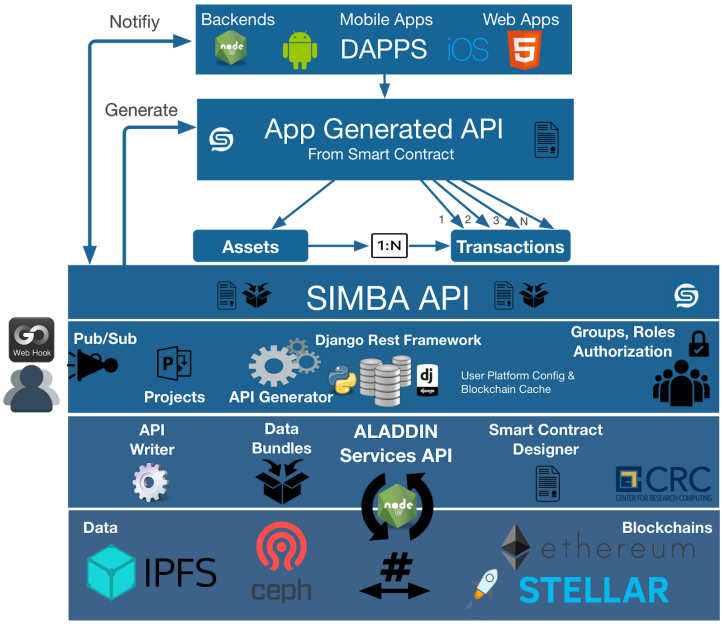
What is Simba?

A Blockchain is a distributed ledger in which an immutable, and therefore non-repudiable, record of transactions or events can be stored permanently and verifiably, without the need for a central authority. Blockchains allow digital information to be distributed, but not copied, meaning each individual transaction can only have one owner. This is enabled through the use of wallets, containing (multiple) special asymmetric cryptosystem keys that are used to sign each transaction, making all transactions identifiable and authentic. Blockchains that employ the use of Smart contracts (programmable pieces of code) can ensure certain transactions are only performed when specified conditions are met without the need for a human to manually intervene --- smart contracts have been described as “cryptographic ‘boxes’ that contain value and only unlock if certain conditions are met.”[1]. Smart contracts are also deployed and written as a transaction onto the Blockchain, which also makes them immutable and signed by the user that deployed them to ensure the authenticity of the code is not compromised.

From an application standpoint however, this underlying tooling is not enough to build production applications from. There are at least two other aspects that are needed: often, applications need to store multiple files, documents or datasets alongside their blockchain transactions, which are simply too large and expensive to store on-chain, hence off-chain support is needed; and private blockchain access control layers are needed to provide the ability to add authorization permissions to the on-chain and off-chain data that is shared, allowing a user to decide with whom they share the data and transactions with, and how.

SimbaChain addresses these needed features and more, the architure of the system is shown to the right. It has a core underlying goal of providing tooling for developers to make it easy to build and deploy blockchain systems across multiple blockchains and data stores. It provides a design tool for generating a business process model for tracking assets, which auto-generates a smart contract and corresponding API for integration with external applications. The resulting API provides REST based access to smart contract methods that transact on the ledger and provides access control using groups for reading or



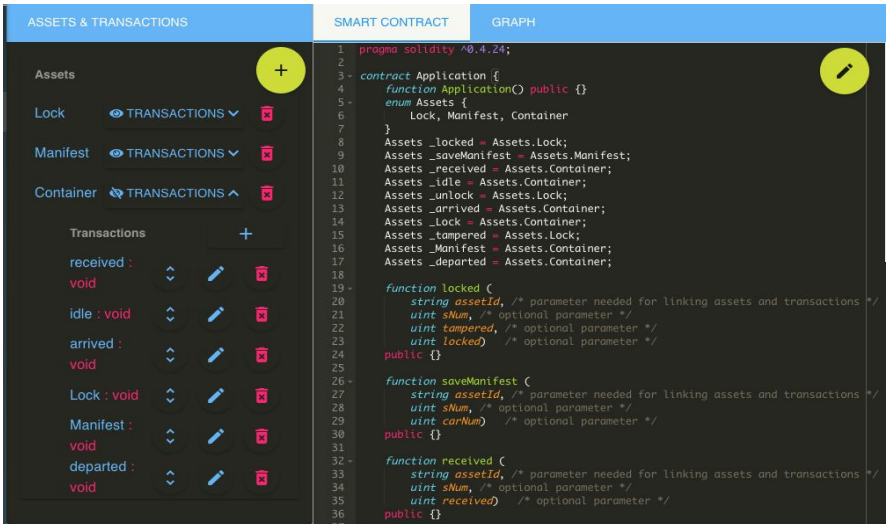
[1] https://github.com/ethereum/yellowpaper

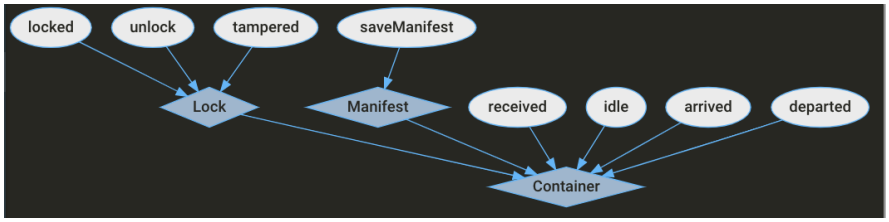
writing to such resources. All data smart contract API endpoints allow multiple data files to be attached and stored in an off-chain data store, such as IPFS or Ceph. The diagram to the right expands on this to illustrates the core features of the system for each level of the development Blockchain stack.

