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Background Document:

Blockchain Based Ocean Shipping

Introduction of potential use case and proof of concept

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# Introduction

This document describes a SAP Blockchain case for ocean shipping and outlines a potential framework for a proof of concept. The content shall be seen as a basis for further discussions about goals, prerequisites, requirements and to be expected efforts for the execution of a proof of concept (POC) using SAP’s Cloud Platform Blockchain Service and a prototyped blockchain based ocean shipping. Selected POC participants will be required to execute a Collaboration Agreement prior to participating in the POC.

Various parties could be part of one or multiple POCs:

* Container Shipping Liner
* Port and Terminal Operator
* Trucking Service Provider
* Freight Forwarder
* Any Selling / Shipping company – Container shipping preferred for now
* Any Buying company / Consignee – Container shipping preferred for now
* Banks – Letter of Credit and related payments
* Insurance Company
* Various Authorities (customs, any certificate granting authority, …)
* SAP Industries
* SAP Consulting
* External Consulting Company
* Our Partner KOBIL, which provides Document Signing and 2-fact authentication with QR code scan
* Tbc

SAP desires to bring customers together, which fit to each other and agree to go for a joint POC.

At the same time customers are also very welcome to suggest the participation of other partners or clients, which represent one of the before mentioned roles.

# Ocean Shipping – Why Blockchain?

## What is Blockchain?

The main intent of the blockchain technology/protocol is (was) to create a unique digital representation of a value or an asset and to facilitate a tamperproof digital transfer of ownership of such a unique asset. As a by-product blockchain technology allows storing data and documents immutably and all the data is distributed to and accepted by connected nodes/peers using a consensus mechanism.

Definitions:

**Blockchain** is a protocol for **Distributed Ledgers** that enables the Decentralized, Secure, Direct, Digital **transfer of values and assets**.

**Distributed Ledger Technology (DLT)** is another terminology used in the same context which talks about a Consensus based Replication of Data across Multiple nodes.

**A Consensus Algorithm** as part of Blockchain is used to guarantee a Consistent State of the Distributed Ledger of Transactions.

**A Smart Contract** is a special piece of Software Code that is part of the Blockchain that executes to automate a series of Business Rules.

## Relevant challenges in Ocean Shipping

Today a lot of business partners play a role in a single international trade transaction, such as seller (shipper) and buyer (consignee), their banks (export, import, correspondent banks), insurers, freight forwarders, carriers and numerous authorities (customs, taxes, security, etc.) and all do have their own systems with their own truths. Many created peer-to-peer interfaces, many communicate via e-mail – especially when documents are exchanged electronically. In order to "proof the truth" still paper-based original forms with stamps and signatures are exchanged and shipped by means of express courier services. **The handling and shipping of papers imply a significant cost factor.**

In fact, for ocean shipping there are legal requirements or trade regulations (e.g. Hamburg Rules, Hague-Visby Rules, Rotterdam Rules), which request a paper-based Bill-of-Lading. However, discussions about [interpretation of](https://www1.doshisha.ac.jp/~tradelaw/PublishedWorks/BlockchainTechnologyElectronicBL.pdf) [Rotterdam Rules](http://www.uncitral.org/pdf/english/texts/transport/rotterdam_rules/Rotterdam-Rules-E.pdf), the [UNCITRAL Model Law on Electronic Transferable Records](http://www.uncitral.org/pdf/english/texts/electcom/MLETR_ebook.pdf) and the [Trade Facilitation Agreement](https://www.wto.org/english/tratop_e/tradfa_e/tradfa_e.htm) of the WTO show the way towards a paperless ocean shipping process will be made possible.

## Blockchain as perfect fit for an e-Bill of Lading

Looking at only the single aspect of an e-Bill of Lading, blockchain technology is a perfect fit to represent a unique Bill of Lading (today paper-based, stamped and signed) by a digital token as unique asset. A digital transfer of ownership of a e-B/L can be facilitated by blockchain technology in a top secure manner.

