer digital documents, or simply confirm a certain personality trait, such as age, without disclosing their identity or other personal information. While the European Digital Identity will be required to be recognized by public services and some commercial services, its security characteristics entice all private service providers to recognize it for services that demand rigorous authentication, opening up new economic prospects which could lead to a 3 to 13% increase of GDP by

2030 if integrated successfully [10]. Three of such potential economic prospects are the integration of the Company Register from the Netherlands Chamber of Commerce, the Vehicle Registry of the Netherlands Vehicle Authority, and the Netherlands Personal Records Database or a combination thereof. These institutions serve as an anchor for legal certainty for Dutch persons and businesses. In this work, we will provide how these registries can create portable trust for legal entities within a zero-trust architecture. Furthermore, this work implies alignment of notions within Self-Sovereign Identity, eIDAS, and implements a use case in collaboration with the Netherlands Chamber of Commerce, Netherlands Vehicle Authority, and the Personal Records Database where trust is made portable.

II. PROBLEM DESCRIPTION

Presently, legal entity representation is done in various ways but does not adhere to the zero-trust architecture methodology [11], inflicting multiple problems specified further in this paragraph. Subsequently, the representation by a natural person of a legal entity will be described as a type of Power of Attorney. A Power of Attorney (PoA) is a legal document that allows an individual or organization (the "principal") to appoint another person or organization (the "attorney-in-fact") to act on their or the companies' behalf. The attorney-in-fact is granted legal authority to make decisions and take actions on the principal's behalf, as specified in the PoA document. PoAs can be used for a variety of purposes, including financial matters, medical decisions, and legal affairs. The scope of the PoA is determined by the principal and can be as broad or narrow as they choose. In this work, all PoAs are limited to the boundaries of legal entities, and the person who is inherently authorized on behalf of a company (in the Netherlands this is the functionary enlisted in the Business Registry) is described to have full PoA over that company. There exists many similar interpretations of PoAs, e.g. delegation, mandate, authorization, and guardianship [12, 13]. The reason the term PoA is used in this work is because, firstly, delegation is used ambiguously and may not have legal effect [14, 15]. Secondly, mandating has an alternative definition in public law¹ and moreover the responsibility in our system should go with the attorney-in-fact, contrariwise to mandates. Thirdly, authorization is too vague and does not necessarily concern legal binding. Lastly, guardianship involves transferring power away from a person who is unable to make decisions for themselves [16], which is inapplicable in our system. With respect to demand, the Dutch government made eHerkenning mandatory for many entrepreneurs [17, 18] but is seeking alternatives [19], showing an insistence on PoA systems. Regarding accountability, the attorney-in-fact is expected to use due diligence and good judgment in carrying out their duties. If they fail to fulfill their responsibilities or abuse their power, they may be held accountable for their

actions [20] adhering to Zero Trust principles. At present, to transfer PoAs from a principal to an attorney-in-fact, the principal must create a PoA document that specifies the powers being granted and the scope of the attorney-in-fact's authority. The principal must then sign the document in the presence of witnesses or a notary public. The attorney-in-fact must accept the PoA and agree to act on behalf of the principal. Finally, the PoA document may need to be filed with the appropriate authorities to ensure that it is recorded² [23]. Examples of record-keeping are the PoA registry of Logius [24], eHerkenning [25], and the Business Registry of the Netherlands Chambers of Commerce [26]. These PoA registries have several benefits, such as increasing efficiency by including streamlined creation of PoA documents. Secondly, improved accessibility, through facilitating easy access and retrieval of PoA documents. Lastly, reducing the risk of disputes over authenticity or validity as these registers are considered authentic. Conversely, PoA registries come with numerous drawbacks. Namely, no cross-border interoperability, costly, publicly available, security concerns, and complexity. All previously mentioned PoA registries are barely implemented outside the borders of the Netherlands and registration is only available in the Netherlands. Furthermore, the PoA registries maintained by public companies are costly³. Further, the registries maintained by the private sector either do not include a PoA registry for legal entities (Logius' registry) or are publicly available (Business Registry of Netherlands Chamber of Commerce), raising privacy concerns. Additionally, the centralized nature of these registries imposes security vulnerabilities. Finally, the PoA document registration process is a cumbersome process that takes weeks. In this registration process, it is obligatory to be identified by a person or send a copy of your identification by post. Taken together, these drawbacks are responsible for the lack of trust in its portability. In our solution, we argue that we can make trust portable for legal entities by assuming the existence of the coming European Digital Identity and tackling each mentioned drawback by adhering to a decentralized zero trust architecture.

