Usage of the Baseline pattern

at the European Investment Fund (EIF)

Study by Unibright

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Abstract

The presented study examines the use of concepts and models of the Baseline Protocol in the context of the introduction of an EU-wide Intermediated Financing Platform at the European Investment Fund. The individual basic concepts of the Baseline Protocol are presented and evaluated for their applicability to the given application.
A proof of concept including a sample implementation using Baseledger and the Baseledger Proxy secure the assessments.

The study shows how the transfer of individual, partially uncoordinated process steps into a workflow-based solution brings advantages which are reflected in higher maintainability, easier adjustment of details, greater automation and, last but not least, in the fact that they can be tested more easily in an automated manner.

Potential extensions in the direction of limited or zero knowledge are not explicitly necessary in order to implement the desired use case, but are also discussed as a potential extension of the platform.

Parties clearly benefit from a standardized process that relies on many comparable cases, without being suspected of being a "data collector" in the negative sense of existing centralized platforms: The baseline patterns supports automation, scaling potential and inclusion of 3rd parties, without putting any of the applicant’s information at risk of being exposed to an unintended use.

The authors of the study recommend the introduction of the Baseline Patterns and concepts in the design phase of the EIF Intermediated Financing Platform.

1 Motivation

Unibright conducted an internal workshop with EIF representatives and decision makers in March 2021 and has been commissioned to deliver a feasibility study. The study shall examine the potential to improve service provision to EIF clients and counterparts, including financial Institutions, small and medium sized enterprises (SMEs) and mandators through the usage of Blockchain and notably the Baseline Pattern.

From the perspective of the European Investment Fund, a robust, transparent and fully auditable process with which to support SME access to EIF-channeled financing where appropriate, is the goal. It is expected that costs and technical barriers could be lowered by covering certain approval and servicing aspects of financial products (accreditation, utilization, draw-downs, etc.) in a user-friendly manner, provided that applicable requirements are respected.

From the perspective of the Baseline Protocol Community, the exploration of a use-case in an institutional environment holds great potential for gaining knowledge on a process-specific and technical level. The involvement of regulators and auditors provides a real scenario for Zero Knowledge Proofs (or Limited Knowledge Applications) and, in a prototype implementation, can provide valuable information about how and whether the baseline standard can be applied or, if necessary, expanded.

The particular context of EIF being an EU body, and the proposed usage of decentralized, distributed ledger technology necessitate special requirements from a potential solution, in terms of data privacy, compliance, technical reliability and service quality aspects like cost predictability and performance.

2 Methodology and Structure of the Document

In the context of this study, the exemplary application of an EU-wide Intermediated Financing Platform is considered. This use case is described in detail in chapter 3.

Chapter 4 presents an introduction to the Baseline Protocol and provides some key term definitions of Baseline related concepts and patterns that are evaluated throughout the study.

Chapter 5 presents the Proof-of-Concept implementation of the presented concepts and patterns in the scope of the introduced use-case. It contains details about different process steps, technical setups and communication sequence.

This exemplary implementation of this use case using the baseline pattern is evaluated in Chapter 6 with regard to the concepts presented above and their potential added value.
For this purpose, four evaluation items are implemented, which per process step ...

1. ... provide information on implementation options
2. ... undertake an assessment of the extent to which the use of the respective baseline pattern/concept adds value
3. ... undertake an assessment of the extent to which the use of the respective baseline pattern/concept means additional work
4. ... make a recommendation to what extent the use of the respective baseline pattern/ concept for the process step is necessary, optional or dispensable.

The study closes with a conclusion and recommendation for next steps in Chapter 7.

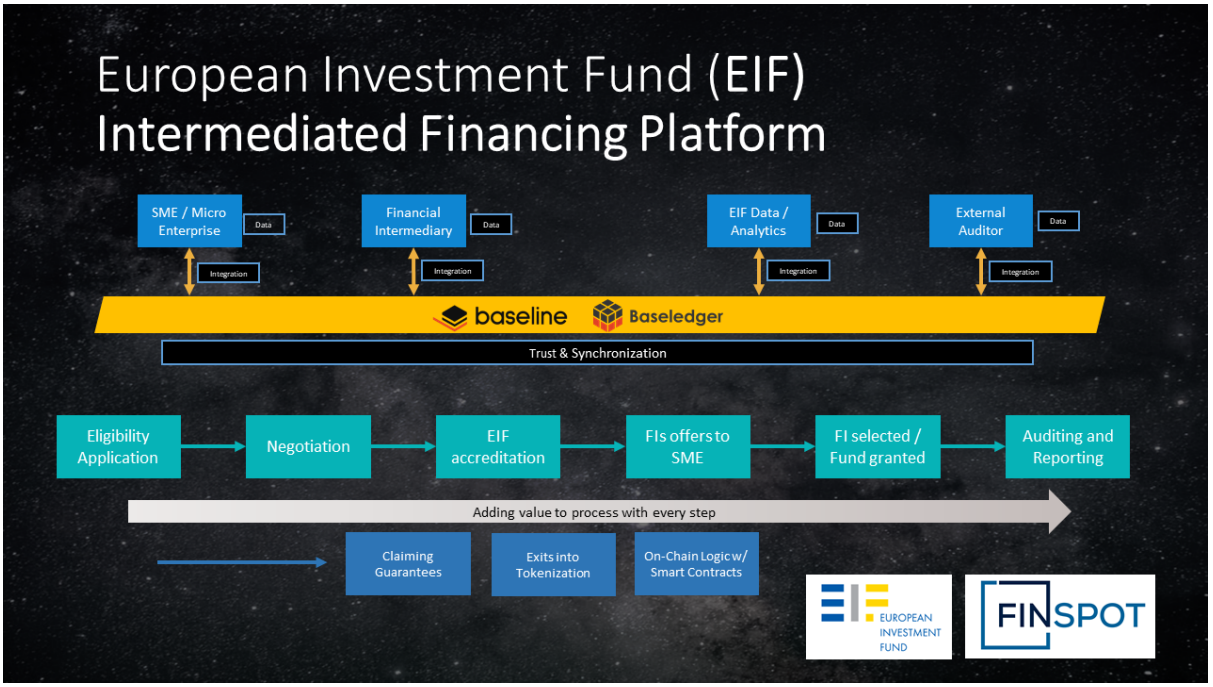
Implementation Details can be found in Chapter 8.

3 Example Use-Case

3.1 General context

The EIF aims to build an EU wide Intermediated Financing Platform, which streamlines the process of application, negotiations, accreditation, offers, grants, auditing and reporting. EIF supports financing for EU-based SMEs through an intermediated model which means, on the lending side of the business, working with banks (and other loan providers) via risk-sharing arrangements, such as guaranteeing newly originated loans to SMEs on a portfolio basis.

In the scope of the presented use-case, Finspot[1] requires access to investment funds from the EU in order to be able to quickly raise money necessary to place the product on the market and scale. Finspot uses the EIF Intermediated Financing Platform and the EIF as an investment fund. Parties involved are not only the SME and the EIF as the platform provider, but also financial intermediaries, EIF internal data analysis departments and external auditors.



Overview of the Platform

[1] Finspot is a fintech company from Belgrade, Serbia focused on solving liquidity issues of SMEs using technology and innovative financial products. One of the products they are working on is a tokenization platform, enabling SMEs to tokenize their assets and offer them to the public, raising capital in a fast and efficient manner.

3.2 Parties involved

SME (=small and medium sized enterprises): the party beginning the process by applying through EIF's portal for accreditation (= acceptance to be covered by an EIF guarantee) to then approach a bank (or several) for a loan

EIF (European Investment Fund): the operator of the "lending portal" enabling SMEs to apply for accreditation and discover the banks in EIF's network for guarantee coverage, and the assessor of meeting the eligibility criteria;

Bank: one of the many lending institutions across the EU with which EIF has entered into portfolio loan guarantee (or other lending risk-sharing) arrangements, and the party to assess the SME loan request from a purely commercial and credit risk perspective. This arrangement is considered to be in place before Baselining.