There are various key value drivers or decision criteria for going for Blockchain:

* **Multi Party Collaboration** – Many different parties interact with each other’s transactions and depend on each other. Multiple Writers post into the blockchain.
* **Transparency & Auditability** – From a situation dominated by a lack of trust, blockchain provides full transparency. Many systems holding own data can be connected to a blockchain which distributes identical data to everyone.
* **Risk and Fraud Minimization** – Frauds and Stolen Freight at ports can be minimized when using transparent consensus data about ownership and entitled parties or even identities.
* **Time & Cost Reduction** – Avoiding paper-based documents and manually shared data allows significant time and cost reductions for various involved parties.
* **Disintermediation** – Blockchain Technology enables partners to save and intermediate service provider for certain transactions and trusted data provisioning.

# SAP Blockchain based Ocean Shipping

## High Level Story

The main value/asset, which is represented and transferred using blockchain, is the Bill of Lading (B/L) document. But also, many other documents can be uploaded and shared. The story starts with documenting a deal (international trade transaction) between Seller and Buyer and providing the required finance documents, like the commercial invoice and the letter of credit. The shipper involves the ocean carrier, who will then provide the Bill of Lading. An owner of the B/L can transfer the ownership, e.g. to Banks or the Consignee. Export and import customs authorities can access and review documentation and a customs clearance status can be set. At destination, a merchant’s haulage is assumed and a trucking company and its driver can be enrolled and entitled. Port authorities and/or Terminal Operators can do an identity check for the driver against the blockchain upon pick-up from the Port of Discharge.

## Capabilities

For demo and test purposes, a cloud app was developed, which accesses the blockchain via the same interfaces as connected backend systems would do. The following steps can be done as of now:

* The shipper (seller) instantiates a new trade in the blockchain and fetches details from a trade finance blockchain - Business Partners, Documents (Letter of Credit, Commercial Invoice, ...) etc. 🡺 Currently hard coded example needs to be replaced by upload capability.
* The shipper enrolls the ocean liner (carrier) to this new trade and uploads export customs relevant documents and signs it digitally.
* Exports customs authorities check documents and finally set customs clearance status.
* The ocean liner (carrier) (for instance using SAP TM) issues the B/L and posts its details into the blockchain. The corresponding PDF document is uploaded to and is digitally signed. There is a special interface available.
* The current owner of a B/L (e.g. the shipper) transfers ownership of the B/L to another business partner (e.g. Banks or Buyer).
* The Buyer uploads relevant documents for import customs clearance and enrolls the local trucking company, which confirmed the delivery order to pickup the container from the port.
* Import customs authorities check all the documents, could trigger an inspection etc. and finally set customs clearance status.
* The local trucker company enrolls the driver’s identity, which is assigned to the B/Ls container in blockchain too.
* The Driver meets the Port Authorities or Terminal Operator to pickup the container. The representative generates a QR code for the container of concern and the driver scans it with his smartphone, which leads to a 2 factor authentication in combination with a check against the identity assigned in the blockchain. A very secure container release process!
* Banks can follow any time and can check documents and status etc in order to arrange payments according to Letter of Credit terms and conditions.
* Digitally signing PDF documents and Secure QR code based authentication via partner KOBIL.

The demo can be watched on [youtube](https://youtu.be/HB7ABR_i6AU).

## Related use cases and potential extensions

There are some other blockchain use cases, which have an overlap or touchpoints with the ocean shipping case. In Trade Financing the Bill of Lading is one of the required documents to fulfill agreed documentation for a Letter of Credit, but Trade Financing looks at many other important things too. Insurance companies need to verify risk levels and transportation details like carrier or routing or documented details about the freight matters. In Commodity Trading the ownership transfer of a Bill of Lading is one scenario out of many others. In Pharma, Chemical or Food documenting the chain of ownership changes is relevant to prove provenance and ownership trails.

For the future, it will be essential to find solutions how to define such business scenarios into relevant and digestible blockchain cases, which then can be adopted by various players with very different end-to-end scenario needs. And it will also be important to find ways to connect different blockchains, which have an overlap or a connection point.