III. SYSTEM ARCHITECTURE

This chapter examines the system architecture of our decentralized peer-to-peer PoA system. The system architecture is intended to be an open standard for European Union member states and the next chapter contains a reference open-source implementation to demonstrate the potential implications of this open standard and the including European Digital Identity.

In Figure 1, a visualization of the open standard system architecture is provided. This system consists of four main

²Within legal entities it is almost never required to make a PoA document publically available [21]. However, exceptions do exist, such as the mandatory UBO registry in the Netherlands [22].

³The yearly price of eHerkenning level 3 (level 3 is required for using the PoA registry) is annually between 41 and 45 euros [27]. Creating or altering a PoA document is approximately 20 euros for each alteration [28].

¹Article 10:10 Awb

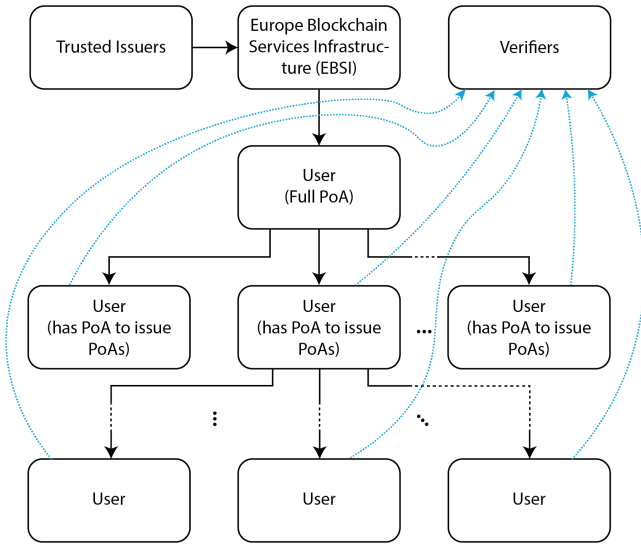


Fig. 1. System Architecture of the Zero Trust open standard for Legal Entities

components: trusted issuers, the European Blockchain Services Infrastructure, users, and verifiers. The trusted issuers are responsible for placing verifiable credentials pertaining legal entities onto the European Blockchain Services Infrastructure. Thereafter, users are able to retrieve their PoA from EBSI, and if they do so directly, the PoA is considered a “full PoA”. Users may also issue PoAs to other users provided their own PoA grants them the authority to do so, indicated by the black arrows. All users have the ability to present their PoA to a verifier, visualized by the blue arrows in Figure 1. The whole chain from a trusted issuer to a verifier is called the zero trust chain, which we will prove as the irrefutable truth in Subsection III-D. Furthermore, all users may serve as a verifier if desired, as it is up to the presenter to accept the verifier. Contrarily, it is up to the verifier to specify their accepted PoA presentations. Each component in the system architecture will be described thoroughly below.

A. Trusted Issuers

In our Zero Trust system architecture, a trusted issuer is responsible for making the link between a natural person’s identity and a legal person, such as a corporation or government agency. Correspondingly, trusted issuers play a critical role by providing the anchor of trust. The connection between an officer and the legal entity at which they operate is in most EU countries recorded at a chamber of commerce, commercial court, or ministry agency, [29] contains a complete list of such registries. These chambers, courts, and agencies are potential trusted issuers. Typically, trusted issuers only have a limited number of officers cataloged in their registry. For our architecture this is not an issue, provided that each legal entity has at least one, which is always the case.

B. European Blockchain Services Infrastructure

The European Blockchain Services Infrastructure is a network of blockchain nodes that aims to provide a secure, reliable, and scalable infrastructure for cross-border public services in all EU Member States, Norway, Liechtenstein, and Ukraine [30, 31]. The EBSI network is based on the Hyperledger Fabric platform and utilizes a permissioned consortium model [32] of which Delft University of Technology will maintain an operational node by the end of 2023. In our system, the EBSI will function as a distributed ledger for the input of trusted issuers. Trusted issuers are ought to register officers of legal entities in the EBSI. These registrations will become available on the EBSI in the W3C verifiable credentials format [33], achievable through the Trusted Issuer Registry API of EBSI [34]. The verifiable credential is a tailor-made credential available in EBSI’s Trusted Schemas Registry [35]. In case a registration of an officer has to be revoked, this is made feasible by the Revocation and Endorsement Registry [36].