European Commission (or other mandator):the ultimate source of the budget/funds which EIF manages and "translates" into market-oriented financial instruments; origin of the eligibility criteria, in terms of qualification as SME as well as any thematic/policy-oriented criteria linked to particular sub-budgets; Mandators would be involved in the "guarantee accreditation and loan application" workflow only to the extent that EIF would be applying mandator rules/restrictions to the accreditation eligibility criteria in the first place. There would be no ex-ante approval ("NO" right) by any mandator as this is delegated to EIF, but there could be a challenge ex-post (towards EIF) on SMEs that have been included, in case of non-respect of the eligibility criteria; Mandators ideally would be able to access, or receive reporting on, SMEs covered by accreditation.

ECA (European Court of Auditors): the authority to perform checks on EC budget expenditure and compliance with eligibility provisions and other aspects of EU law;

Regular auditor: typically, one of the "big 4" which performs the annual audit of EIF and includes carrying out sample checks of operations under contracts with financial intermediaries.

3.3 Limitation of Knowledge between parties

The desired added value of the platform consists largely of the inclusion of automation and scaling effects as well as a comprehensible, independently notarized process sequence. In the use case presented, there may be some places where certain data must be masked from third parties, but their existence must be proven without disclosing details about the data itself. These potential additional applications of knowledge limitation are listed separately in the process description.

4 The Baseline Protocol

4.1 About the Baseline Protocol

The Baseline Protocol creates the opportunity for compelling enterprise blockchain solutions by addressing core demands for enterprises looking to use blockchain technology: privacy, permission, and performance. It combines the advantages of public and private blockchains while mitigating their respective drawbacks.

The Baseline Protocol is an approach to using a public blockchain (i.e., a mainnet) as the common frame of reference between disparate distributed systems, including traditional corporate systems of record, databases, state machines or even different blockchains. Baseline is a particularly promising way to reduce capital expenses and other overhead while increasing operational integrity when automating interorganizational business processes and data sharing.
The Baseline Protocol enables confidential and complex collaboration between enterprises without sharing sensitive data on-chain. It enables the execution of workflow business logic under zero-knowledge. It supports tokenization and DeFi while leaving enterprise data safely in traditional systems with zero impact on end users.

Participants in a business process, such as subsidiaries or business partners (like subcontractors) collaborate under various agreements, but may struggle to verify or reconcile those agreements — in other words, to trust that terms and conditions that have already been agreed upon are actually followed. Baseline enables trust among organizations which otherwise have no reason to trust one another by using a public blockchain to store relevant proofs, while leaving sensitive business data off-chain.

4.2 Baseline Concepts, Patterns and Definition of Terms

Within the scope of this study, various key concepts of the Baseline Protocol are examined in more detail below in order to be able to evaluate their suitability and their potential in relation to use cases within the EIF. The specific relevance of the terms presented for the EIF are presented after the definition of the term. The methodology for the evaluation is presented in detail in the next chapter.

4.2.1 Workgroups, Workflows and Worksteps

A *Workgroup* is a set of parties participating in the execution of one or more given workflows. A Workgroup is set up and managed by one party that invites other parties to join as workgroup members.
A *Workflow* is a process made up of a series of worksteps between all or a subset of parties in a given workgroup.
A *Workstep* is characterized by input, the deterministic application of a set of logic rules and data to that input, and the generation of a verifiably deterministic and verifiably correct output.

> *In the context of the EIF, workgroups could be composed of the different parties participating in a process on a digital platform which is operated by EIF. This process could be represented by a workflow and is defined by a series of partial processes, the worksteps. For example, an SME applying for an EIF guarantee accreditation would define a workgroup with the members "SME xyz" and "EIF". The funding application represents the workflow, and the different application steps define the worksteps.*

4.2.2 System of Records and Consensus Controlled State Machines

The integrity of the data in data architecture is established by what can be called the *System of Record (SoR)*. The system of record is the one place where the value of data is definitively established. In the context of Baseline, it is important to understand that each participant in a workflow may most probably operate its own System of Record, independent from the systems of record of other parties.
By usage of the Baseline Protocol, it can be ensured that the respective states (e.g. the current state of a dataset) is synchronized between two systems of records, and that this synchronization is notarized in a *consensus controlled state machine*.

A *Consensus Controlled State Machine (CCSM)* is a network of replicated, shared, and synchronized digital data spread across multiple sites connected by a peer-to-peer and utilizing a consensus algorithm. There is no central administrator or centralized data storage. In the context of Enterprise processes and the Baseline Protocol, the term “blockchain” is often used to represent what is called CCSM here.

> *In the context of EIF, the systems of record used in a workflow could be an ERP system like a SAP system on the side of the EIF and an Excel sheet on the side of the applicant. The application created by the applicant would represent a state that has to be synchronized between these two systems of record. The agreement on the fact that both systems of record hold the same state (meaning they both agreed that they are handling the same application with the same specific values) would be notarized in a CCSM, for example the Baseledger Network.*

4.2.3 Off-chain and On-chain

As part of the standard specification of Baseline, a distinction is made between *off-chain* and *on-chain* process parts. *Off-chain* refers to the parts that can be achieved without a CCSM, e.g. direct (private) message communication between two SoRs. *On-chain* refers to the parts of the process that involve a CCSM, e.g. when it comes to notarizing the agreement with regard to data synchronization on a CCSM. The standard does not determine the extent to which a “baselined” process has to take place on- or off-chain, as long as at least proof of the synchronization that has taken place is anchored on-chain.

> *In the case of EIF, this means that the potential application of the baseline pattern has to implement the connection to a CCSM as an innovation. Off-chain processes, such as sending and receiving an application in the example described, can either be accomplished with (potentially existing) technical means (EDI, manual integration) or, if necessary, build on a service-oriented implementation of commercial providers such as Unibright.*

4.2.4 Privacy, Full-, Limited-, and Zero-Knowledge

A central component of the Baseline Protocol is the preservation of *Privacy* of the data exchanged between the participants of a workflow. In contrast to the widespread understanding of a CCSM or blockchain as a “distributed database” in which private process data is publicly stored (and can be viewed), the Baseline Protocol relies on keeping private

data in the participating system of records private, and only stores evidence of the synchronization in an encrypted way in a CCSM.

The concept of privacy is broken down into 2 basic requirements within Baseline:

1. *"No third party should be able to see which parties are communicating with each other and handling processes."*

This is ensured, among other things, by the fact that the communication between the process participants takes place off-chain on private and secure channels. The data is anchored on the CCSM using hashes, i.e. non-reversible representations of data using character strings without any informational content of their own. This can be done, for example, by using Merkle trees, binary trees in which the content is represented by leaves and the roots of these trees only contain the links between the leaves and nodes below.

2. *"I want to be able to prove something to third parties without having to disclose my complete knowledge of what I want to prove"*

In processes in which only process participants are involved who fully exchange all data between each other, these participants already have full knowledge of this data. However, if third parties come into play who have to verify parts of the data exchange without having to view the entire data exchange, technologies such as “zero knowledge proofs” or other technologies are required. The use of such technologies is also part of the baseline standard.

> *In the case of EIF, applicant and EIF may operate under full knowledge in respect to each other. This, the first concept is an essential prerequisite for automatable, privately secured communication between the participants. The second concept is not mandatory, but may show its effectiveness when it comes to situations, where a third party auditor or mandator wants to verify parts of the process (for example that specific payments have been made) without having to see the full data (for example negotiation of specific terms between the two parties that have no effect to the fulfillment of payments). In that case, the implementation needs to provide tools and mechanisms to enable this concept.*

4.2.5 Layer 1 and Layer 2 (Blockchain) Solutions and Scaling

A Layer 1 network is a blockchain in a decentralized system. Two examples of this are Bitcoin and Ethereum. In Layer 1 scaling, the underlying blockchain protocol is changed to make scalability possible. With these solutions, the protocol's rules are changed to increase the capacity and transaction speed, thus accommodating more data and users.