For the proposed POC there is no intent to work on such related solutions.

There are many ideas how to extent the POC with further feature and functions.

Besides technical features for a generic POC enablement like onboarding and BP network features and further interfaces, it is mainly about features for certain scenarios or process steps. There are ideas to implement an integration to [SAP GTS](https://www.sap.com/products/global-trade-management.html), to [SAP Global Track and Trace](https://www.sap.com/assetdetail/2017/05/06c78e1a-bc7c-0010-82c7-eda71af511fa.html) and to SAP LBN, also to integrate a booking choreography, features for charge agreements and approvals and for further special status proofs like the Proof of Delivery and many more.

For the proposed POC SAP does not commit to develop or extent features and functions upon customer requests. Development decisions will be taken based on SAP’s discretion.

## Components and Architecture



The simplified Architecture View of the POC is represented above.

1. **The Hyperledger Fabric**

As part of the Linux Foundation, the Hyperledger Project aims at creating a DLT and Blockchain Technologies and Frameworks. The most prevalent of them is the [Hyperledger Fabric](https://www.hyperledger.org/projects/fabric) technology that is a DLT and Smart Contract providing engine. The Hyperledger Fabric Blockchain network forms the core of the architecture and is hosted on an AWS Instance. This is a Permissioned Network and hence establishes a Consortium. It hosts a bunch of Nodes that host the Peers which participate in the Blockchain. These Peers at a high level represent Business Partners on the Blockchain Ocean Shipping network and transact business using a Smart Contract or ChainCode as it is known in the Hyperledger Fabric world.

1. **SAP Cloud Platform Blockchain Service**

The SAP Cloud Platform Blockchain Service is part of the SAP Leonardo portfolio of products and services. It is a platform to enable the development of Blockchain applications and to manage the deployment of Blockchain networks. It works on the underlying Hyperledger Fabric network instance. It is available on the SAP Cloud Platform (Cloud Foundry). It is currently in a Pilot phase and no productive usage is supported at this moment.

The Blockchain Ocean Shipping POC uses this service to get access to the underlying Hyperledger Fabric Nodes, Deploy & Test Chaincode, View the Blocks and Transactions that are getting created etc.

For our Customers who intend to work on this POC they will need to have access to an SCP account on which the Blockchain Service will be enabled and then the account shall be provisioned with the artifacts for this POC.

1. **SAP Blockchain Ocean Shipping Components**
   * UI Application

This is a layer built using the SAP UI5 Technology and is available in the form of a browser-based app that can be used by the various personae to interact with the Blockchain by Creating Trades, Adding and Approving Documents, Assigning ownerships etc. It is hosted on the SAP Cloud Platform – the Neo edition.

* + Service Layer

This is a layer built using Java Technology and exposes mid-tier services that interact with the UI and the Blockchain Service. The features of this Service Layer are as below:

* 1. Exposes an External REST based APIs to Post Bill of Lading to the Blockchain and Track the Ownership of the Bill of Lading.
  2. Interacting with the partner Mobile App from KOBIL which will be used to Digitally Sign Bill of Lading documents (other documents as well). These Documents are stored in the SAP Cloud Platform Document Store.
  3. Interacting with the QR Code Mobile App from KOBIL to Securely release Containers.
  + SAP Document Store

In this POC we use the SAP Cloud Platform’s Document Store to store the Bill of Lading documents (other documents as well) to be shared with various users and also to be digitally signed by the partner KOBIL mobile App. The Document references (Document hashes) are stored in the Blockchain whereas the Documents themselves are stored in this secure Document store that is protected with a Technical user access.

* + Smart Contract – Chain Code

This is the special piece of software code written in a specific language called GoLang which is mandated by the Hyperledger Fabric Blockchain to write Smart Contracts which are called Chain Codes. The Chain Code has the constructs to Create Bill of Lading (and other documents), Apply Digital Signature & Approve documents, Assign and ReAssign Ownership of Bill of Lading, Maintain the state and stage of the Trade and Securely Release Container. The Chain Code is deployed on the Blockchain network via the Blockchain service Cockpit and will be propagated to all the nodes on the Blockchain network. It is accessible to the Java Service via a REST Interface(??).

