Triple Entry Accounting (TEA) Data
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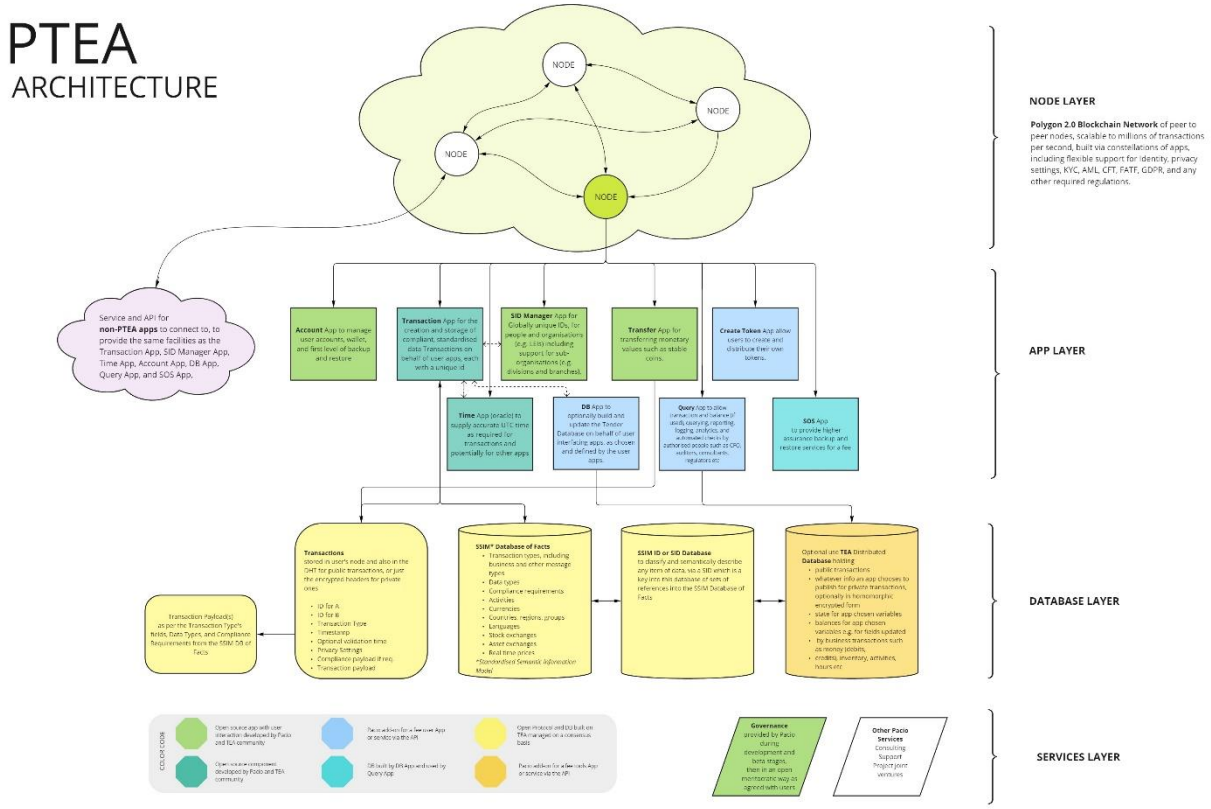
Pacio is creating a Triple Entry Accounting (TEA) system described in the Pacio White Paper with the digital Id needed for TEA plus backup security being provided managed by Pacio's Secure Online System (SOS).

This document provides greater details of how Pacio TEA (PTEA) data is stored and processed.



The component parts of TEA shown in the diagram above are described in this paper.

1 Polygon 2.0 Blockchain

As described in section 5 'Blockchain Choice' of the Pacio White Paper, Pacio has chosen to develop and launch with Polygon 2.0 with its "unlimited scalability" promise as of late 2023.