Layer 2 is the name given to a scaling solution that enables high throughput of transactions whilst fully inheriting the security of the underlying blockchain that it is built on. Blockchains such as Ethereum have grown in popularity over the past several years as they are programable (smart contracts) and censorship resistant, meaning that a wide number of products and use cases can be built on-top of them. The problem with Ethereum is that it can only process 7 to 11 transactions per second, compared to the Visa network of over 20,000 transactions per second. As the blockchain becomes congested, economic actors (users) compete with each other to have their transactions processed in a short space of time. This leads to a bidding war for space in each block and causes the price of transactions to soar. At some points in 2021, costs increased to over $80 to send a token to another address on the Ethereum network.

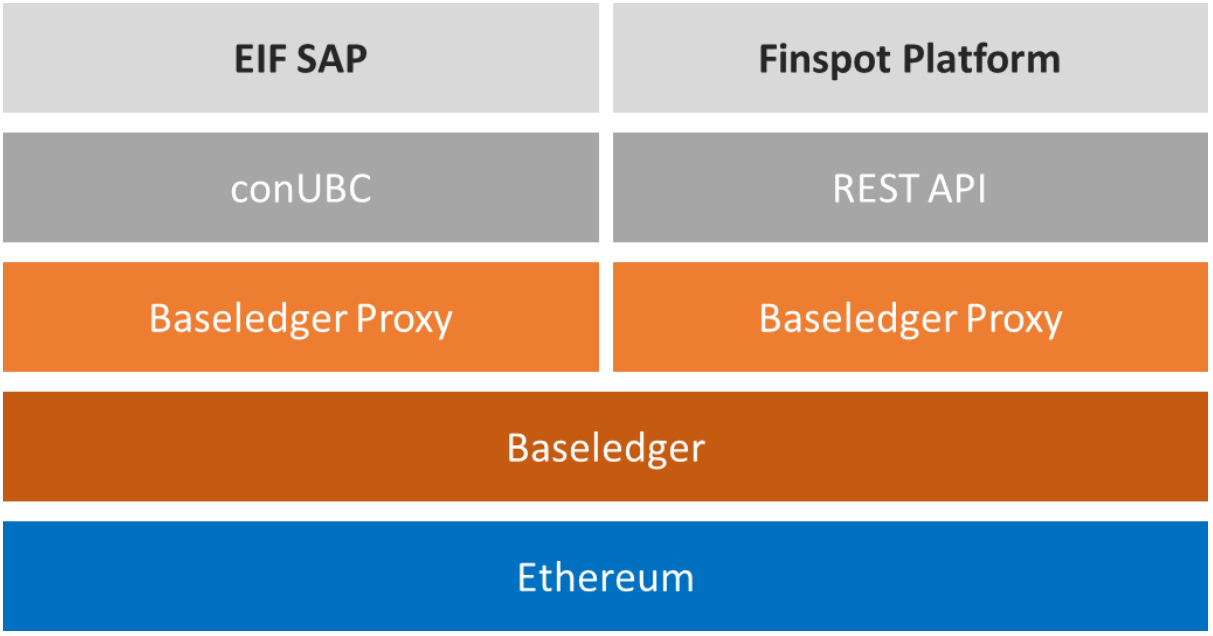
In order to solve the bottleneck problem described above, layer 2 solutions have been launched to take the pressure off Ethereum. Layer 2 solutions enable transactions to be abstracted away from the underlying blockchain, meaning thousands of transactions can be processed per second. The two main forms of layer 2 solutions are zero knowledge rollups and optimistic rollups. Importantly, the property that separates a layer 2 such as DeversiFi, StarkWare, Optimism and Arbitrum from a side-chain such as Polygon, is that layer 2 solutions inherit their security from the Ethereum chain itself, and are not reliant on any other network, validators or entities to secure funds, as is the case with sidechains.

> *In the case of this study and the EIF related Proof of Concept, Baseledger is considered as a L2 solution to Ethereum for baselined processes.*

5 Proof of Concept

5.1 Implementation Tech-Stack

The Proof of Concept implementation uses the following **tech-stack**:



The PoC uses *Baseledger*[2] as the *common frame of reference*. Transactions in Baseledger can be anchored regularly in *Ethereum*. The respective *Systems of Record* of the participants (a *SAP* system representing a standard ERP system of EIF; and the *Finspot Platform* representing a customized system of record) use the *Baseledger Proxy* offering the implementation of Baseline concepts, like workgroup management, messaging and local persistence.

Further details on implementation and technical components used can be found in chapter 8 ("Implementation Details").

[2] docs.baseledger.net

5.2 Process Description

Baselining enables EIF and SME Finspot to set up an integration channel with the goal to reduce costs, to gain efficiency and to speed up the process of application assessment, funds release and monitoring. For the scope of the study, parts of the described process are implemented in a proof-of-concept implementation. This implementation includes the *Workgroup Setup*, the *Baselining* of the application, and the *proof* of an application detail towards an external, third party.

5.2.1 Workgroup and Workflow Setup

3. EIF uses a baseline-stack (open-source or vendor provided) and creates an accreditation workgroup with relevant worksteps representing the application process and regulatory requirements
4. Finspot applies for EIF accreditation via website or some other channel and applies for participating in the accreditation workgroup
5. EIF sends an automated invitation to Finspot to join the accreditation workgroup
6. Finspot uses a baseline stack (open-source or vendor provided) and accepts the invitation
7. Finspot integrates own platform to the selected baseline stack and the workgroup steps as defined by EIF

5.2.2 Baselining of the Accreditation

8. Finspot requests funding amount and describes purpose
9. EIF receives the request, accepts it as a proposal and creates a new document representing the application with status “in review”
10. Finspot receives the new document explaining necessary information and data
11. Finspot sends the necessary information and data
12. EIF receives a completed template (in format pre-defined by the workflow) that can be automatically processed by the system
13. EIF approves the accreditation

5.2.3 Baselining of the Funding Request

14. Finspot selects and approaches banks(s) from within the EIF network for loan requests and invites the bank(s) to join the workgroup

15. Finspot receives positive response from a bank, including a funding offer (the bank can verify loan guarantee accreditation of EIF)
16. EIF receives the status update and Finspot accepts funding terms
17. Finspot receives the request for monitoring
18. Finspot receives the funds
19. EIF receives status update (also ongoing for disbursements/repayments of loan/guarantee calls)

5.2.4 (Proofs to 3rd parties)

The process steps presented (1-19) do not require any knowledge limitation or evidence to third parties. The following cases would be considered as a potential extension:

Eligibility/Policy criteria

The communication between EIF and the SME may include elements that are not intended to be known or discoverable by the bank, and can include for example:

- Split of men/women among employees
- Expenditures on “innovation” or “technology”
- SDG-oriented scoring

Lending criteria

Lending criteria is the commercial basis for accessing the loan and may include sensitive information not intended to be shared with, or discoverable by, the EC, ECA, auditor, or even EIF.

Post Loan Phase

The Baseline pattern workgroups and workflows should also be considered for the post-loan monitoring phase, including recognition/alert for SME loan default, potentially triggering payments due from EIF to bank under EIF guarantee arrangement and shared status of outstanding loan.

5.3 Minimum Data Models, proofs and anchoring

To support the scope of the PoC in regards to the desired synchronization, automation and notarizing, the **minimum data models** of the process can be described as follows. Potential fields under limited knowledge to 3rd parties (as an extension to the Process as described in 5.2.4) are listed separately:

Funding Request

- Mandatory Fields
    - Applicant Tax Identifier
    - Application Outline
    - Requested Amount

Application Document

- Mandatory Fields
    - Applicant Tax Identifier
    - Application Details
    - Requested Amount
    - Application Status
- Fields under limited knowledge towards 3rd parties
    - Split of men/women among employees
    - Expenditures on “innovation” or “technology”
    - SDG-oriented scoring