1. **SAP Transportation Management (SAP TM)**

In a most current SAP TM test system a modification-free enhancement was developed to access the blockchain. Here it is assumed that the TM system is operated by an ocean carrier. The Bill of Lading document can be issued and posted into the blockchain. Details are transferred via an interface and also the finalized PDF document, which usually would be printed, is streamed via the same interface. Lot’s of further features are required for productive use. It is SAPs intention to extent the implementation over time. For example it needs being taken care of that a paper B/L cannot be printed any longer if a B/L was issued into a blockchain. Also master data settings are required to control when and for which ordering party a B/L shall be posted into a blockchain instead.

Another interface, which was implemented in SAP TM, can retrieve the current ownership data of a particular B/L. Currently it is assumed that this interface is not required in real world.

SAP evaluates whether the SAP CD CSL solution can be blockchain enabled as well, so that container shipping lines, which run SAP TM with the CSL solution, can benefit without own development efforts.

1. **Partner Mobile Apps by KOBIL**

We have partnered with a company called KOBIL who are an Digital Identity & Access Management company and have provided us with 2 Mobile Apps (iOS and Android based) that perform the following operations:

* + Digitally Sign Documents like Bill of Lading
  + QR Code access for Authorizing Container Release

In addition to the mobile apps, KOBIL provides 2 more components – a KOBIL Cloud Engine and a KOBIL SAP Cloud Connector which is deployed on the SAP Cloud Platform (Neo). The routing of the requests to Digitally Sign documents and QR Code Scans happen thru this Connector to the Cloud Engine.

# A Proof of Concept

## Objectives / Goals

One POC can have one or multiple participants. A company could participate in multiple POCs with different sizes or contents. SAP is one participant per se. If digital document signing or 2-fact authentication with QR code scans is included in the POC, then also our partner Kobil will likely be a participant.

Participants have the right and duty to use the prototyped ocean shipping application with the goal to execute tests of a real-world example.

The intention of a POC is to prove the relevance of blockchain technology, understanding potential benefits and to support defining a future solution with required feature and functions. Hence, SAP expects from participants to execute the POC non-productively with a real-world-example as close to the real business as possible. SAP expects to receive feedback, ideas, gap descriptions and statements about the relevance of technology and about potential benefits and savings.

## Content options

Each POC team shall define the intended content for itself. SAP has got predefined potential options in order to help participants to take a decision. In chapter 3.2. the capabilities of the available prototype have been outlined. The options reflect a selection of available capabilities.

### Bill of Lading Focus

Today’s paper based B/Ls are a perfect fit to apply Blockchain technology, hence this would be the best choice to stay as close as possible with the original intention of blockchain technology.

A POC with a dedicated focus could look at the B/L document only.

The B/L can be instantiated in the Blockchain via an interface. If SAP TM is used the interface is implemented already. The sample code could be provided in order to enable an own TM system. SAP also works on enabling the SAP CD CSL solution. It is not mandatory to have an SAP TM system.

Together with the details of the B/L, also a PDF document can be streamed. It is stored anonymously in a document center and can only be accessed by it’s unique link. A hash is stored into the blockchain too.

Upon instantiation of a B/L the shipping company is the current owner. The ownership of a B/L can be transferred via the blockchain. The new owner has to have an identity in the network too.

There is also an interface to look up who the current owner of a B/L is.

Option: For short distance trade lanes or other scenarios in the EU / Baltic Sea, today electronic sea waybills / express waybills are used. For the Blockchain POC it does actually not matter – the POC could also be done with Seawaybills.

If no interfaces will be implemented by a POC participant, there is also a cloud app to access the blockchain.