	Blockchain	Simba
Access Control	Private - external tools, public - none	Permissioned Data & Blockchain in API
Wallet	Keys Sign Transactions	Fully Integrated Wallets (Browser/ APIs)
Data Store	External Data, Hashcode On-chain	Automated Off-chained Data
Smart Contract	Non Reputable Code & Automation	Write Smart Contacts With Zero Code
Blockchain	Non Reputable Transactions	App Interface to Multiple Blockchains

For the **Blockchain** layer, Simba provides a generic API to multiple Blockchain systems, thus the system does not have a dependency on a single Blockchain or DLT implementation. Currently, the platform supports Ethereum and Stellar but several more are on the roadmap. Furthermore, although SimbaChain is proprietary, it will soon release a code generation capability that auto generates source code that binds to the specific Blockchain system and Data Store the user has configured. This makes it possible for developers to export the system into an enterprise environment or to use SimbaChain to create open source APIs for public use.

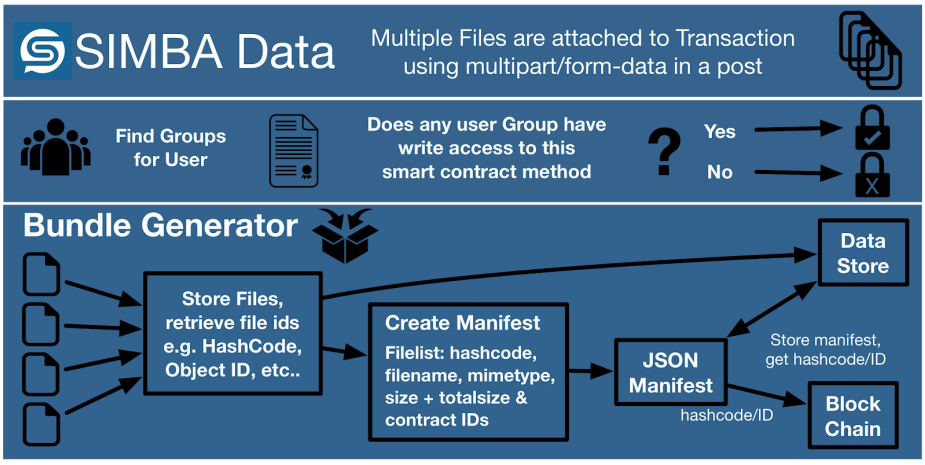
Smart Contracts provide the interface, and business logic, to what is written on the Blockchain and what rules need to be satisfied for this write operation to take place. In SIMBA Chain, Smart Contracts are automatically generated from conceptual models that define the Assets and Transactions that transact on those Assets. Such models are specified using the Simba's Web App's UI shown on the right. A user simply uses the GUI to add Asset or Transactions along with their methods and parameters, and SimbaChain automatically generates the smart contract for the platform they select (in this case, Solidity code for Ethereum). It also generates a graph of the relationships for the model as shown just below. The resulting smart contract once deployed on





the blockchain is dynamically exposed as a application REST interface for simpler external application interaction with the blockchain.

Data Stores in SimbaChain uses the same adapter pattern as the Blockchain one; that is, a single generic REST interface can support the simple integration of different data stores. Right now Simba supports the Ceph, IPFS and flat file system based data stores. As shown opposite, data flows into the system through the application's REST API (generated by Simba) by attaching one or multiple files to the transaction. This is achieved by using a simple multipart form post. Transactions are then checked for access (see below) before being passed to the data bundling mechanism, which stores all files into the Data Store and collects each hashcode into a JSON manifest file. The manifest is then stored into the Data Store and its hashcode is stored onto the blockchain. Using this mechanism, the system can easily retrieve all files by first retrieving the manifest then using each hashcode to retrieve the files. The hash also serves as a digest to guarantee the integrity of the data.



A private key of a **Wallet** is required to sign a transaction. In SimbaChain we do not store user's private keys, instead we provide a callback mechanism that allows the developer's application to sign transactions on behalf of their users. When a transaction request is made on Simba using the application API, it sends it off to the blockchain adapter to generate the transaction payload. This payload is then returned to the sender for signing. Along with the transaction payload the headers include the external user ID so that user in the developers external system can be extracted and their private key applied to the transaction, for signing. This signed transaction is returned to Simba for submission to the blockchain. An example of this implementation is in the Simba Dashboard, which implements this functionality in the "Make Transactions" tab of the Application view, using an in browser implementation of a digital wallet.

SIMBA Chain provides core **Access Control** functionality to define rules on who has read and write access to each Smart Contract method. It also defines separate access policies for blockchain access and for data store access. Using this mechanism, you could enable a permissioned File Store with a public Blockchain or you could make both permission using a private Blockchain and Data store, as shown opposite. Permissions are set on each smart contract method using group based authorization. A developer creates groups, either using the Simba dashboard or programmatically using the API, and then a group can be associated to

each method in the app, assigning read/write privileges and even embargoed access, if desired. The developer then can register external users IDs from their own application (any user ID can be any identifier generated from the developer's authentication system), and then they can dynamically assign users to groups to give each user the appropriate access. Upon invocation, the external application provides the external user ID. Simba then looks up all of the Groups that the User belong too and checks whether any of those Groups has write access to the smart contract method that the REST API corresponds to. If so, then the invocation succeeds. If not, an error is thrown. By being able to programmatically define groups, users and permissions, one can provide fine-grained control on who has access to what for each component in an external application dynamically.