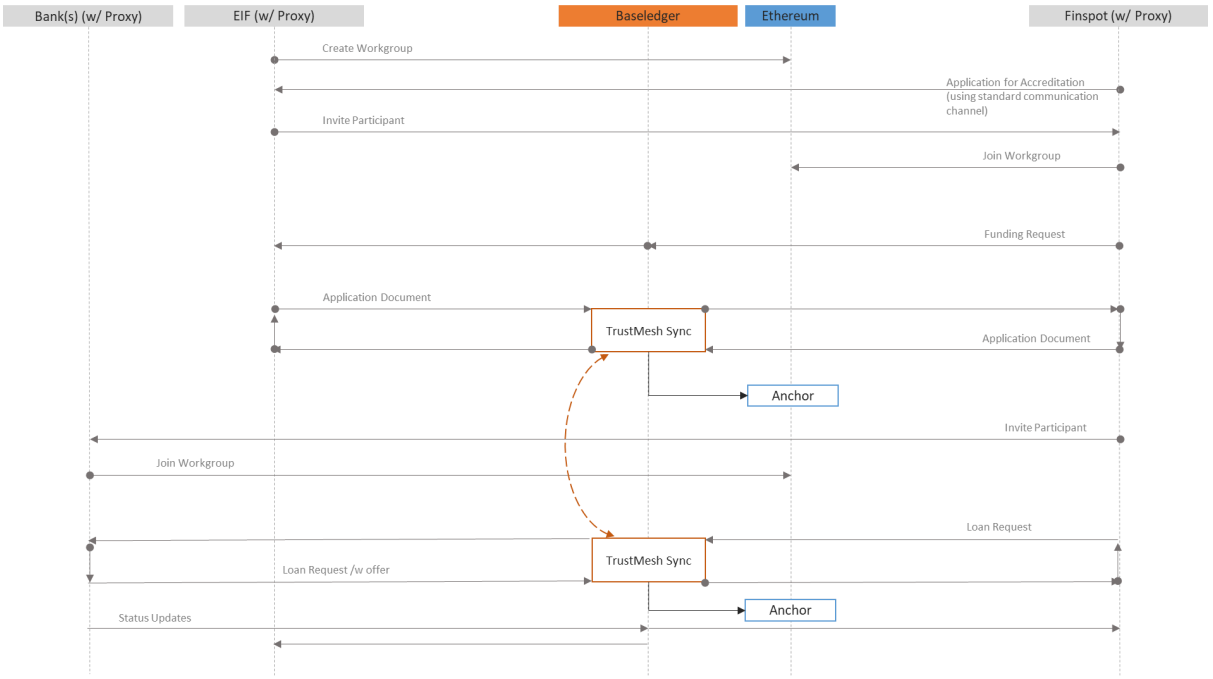
Loan Request w/ Offer

- Mandatory Fields
    - Applicant Tax Identifier
    - Reference to Application Document
    - Requested Amount
    - Request status
- Fields under limited knowledge towards 3rd parties
    - Sensitive information on credit worthiness

The following **proofs** are taking place:

1. Bank proofs existence and status of Application Document
2. EIF proofs existence, reference and request status of Loan Request

All TrustMesh[3] Synchronizations reaching the final state of approval are **anchored** from Baseledger to Ethereum.



Sequence Diagram of the process steps, the occurring (limited knowledge) proofs and anchorings

[3] See Chapter 8 for details

6 Evaluation

6.1 Structure and Semantics

As described in Chapter 2, the exemplary implementation of the presented use case using the baseline pattern is evaluated with regard to the baseline related concepts and their potential added value.

The evaluation follows the structure of the process described in chapter 5.2. and applies the following evaluation semantics:

1. Per process Part, implementation alternatives for the different worksteps are described, and the choice selected implementation alternative is justified.
2. Per process part, the added value of the baseline patterns applied to the different worksteps is evaluated with “high”, “medium” or “low”.
3. Per process part, the additional work caused by the application of baseline patterns to the different worksteps is evaluated with “high”, “medium” or “low”.
4. Per process part, a recommendation is made to what extent the use of the respective baseline pattern/ concept for the worksteps is “mandatory” or “optional”.

The evaluation results are summarized in a table overview and used for a conclusion and recommendation in Chapter 7.

6.2. Evaluation Details

6.2.1 Workgroups

A workgroup solution based on blockchain compatible identities is a prerequisite to the process from a data ownership and data privacy perspective to be “baseline-compliant”: To establish process synchronization based on workflows, means that many the participants have to identify each other and to find each other prior to the exchange of process related data.

Thus, the main decision in the setup phase is how to replace several point-to-point integrations for workgroup participants into a *baseline compliant solution for identity and*

workgroups. This is achieved by the setup of “baseline-stacks”, in case of the PoC by using the Baseledger Proxy. Parts of the functionality of this proxy are the setup and maintenance of workgroups and endpoint-addresses of underlying protocols, the exchange of secured private point-to-point messages, the connection to Baseledger as the layer for storing proofs and providing methods and libraries for proof calculation and verification.

A related decision is to be made concerning the workgroup *persistence*, holding the information on how to interact with other members of the workgroup, which can be on- or off-chain. In the PoC, the Workgroup setup is negotiated under baseline patterns, the workgroup and identity persistence happens off-chain, inside the System of records.

Added Value: “Medium”

It can be discussed, if the added value is to be considered “low” (as an isolated setup of a workgroup concept does not bring any additional value per se) or “high” (as all following steps are dependent on a proper workgroup setup.

Additional Work: “Medium”/ ”Low”

To use the pre-packaged functionality of a solution like the Baseledger Proxy means integration with existing system landscapes. In the case of the PoC this integration was enabled by standards like REST APIs, which still lead to some degree of manual effort. This manual effort may be lowered as soon as Baseline evolves to an industry standard which is integrated by the providers of the system of record “out-of-the-box”.

Recommendation as to necessity: “Mandatory”

The setup of workgroups and with it, the integration through a baseline-as-a-service-stack are essential parts of the Baseline concepts and cannot be omitted.

6.2.2 Workflows

The definition of workflows mainly consists of the definition of worksteps, constraints on dependencies between worksteps and the minimum requirements on the actual data exchanged inside a workstep.

Added Value: “High”

It can be observed in many process automation projects, that already defining, discussing and negotiating details of a workflow as such provides added value. It is the prerequisite for a process to be automatable and scalable.

Additional Work: “Medium” / “High”

In the case of the PoC, the workflow definition inside the system of record of EIF (represented by a SAP system) was established by means of the workflow engine inside conUBC. The SAP related standard data models were also used on the side of the participant with manual integration. This manual effort may be lowered as soon as Baseline evolves to an industry standard which is integrated by the providers of the system of record “out-of-the-box”.

Recommendation as to necessity: “Mandatory”

Workflows are an essential part of the Baseline concepts and cannot be omitted.

6.2.3 Baselining of the Accreditation

The accreditation workflow part includes the participants of EIF and Finspot, who are aligning on the accreditation request and are exchanging needed documents (potentially in different versions). The whole part builds upon the established workgroup setup and working integration of the systems of record into the respective baseline stacks.

From that point on, the process synchronization is based on a standardized pattern. The technological effort is abstracted by means of the Baseline-as-a-service-stack (here: Baseledger Proxy) and connection to Baseledger and Ethereum.

Added Value: “High”

This is a first occurrence in the process, where baselining (the accreditation) adds value not only by means of standardized synchronization and integration, but also in preparing value for the following steps. New parties may be taking part in the workgroup and then can rely on a notarized state synchronization incl. multi-party approvals, without needing to know all details of the synchronized data.

Additional Work: “Low”

In the case of the PoC, all additional effort was linking the process steps inside the systems of record to the predefined worksteps (and the corresponding technical connection points) by using the Baseledger Proxy.

Recommendation as to necessity: “Mandatory”

Baselining the initial part of the process is mandatory to benefit from the added value in later steps.

6.2.4 Baselining of the Funding Request

The funding request includes a new party (the bank) for the first time. The bank has to provide the same effort for an initial connection to a baseline-as-a-service stack and to integrate the system of record. This integration can serve for all future baseline-related cases and only has to happen once.
From a process standpoint, the bank can build upon the preparation of the workflow up to that point, even if the bank was not involved directly in the process before.

Added value: “High”
All point-to-point communications between EIF and a bank, for example to reassure details of the accreditation, are replaced by a standardized process that builds on existing TrustMesh Proofs. The data integrity and privacy from the applicant Finspot towards EIF and the banks is assured, without limiting the potential of the application itself.