C. Users

As a user in our system, you will be required to complete an onboarding process⁴ in pursuance of binding the EU Member States’ Personal Record to the device used by the user. Correspondingly, the process involves identifying with an EU-recognized identification document such as a passport or ID card. The enrolment must meet the “high” Level of Assurance (LoA) proclaimed in the Architecture and Reference Framework⁵ and outlined in the eIDAS regulation [6, 38]. The feasibility is a lively argument with respect to user’s hardware concerns [39], privacy issues [40, 41], cross-border governmental distrust [42], and offline operability [43]. In the provided architecture we assume that personally identifiable data on LoA high is available. Nevertheless, this assumption is not strict, as the Zero Trust Architecture provided can still be operational with an already existing form of electronic identification. However, this will make the system more centralized and dependable on these services, e.g. MyGovID, SPID, FranceConnect and DigiD, altering the decentralized character of this work. Acquiring personally identifiable data on the LoA high in a decentralized manner has not yet been accomplished and is outside the scope of this research. Notwithstanding, the most obvious approach to achieving this is through linking the scanned identity document to the natural person and proving its integrity with biometrics [44, 45]. Once the personally identifiable data is linked to the device of the user, the user can collect their link to a legal entity from the EBSI. Consequently, the user now possesses a digital proof of their identity and a proof of a

⁴Specified as “enrolment” in the eIDAS regulation [37]

⁵The official Architecture and Reference Framework has not been published yet. However, sequential draft versions include the following: *The mechanisms through which the PID is generated and provided to the EUDI Wallet are up to the Member State and are only constrained by legal requirements such as the requirements of LoA high, GDPR or any other national or union law.*

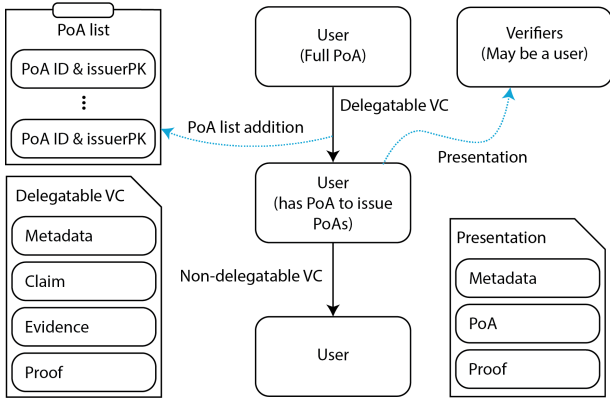


Fig. 2. Components of the Zero Trust Architecture

full PoA of the legal entity they are an officer of. Combined, this empowers the user to act on behalf of the legal entity and the ability to issue PoAs to other users. Subsequently, a complete decentralized hierarchy of rights and obligations can be established, enabling any authorization connected to a legal entity anywhere at any time. While the users are in complete control of their own PoAs and their issued PoAs and are not required to trust one another. The system will contain branches and verifiable chains, which can be revoked or altered. Revocation is achieved by altering the Zero Knowledge PoA list of the corresponding legal entity. Transferring a whole branch of PoAs can be altered by the principal by modifying the PoA list with a signed message. Conclusively, the user will be able to provide a presentation of their PoA which a verifier can trust. Accordingly, enabling the user to irrefutably represent a legal entity where the user sees fit.

D. Verifiers

The presentation presented by a user can be verified by a verifier, and every user within the system can act as a verifier. However, a verifier can also be an entity outside the system which happen to accept presentation from our system. The format of a PoA is as delegatable verifiable credential which is added to the gossiped PoA list upon issuance [46]. The functionality of this list is to enable revocations and alterations of PoAs and its branches. Our Zero Trust Architecture system conjointly adheres to the Zero Knowledge Proof paradigm⁶ [47]. Figure 2 provides more depth to the components within the Zero Trust Architecture.

IV. EVALUATION

In this Chapter, we present the outcomes of implementing the Zero Trust Architecture for Legal Entities on top of Bambacht’s Decentralized Societal Infrastructure [48]. The

⁶The only knowledge an adversary could obtain is the number of given PoAs corresponding to a public key.

Decentralized Societal Infrastructure is a decentralized platform that is designed to provide identity, trust, money, and data services. It is made using the IPv8 protocol, which allows for post-quantum secure data sharing and communication among a network of peers [49]. In order to evaluate the performance and efficacy of this implementation in a real-world situation, we have augmented it with our own work. Our implementation enables us to evaluate the scalability and dependability of our system, in addition to identifying prospective use cases for the Zero Trust Architecture for Legal Entities.

A. European Blockchain Services Infrastructure

B. Trusted Issuer - Netherlands Chamber of Commerce

The implementation allows you to easily and securely verify your identity using your legal documents. Consecutively, the user is able to obtain their power of attorney from the Netherlands Chamber of Commerce. The requirement is that you are registered as an officer at that legal entity. This is achieved through connecting with the HR Dataservice from the Netherlands Chamber of Commerce. To receive a signed XML from which the officers of a legal entity can be deduced. In order to access this data, a fee for start-up costs of 1040 euros and 2.40 euros for each call is required⁷ [50]. In our implementation the user interacts with a pre-production server of the HR Dataservice, switching to production is a matter of paying, adding the keys and adjusting one boolean [51]. Once successful, the user can issue PoAs to other users. Figure 3 visualizes how a root PoA can be obtained and verified by a verifier.