NOTE: If ever a new blockchain becomes available which proves to be superior to Polygon 2.0 for Pacio system needs, Pacio will switch to that blockchain, with all historical data being copied to the new blockchain, with the change of underlying blockchain being transparent to TEA by Pacio users.

2 TEA Accounts

All TEA activity involves a transaction and at least one account, or two accounts when another entity is involved, which is the usual case. One account transactions apply only to setting account or profile options.

TEA accounts record TEA balances defined by TEA user apps. This allows for any number of both fungible tokens, including any kind of currency, and non-fungible tokens (NFTs), with no intrinsic token. The TEA fungible token is just one of the possible tokens.

People and entities may have one or more accounts.

Accounts can be created with different identity and privacy options.

Account Keys

Part of the greater ease of use added by PTEA is human friendly account Ids as defined by the app which creates them such as "Internet Subscription" rather than something like 149ztpykfwzVjebdN7USg4akg6LWSQcKtn or 0x00bd760f2df04f3ef4ad0e7214a3e29c504a6da3 for account references as used with Bitcoin and Ethereum.

Account Properties

An account will always have a SID associated with it. In addition accounts will include properties with default setting which a user can change re

- Id disclosure – as per the Id Manager app
- Privacy preferences
- Security preferences

2.1 Wallet

The intrinsic TEA wallet provides accounts, balances, and transactions access.

The rules applicable to any token used by a wallet are stored within the wallet by copying from the token genesis transaction. Most apps which define tokens will use the optional TEA DB to make this easier and faster.

3 TEA Transactions

All PTEA activity involves a transaction and at least one account, or two accounts when another entity or counterparty is involved.

3.1 Mutuality and Consent

TEA transactions other than single account profile update ones are between accounts who are mutually aware and consenting, and this consent is demonstrated by the countersignatures of each agent on the transaction saved to the blockchain.

This mutuality and consent is a great strength of PTEA versus blockchain cryptocurrencies which

typically operate based on a single signature from the spender. There is no evidence for the receiver to know that they are even party to a transaction, much less a crime if funds are being stolen.

3.2 Immutability and Verifiability

TEA transactions are immutable and verifiable because of how they interact with the blackchain.

3.3 Optional Validation Time

TEA transactions are final by default, but the sender and recipient can agree to allow cancellation within a certain period, an optional validation time. Such transactions can be recalled or revoked up to the expiration of the validation time.

That option provides protection against accidental loss through a transfer being sent to the wrong account eg for a large value transaction such as for the purchase of a house, where a mistake – sending to the wrong account – would be extremely expensive.

The processes required to allow for delayed validation are also useful for two other cases: where compliance requires human or delayed confirmation, and where a set of transactions is only valid once the whole set is complete.

3.4 Defined by Apps

Transactions are defined by apps within the structure defined below. This allows for any number of data fields, and both fungible tokens including any kind of currency and non-fungible tokens (NFTs), with no intrinsic token.

3.5 Transaction Structure

A TEA transaction for account A or between accounts A and B is structured as a header and one or two payloads:

3.5.1 Transaction Header

The transaction header holds:

- SID for A
- SID for B, or null if the transaction is a single account one just for A. Single account transactions apply to:
  - setting account or profile options
  - setting application state
  - internal transactions such as double entry accounting entries for a single entity.
  - Transitional TEA transactions. For example, if business A using TEA buys from business B not using TEA, the TEA entry would still be created, but be signed only by A. When B adopts TEA the entries could be found and picked up by B. In the meantime, B's auditor or CFO or consultant etc could find them for comparison with B's internal records
- the UTC creation time of the transaction
- the UTC validity time of the transaction, which equals the creation time or null if one or more of the the following three fields are defined, in which case a subsequent update of the transaction is required once the condition or conditions have been met, for this value to be set and the transaction processed
- delayed validation required: true if the transaction involves compliance data that requires human (or delayed) checking by the recipient or recipient’s agent. false otherwise.