Additional Work: “Medium”
To use the pre-packaged functionality of a solution like the Baseledger Proxy means integration with existing system landscapes. In the case of the PoC this integration was enabled by standards like REST APIs, which still lead to some degree of manual effort. This manual effort may be lowered as soon as Baseline evolves to an industry standard which is integrated by the providers of the system of record “out-of-the-box”.

Recommendation as to necessity: “Mandatory”
The added value of baselining the first part of the process directly adds value to this next part of the process. To benefit from all the outlined features, it is mandatory to include that part in the baselining process.

6.2.5 Proofs to 3rd parties

Using core baseline patterns for ZKP/LKP to proof and anchor the approval data on-chain, and involving techniques like TrustMesh, 3rd parties can benefit from the prepared work. For example, the usage of a correct TaxID of the applicant can be verified without the need to reveal any of the application data details.

Added value: “Medium”
A minimum of technical effort leads to high benefits in terms of automation, efficiency and privacy. The inclusion of 3rd parties in the given use-case are only optional.

Additional Work: “Low”

The proofs can be verified independently on the baseline-as-a-service-stacks of the participants or - if needed - onchain.

Recommendation as to necessity: “Optional”

The value of the baselined processes is also high without involving 3rd parties to verify any workstep parts, it just adds to the overall value if it happens.

7 Discussion, Conclusion and Recommendation

Resulting from the evaluation in the former chapter, the following result matrix can be derived.

	Added Value	**Additional Work**	**Necessity**
Workgroups	Medium	Medium / Low	Mandatory
Workflows	High	Medium / High	Mandatory
Baselining of the Accreditation	High	Low	Mandatory
Baselining of the Funding	High	Medium	Mandatory
Proofs to 3rd parties	Medium	Low	Optional

7.1 Discussion

The result matrix shows a clear tendency towards higher additional work in the setup phase. This additional effort has to be evaluated along the existing state of digitalization, automation and integration: As the Intermediated Financing Platform itself is in the design phase, all efforts towards participants integration that have to be done anyway can already be planned and implemented in a baseline compliant manner.

The process of onboarding new potential process participants shifts the needed efforts to the phase where the participants join workgroups. By doing so, the process related and technical specifications have to be defined already in a way enabling baselining.

The workflow setup is the part with the highest additional effort, especially in an environment, where this process hasn't been digitized, automated and standardized before. This also explains the high value, not only for baselining, but for the overall quality of the synchronization and integration process.

The technical requirements to join a baseline process are dependent on the chosen software components that implement the pattern. In the given PoC all integration components were based on technical standards like REST APIs or on proprietary components that have been certified by 3rd parties, like the conUBC.

7.2 Conclusion, Alternatives and Recommendation

The added value of introducing baseline patterns into the EIF Intermediated Financing Platform process clearly shows itself in the later phases of a baselined processes, especially then, when reoccurring coordination takes place. Data Exchange, multi-party-workflows, -synchronization and coordination directly build upon the processes established in the workgroup and workflow setup phase.

The transfer of individual, partially uncoordinated process steps into a workflow-based solution already brings advantages on a purely conceptual level. These are reflected in higher maintainability, easier adjustment of details, greater automation and, last but not least, in the fact that they can be tested more easily in an automated manner.

All these advantages are desired "side effects" of the baseline pattern, which show up as the main effects in the given environment. Potential extensions in the direction of limited or zero knowledge are not explicitly necessary in order to implement the desired use case, but are already prepared by applying the baseline patterns in such a way that they can be implemented with significantly less effort as soon as they are needed.

As the given use-case explicitly references a platform, it can be assumed that many of the processed business cases are very much alike from the prerequisites and expectations. It can also be assumed that EIF as the accreditor and participating banks providing the funding are participants of many comparable business cases, where only the actual applicants change. Both parties clearly benefit from a standardized process that relies on many comparable cases, without being suspected of being a "data collector" in the negative sense of existing centralized platforms: The baseline pattern supports automation, scaling potential and inclusion of 3rd parties, without putting any of the applicant’s information at risk of being exposed to an unintended use.

Theoretically, classic integration solutions and technical point-to-point connections are alternatives to using the baseline pattern. An architecturally correct designed software of the "Intermediated Financing Platform" should be able to separate the data exchange from the display and internal connection.
In this case, however, a replacement for the implicit workflow orientation would have to be found, e.g. by using third-party software, the integration of which means additional effort on the platform side. At the same time, moving away from a standard like Baseline at this point

means that every participant has to manage and implement the workflow logic, including integration, on their own side again.

If the platform idea as such were not pursued further, maintaining the status quo would also be an alternative: Here, all the effort involved in exchanging data and information would continue to consist of the manual coordination of emails, file attachments and manual logs. This means that the use case can basically be offered and supported, but without any integration and standardization, and thus with a lot of manual effort both on the part of the platform and on the part of small and medium-sized companies.

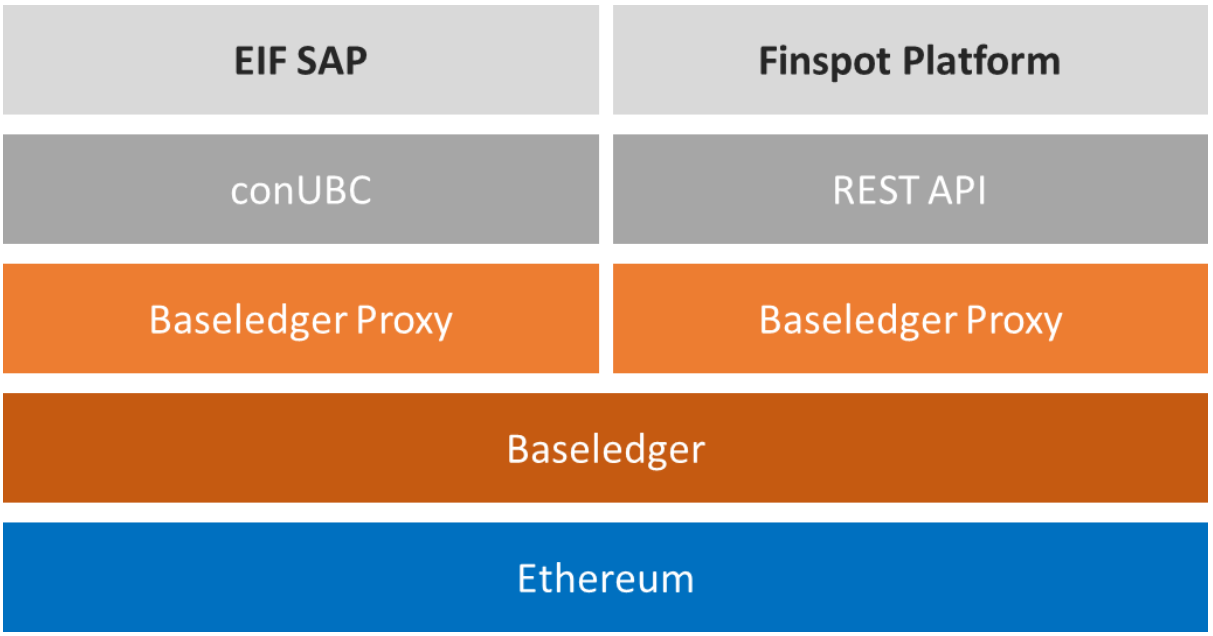
All Baseline implicit advantages presented in the evaluation in terms of synchronization, notarization, integration of third parties in relation to proofs under limited knowledge are inherent features of Baseline, for which there currently exists no integrated alternative solution in the form presented.

The authors of the study recommend the introduction of the Baseline Patterns and concepts in the design phase of the EIF Intermediated Financing Platform.