C. User

Figure 4 shows how a PoA is issued to another user.

V. PERFORMANCE ANALYSIS

⁷Expectation is that the price for each call will free of charge in the future.

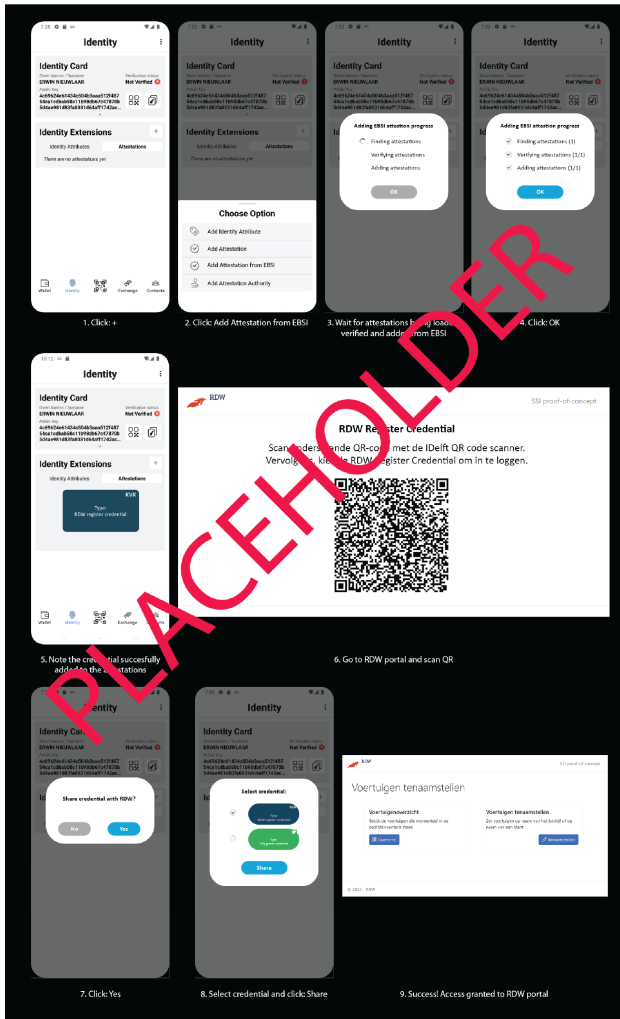


Fig. 3. Flow obtaining a Power of Attorney

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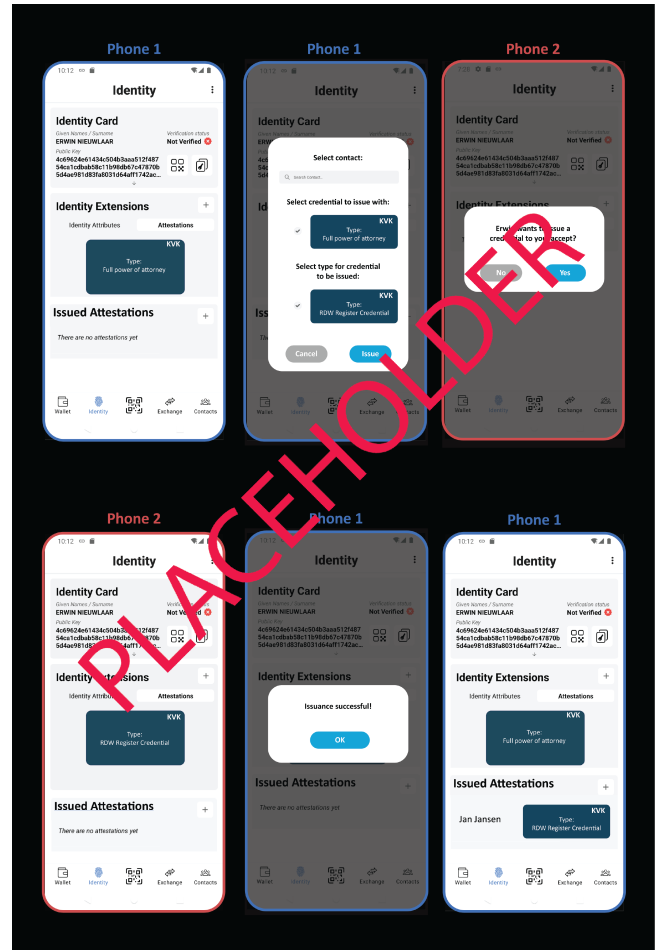


Fig. 4. Issuance of a Power of Attorney

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