### Subcontracting inland truck transport

A small POC with a dedicated focus could also look at the process of subcontracting the delivery of a container at destination. If it is a carrier’s haulage case – it is a POC for an ocean carrier. If it is a merchant haulage case – it could be a POC for Consignees or Freight Forwarder.

As of now, there is a feature to assign the trucking company to a container of a B/L. There are ideas to enhance this by required interfaces. The POC would include the joint work on process and interface choreography.

### Secure Container Release Process

A self-contained focus process could be the secure container release process at a port of discharge.

Looking at the high amount of claimed stolen freight this isolated scenario itself could pay nicely, if all participating parties find a way to share the benefits. E.g. including insurance companies, which could reduce risk levels when a blockchain based electronic container release system is used.

The focus of the process could be on posting/receiving the drivers identity per B/L and container in the blockchain, the enrollment of a driver to the process and the verification step at the terminal via a QR code scan.

One could think of also including the subcontracting of the trucking company.

### Multi-Party document sharing and signing

A special focus of a POC could be to look at the sharing of documents. Any kind of PDF document could be published to relevant partners and digital signature processes could be implemented (one signature of the issuer OR multiple signatures from acknowledging parties). It could be verified how partners could work with multiple document versions or how media breaks or fraud could be eliminated.

Any kind of parties could work together here – shipper, consignee, carrier, authorities.

A special example document could for instance be the Proof of Delivery.

### Cooperation with authorities

One focus POC could be about cooperating / collaborating with authorities. Or even about collaborations between different authorities, which might use the customs authority as single window of contact to parties of international trade and transportation. Contentwise it also could be about document sharing and transparency etc. but also about dedicated interfaces e.g. about status or next step info.

SAP aims to intensify contacts with authorities about this topic.

If a POC participant has got contacts and could include them into a POC, that would be highly welcome at this stage.

A special POC could also be about testing a SAP GTS integration, which is intended but not yet available.

### Freestyle - any possible scope

Participants of a POC could certainly also agree on any possible scope – a free selection of steps out of available capabilities. See chapter 3.2.

## Technical Requirements

Participants will get access to SAPs Cloud Platform and its infrastructure for the time of the POC. The provided cloud app could suffice doing a POC. However participants also could implement interfaces in order to connect own backend systems to the blockchain.

### Getting access and register

[*Assumption: The Customers (their users and their partners) who will work on this POC shall do so on SAP’s environment for the initial phase and NOT do so on their own environments yet. In a later phase of the POC participants and SAP could agree on extending the infrastructure into the customer owned SAP Cloud Platform environment/space.]*

* SAP Cloud Platform (Neo) User

Every Primary Customer who is slected for the POC shall be Onboarded on the SAP Cloud Platform (Neo) with a unique “P” User ID and given access to the Blockchain Ocean Shipping UI App.

* Onboarding on the KOBIL Mobile Apps

A Customer who is an Ocean Liner will get access to a Mobile App from KOBIL to Digitally Sign Documents (like Bill of Lading). Once the User has installed this App, there needs to be certain configuration performed to first create a Signature and associate it with a Digital Signature.

A Customer who is a Truck Driver profile will get access to a Mobile App from KOBIL to perform QR Code Scan for Secure Container Release.

Both apps are available for iOS and Android.

### Optional implementation of Interfaces

The implementation of interfaces is optional. The Ocean Shipping Blockchain has got an interface layer, which provides restful web services, for which partners can send a JSON payload.

Upon request SAP will provide the details like the service endpoint URL the user credentials, which correspond to the SCP user, which was created under 4.3.1. , and sample payloads. Currently the most important interface is the posting and instantiation of the Bill of Lading. The interface has got some segments for details of the B/L and a segment for the base64 encoded B/L PDF document. For a SAP TM backend system, SAP can provide the ABAP sample implementation.

## Doing / approach

In a preparation phase the participants align the scenario and the content of the POC. Furthermore, technical prerequisites (ref. to 4.3 ) are discussed and addressed. Identities are created in the blockchain by SAP or an onboarding tool will be made available. Participants exchange their IDs so that everyone knows and recognizes the relevant peers.