8 Implementation Details

8.1 Overview

As outlined in chapter 5.1, The Proof of Concept implementation uses the following **tech-stack**:



8.2 Baseledger

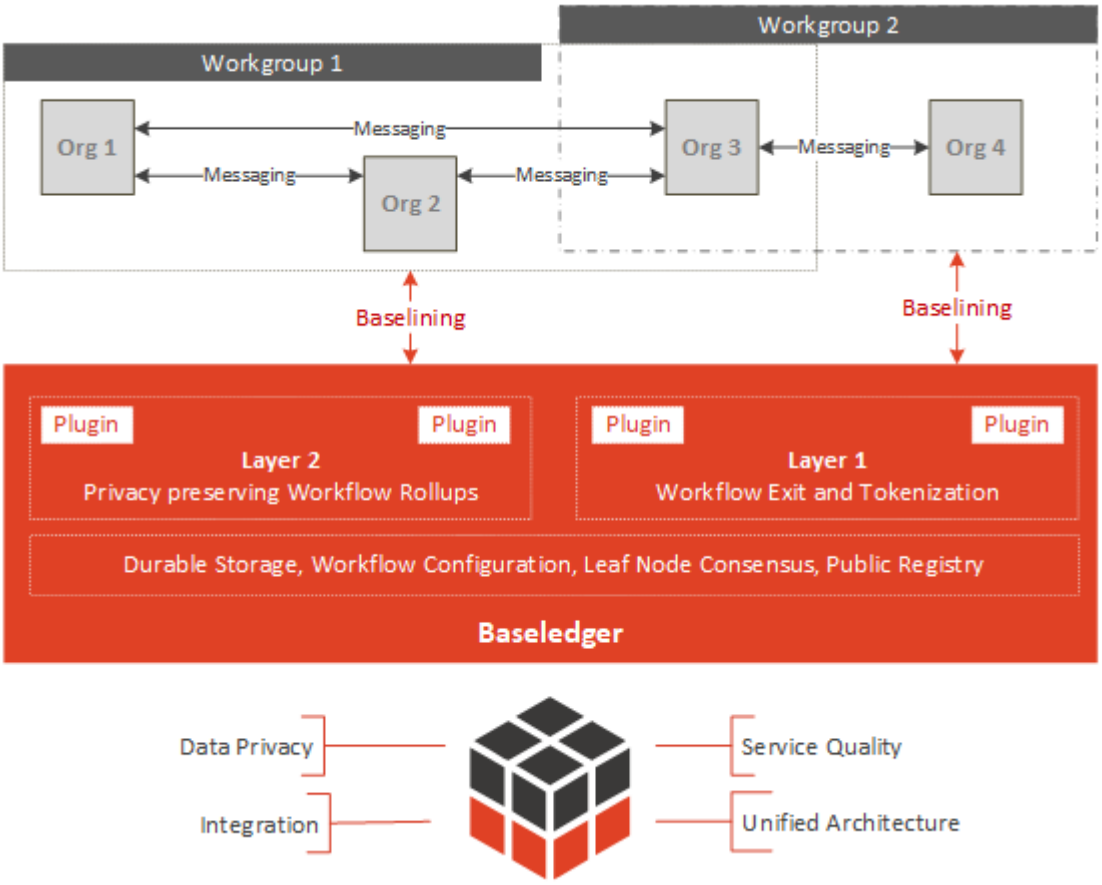
The PoC uses *Baseledger*[4] as the *common frame of reference*.

Baseledger is a public-permissioned, council-governed blockchain network that fulfills the major requirements of enterprise organizations for participating in Baseline-enabled processes: A unified architecture ensuring service quality, data privacy and integration.

Baseledger serves as the underlying ledger for coordinating leaf node consensus, configuration, public DID registries and protocol interoperability enabling workflow exits and tokenization ("Layer 1") and privacy-preserving workflow and workstep rollups under zero-knowledge ("Layer 2"). Baseledger can serve as the basic protocol to serve Layer 2

[4] docs.baseledger.net

functionalities and act as Layer 1 by storing baselined proofs in the Baseledger network: Transactions in Baseledger can be anchored regularly in *Ethereum*.

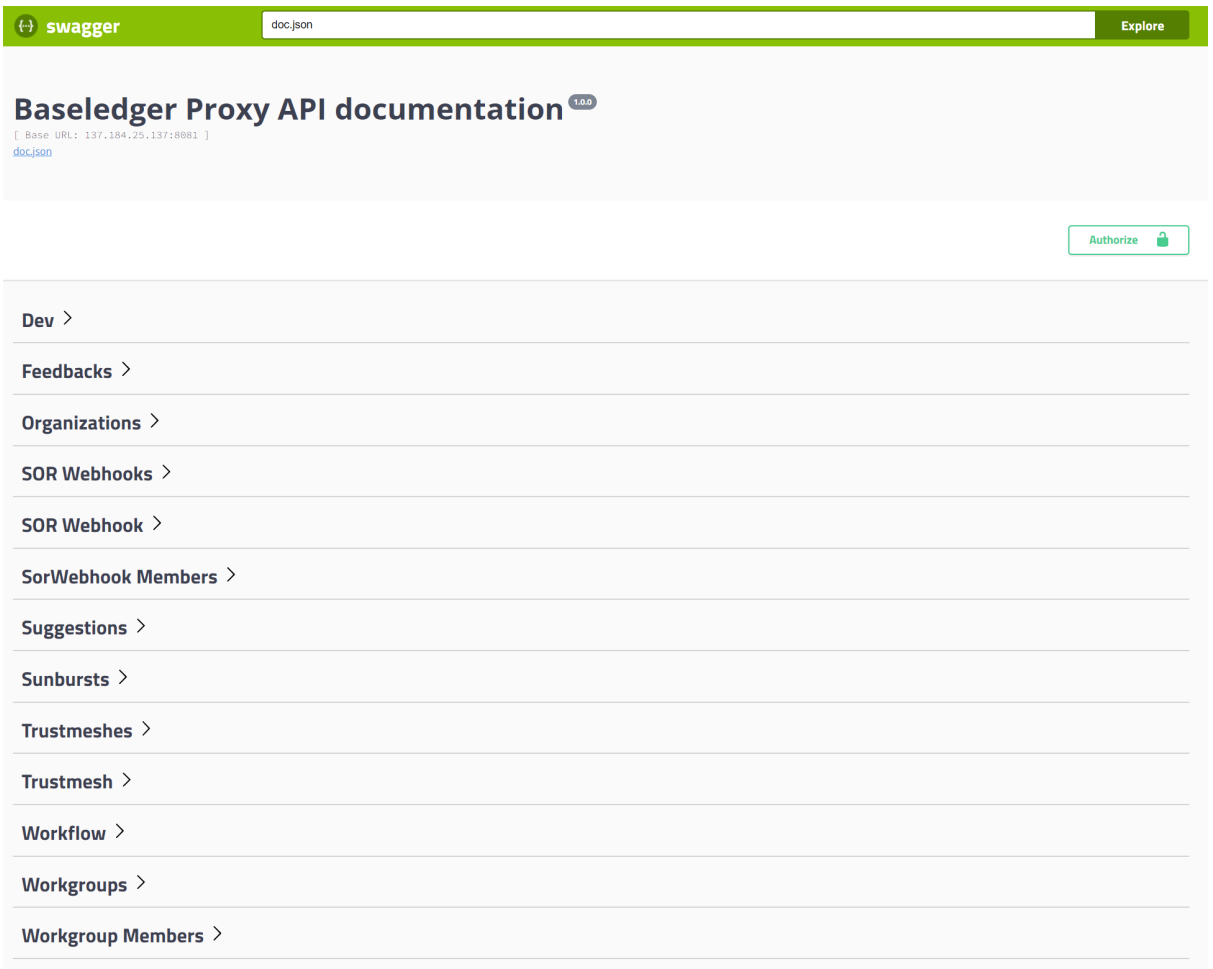


Baseledger Overview

Baseledger itself can serve as the minimum viable protocol to serve Layer 2 functionalities and exit them into Layer 1 by storing baselined proofs in the network. Additionally, Baseledger always works as the underlying Ledger for coordinating any multi-chain setups, e.g., combining Baseledger with Ethereum for DeFi.

8.3 Baseledger Proxy and conUBC

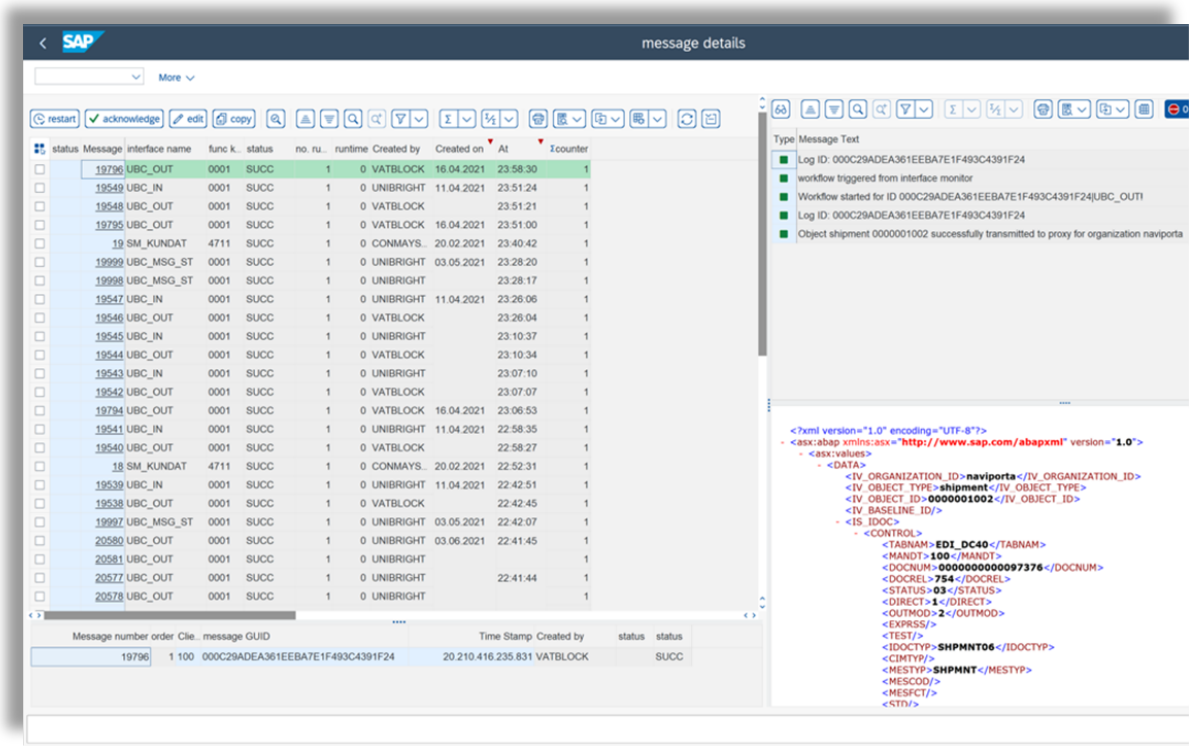
The respective *Systems of Record* of the participants (a *SAP* system representing a standard ERP system of EIF; and the *Finspot Platform* representing a customized system of record) use the *Baseledger Proxy* offering the implementation of Baseline concepts, like workgroup management, messaging and local persistence.



Overview of the Baseledger Proxy API, example: http://bob.lakewood.baseledger.net/swagger/index.html

The connection between the systems of records and the Baseledger Proxy is standardized on SAP side by using the *conUBC*[5] connector, and custom built for the Finspot Platform by using the *REST API* services offered by the Baseledger Proxy.

[5] concircle.com/en/solutions/conubc



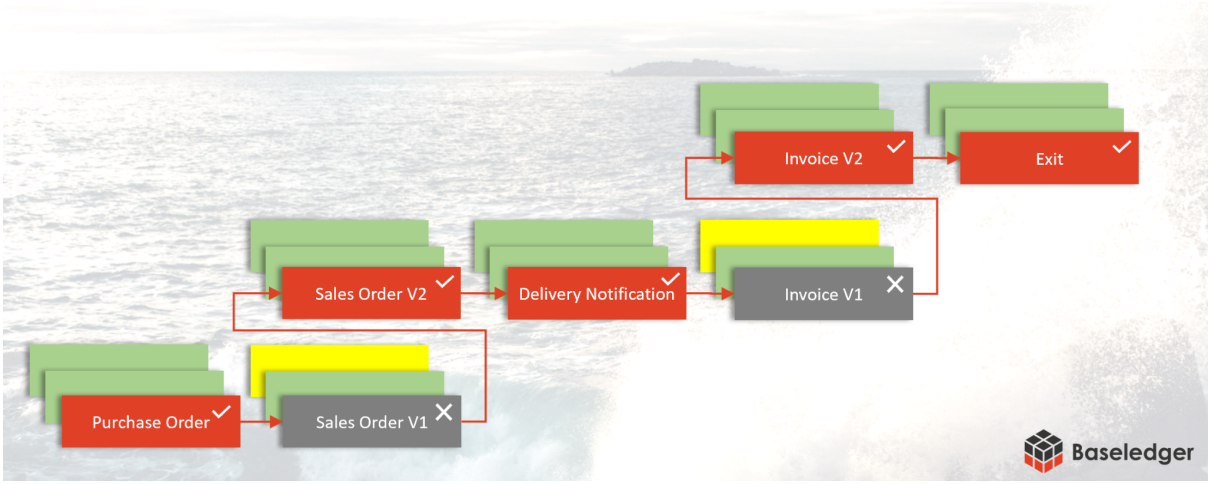
A workflow definition inside SAP using the conUBC workflow engine

Workgroup and identity concepts are considered to be implemented on Ethereum. A detailed implementation of smart contracts on Ethereum to store workgroups and identities are not part of the PoC. The PoC can be extended in that direction.

A standard communication channel (Email / Webforms) to digitally enable pre-baselined communication is considered to be established prior to the process.

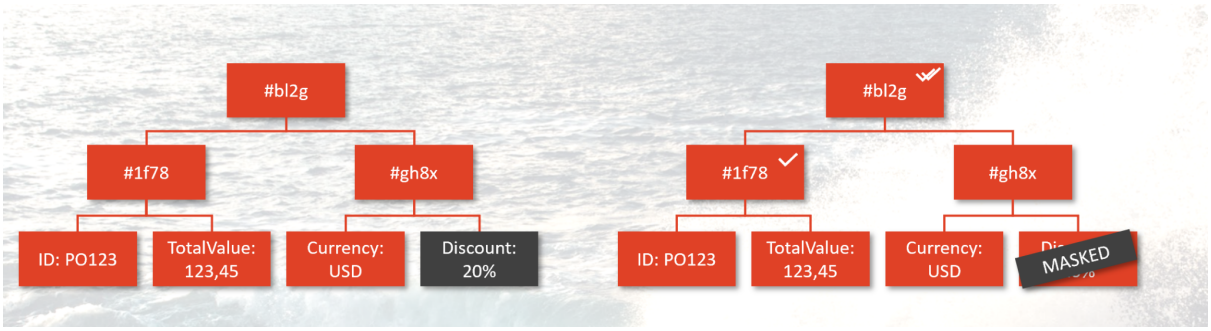
8.4 TrustMesh

The Proof of Concept Implementation uses the **Baseledger TrusthMesh concept for Limited Knowledge**: "TrustMesh" is a concept for versioning of state objects across workflows and worksteps. It has been used in various Proof of Concept implementations during the Testnet operation phase of Baseledger Lakewood.
TrustMesh defines a complete history of requests, multi-party-feedbacks, (new) versions and different worksteps are stored as TrustMesh entries. The TrustMesh defines the complete relation of different worksteps, their versions and approvals of one workflow. TrustMesh holds the references to BusinessObjects in the system of record, to TransactionIDs in the blockchain and to feedback gathered from Business Participants.



A graphical representation of a TrustMesh with different worksteps, versions and multi-party- approvals.