Based on the agreed content and derived required step an action plan is defined about:

- who shall access the blockchain in which sequence

- which transaction details or documents are shared

- what kind of notification is required

Participants access the blockchain via the provided SAP cloud append simulate the steps OR participants could optionally also implement an interface from own backend systems.

At the beginning a guide straight forward step by step scenario execution is preferred in order to gain experience and share learnings.

Unguided free tests shall prove the stability and allow gaining confidence.

An ultimate goal is to execute a real world example in parallel to its current handling / operation.

To be detailed out…

## To be expected efforts

During the POC a Single Point of Contact shall be made available for regular phone calls. It is to be expected that progress needs to be reported multiple times per week in a reasonable format.

It is expected that each participating party can bring in the required technical and business knowledge.

If it is preferred to have a consultant onsite to manage or cover the project tasks, SAP can provide an offer upon request.

Development efforts need to be expected if interfaces from own backend systems (like TM) to the Blockchain are to be implemented. Each party needs to cover those efforts for implementations on its own.

It is expected that participants execute a real world example with data and documents. Efforts to gather required details and documents and the execution steps of the POC itself shall be planned by each party. There is no estimate yet.

In case data and document anonymization is required, the requesting party must cover the efforts.

It is expected that the POC is documented by every participant. Additional efforts arise for review and consolidation and an agreement of a joint report and story.

## Formal Requirements / To be expected costs

SAP will provide a formal Collaboration Agreement, which need to be signed by the participating parties.

No further details here. Please request this Agreement separately.

SAP intends to provide the SAP infrastructure, which is required to execute the POC. Participants get access via a to-be created SAP Cloud Platform account. The identity can then be used to access the app and to access the blockchain interfaces via Rest APIs.

In case participants like to use the mobile apps of the partner KOBIL, KOBIL grants access to the apps individually per Apple-ID or Google-Appstore-User, while KOBILs own terms and conditions apply.

Participants need to cover all own costs.

It is assumed that the POC can be executed remotely and no face to face workshops are required. If face to face workshops are agreed to, then resulting travel costs must be covered by each party.

The POC is exploratory in nature and there is no guarantee that the POC will be completed or productized.

## Data Privacy

In this POC, we could have different customers onboarded, who will work with their relevant Business Partners. To ensure data protection and access SAP intends to use the concept of the Hyperledger Fabric [Peers](http://hyperledger-fabric.readthedocs.io/en/release/glossary.html#peer) and [Channels](http://hyperledger-fabric.readthedocs.io/en/release/channels.html) specific to each customer and their partners. This is supposed to ensure that data does not overlap between customers.

However, participants of the POC are asked to take care of required privacy levels. If data or documents shall not be shared with others, then relevant pieces shall be anonymized or blacked out by the participant before the data or documents are shared via the Blockchain.

Participants, which agree to execute the POC together with other companies, will need to agree also to share the relevant personal data to establish contacts between the participants.

# References

* [3 minutes introduction video](https://youtu.be/-N_jAJyh8_E) on youtube
* [16:30 minutes video on youtube](https://youtu.be/HB7ABR_i6AU)covering the E2E live demo

# Contacts and Roles

|  |  |  |
| --- | --- | --- |
| Name | Role | Company |
| Steven Kim | Program Manager SAP Leonardo Blockchain Co-Innovation | SAP America |
| Stefan Foerster | Product Owner SAP TM Development | SAP SE |
| Raghavendra Deshmukh | Dev. Manager IOT Seed and Innovation | SAP Labs India |
| Bernd Lauterbach | Chief Solution Architect T&L Service Industries | SAP SE |
| Stefan Sauer | Industry Solution Manager Ocean Liner, Ports & Terminals | SAP SE |
| Ralf Hierzegger | Chief Product Owner Container Shipping Liner Solution | SAP SE |
| Markus Tak | Chief Technology Architect | KOBIL |
| Murat Ayranci | Marketing & Business Development | KOBIL |