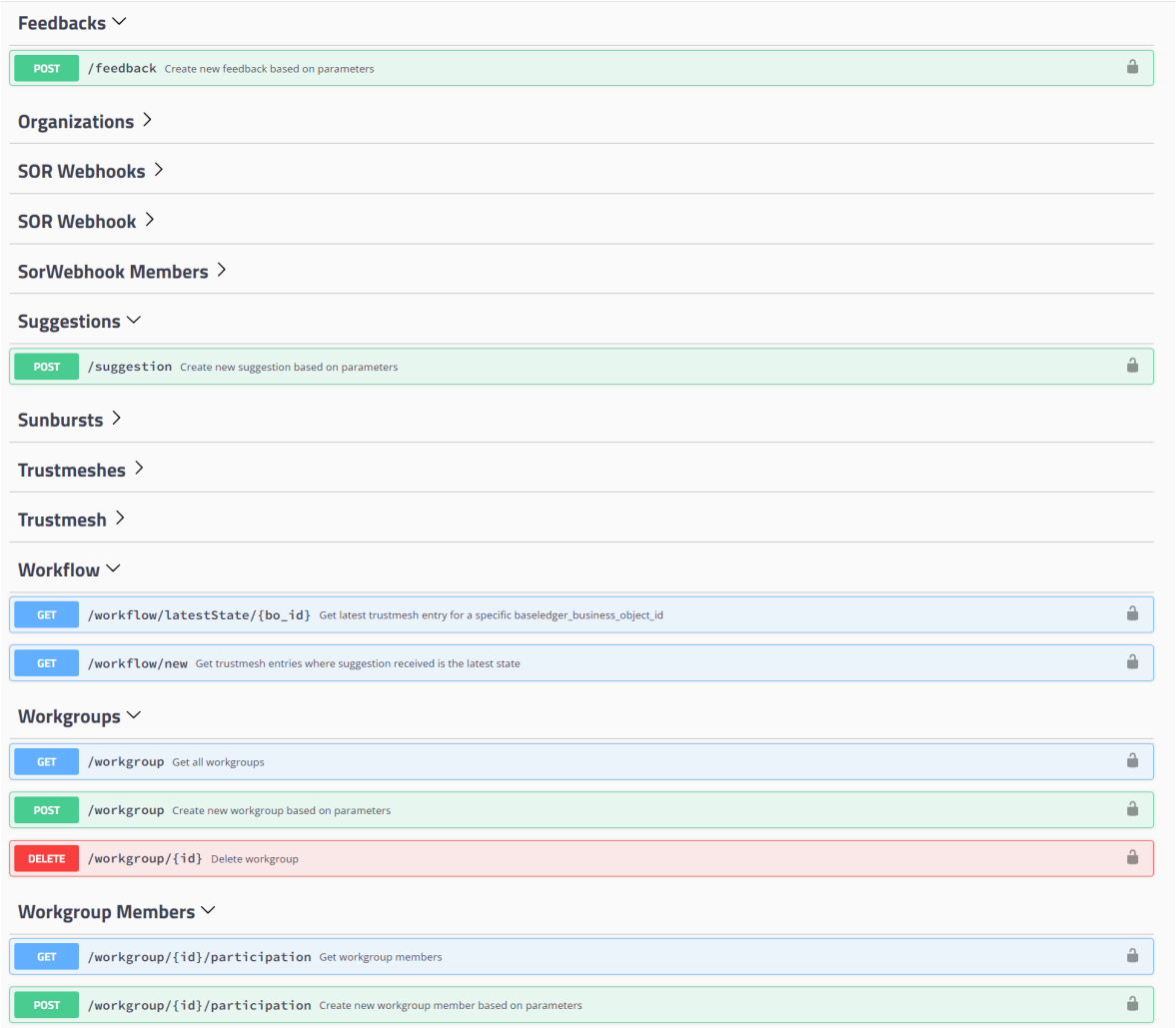
The main underlying data structure of a TrustMesh entry is a **masked merkle tree**. It holds the elements of a (business) objects in the leaves of a merkle tree and calculates intermediate hashes up to the root hash, which is stored in the TrustMesh entry. To proof the consistency of a TrustMesh and its entries, a 3rd party can retrieve a masked merkle tree, with only intermediate hashes and those leafs that are part of limited knowledge. All other leafs are masked, but with the intermediate Hashes, it is possible for a 3rd party to proof the consistency of the overall TrustMesh.



An example of a merkle tree (left), and a masked merkle tree (right) with intermediate hashes.

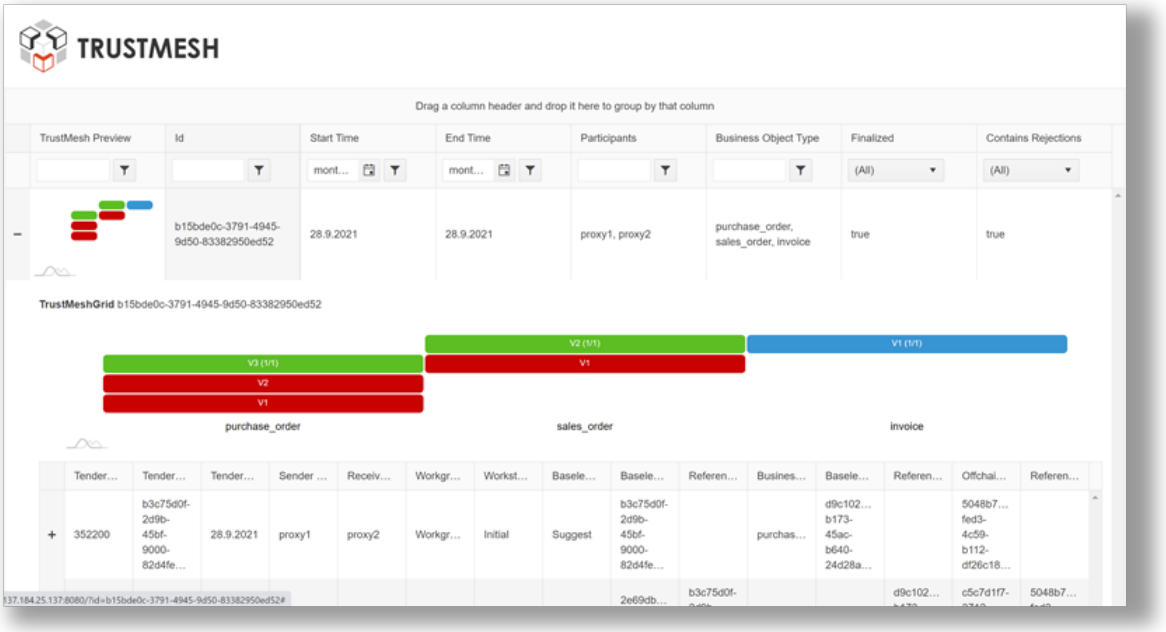
Details on the TrustMesh concept and implementation can be found at https://docs.baseledger.net/baseledger-concepts/trustmesh

The implementation on **BaseledgerProxy** includes methods to create and retrieve TrustMeshes and entries, as well as posting suggestions and multi-party-approvals.



Details of the Baseledger Proxy API, example: http://bob.lakewood.baseledger.net/swagger/index.html

The **visualization** of synchronization processes, independently from the underlying systems of record is also offered by the Baseledger Proxy.



A TrustMesh visualization on one of the participant's Baseledger proxy

9 References

About EIF

The European Investment Fund (EIF) is part of the European Investment Bank group. Its central mission is to support Europe's micro, small and medium-sized businesses (SMEs) by helping them to access finance. EIF designs and develops venture and growth capital, guarantees and microfinance instruments that specifically target this market segment. In this role, EIF fosters EU objectives in support of innovation, research and development, entrepreneurship, growth, and employment.

About Unibright

Unibright is a team of blockchain specialists, architects, developers and consultants with 20+ years of experience in business processes and integration. Unibright offers Consulting with Unibright Solutions, Low-Code-Integration Tools with the Unibright Framework, programmable DeFi with Unibright Freequity, and the Universal Business Token UBT. Unibright is engaged in the Baseline Protocol, offers Baseledger as a solution to orchestrate and trust-enhance B2B processes and offers ERP-Blockchain-integration with Partners like Concircle.

About Finspot

Finspot is a fintech company from Belgrade, Serbia focused on solving liquidity issues of SMEs using technology and innovative financial products. Finspot offers an online platform, based on the enterprise-grade solution, enabling SMEs to either finance their invoices via factoring or tokenize their assets and offer them to the public, raising capital in a fast and efficient manner.

Links to further Material

eif.org
baseline-protocol.org
baseledger.net
unibright.io
finspot.rs

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