- optional UTC validation time for a two account transaction, null if not in use. Not applicable to single account transactions.
- Id of the header of a set of transactions if this is one transaction making up a set such as a set of double entry accounting transactions for an entity which must balance to zero, null otherwise.
- The Transaction Type covered in section *7 TEA Data*
- Account balance(s) (encrypted) if applicable to the transaction type. Including the account balance in transaction headers assists account recovery in the event of device loss, facilitates data pruning and makes life easier for light nodes.
- Privacy Settings. Transactions may be private (visible only to authorised people/entities), or public, according to account and app settings, as described in section *5 TEA Privacy*

3.5.2 Transaction Payload(s)

- Compliance Data if applicable to the transaction as covered in section *6 PTEA Compliance.*
- Payload of structured transaction data as covered in section *7 TEA Data.* This is a variable data section defined by the app generating the transaction. For example, a business app creating an invoice could include an invoice total or header plus any number of line items including things like inventory/bar codes, price, quantities, and activities etc. This data would typically be in json format, but could be in any format which the app developers choose.

3.6 TEA Time

Times used in transactions need to be accurate. Many apps running on PTEA are also likely to need record or process times.

TEA uses only UTC (Coordinated Universal Time) in transactions. It is up to an app that shows times to convert UTC to local time according to device settings.

The clock of the device hosting a TEA app, or blockchain node devices either cannot be used for these time needs as device clocks are not accurate enough, and in any case can be set wrongly, either by accident or design.

Thus PTEA includes a *Time App* oracle to supply the current UTC time.

4 SIDs

All TEA activity is identified by IDs, so IDs are intrinsic to TEA.

PTEA uses SIDS provided by the Pacio Secure Online System (SOS).

SOS and SIDs are described in the White Paper and in full detail in the separate Secure Online System (SOS) document.

5 TEA Privacy

Private transactions may specify in the privacy settings section of the transaction header the SID(s) of the entity or entities (person/people, organisation/organisations) which are authorised to view it. Viewing rights allow viewing on a temporary or time limited basis.

Need to extend this to be SID (entity) based.

6 PTEA Compliance

PTEA has built in KYC[1] (Know Your Customer), AML[2] (Anti-Money Laundering), CFT[3] (Countering the Financing of Terrorism), FATF[4] (Financial Action Task Force), GDPR[5] (General Data Protection Regulation) regulatory compliance – PTEA plays by the rules to work better for every legal use. It is not on some ideological mission.

6.1 KYC

KYC compliance is met by the use of SIDs with every account and every transaction.

6.2 AML, CFT, FATF

The AML, CFT, and FATF rules or advisory proposals are complicated, depend on transaction type, and are variable over time, and in some cases by jurisdiction.

The regulatory environment is in a state of flux, and that is likely to continue indefinitely. Accordingly, any solution has to be flexible, able to cope with change.

The PTEA approach is to store the requirements in the *SSIM Database of Facts* according to transaction type, date range, and jurisdiction if applicable. The compliance state at the time of the transaction will be stored as part of the transaction compliance payload.

Then the Transaction App which builds and stores compliant transactions on behalf of apps which call it, checks to see if compliance data is required, and then that the compliance data has been passed to it for inclusion in the transaction's compliance payload.

In some cases human verification of the compliance data will be required by the recipient, or an agent of the recipient. The PTEA transaction header allow for this being recorded. The transaction then only becomes valid and is processed once the compliance data has been signed off as valid.

One of the best known FATF rules in the banking world is the so called "travel rule" which mandates that the source and purpose information for transfers above a certain amount should travel with the transfers through all its hops between sending and ultimate destination banks, possibly via correspondent banks in between. In the PTEA case there are only sender and recipient nodes, not intermediate or correspondent ones, but as regulations become tighter or tougher, some types of PTEA transactions are likely to be subject to the "travel rule" for the single TEA hop.

6.3 GDPR

The European Union General Data Protection Regulation (GDPR) governs how personal data must be collected, processed, and erased. Though GDPR is an EU regulation it has in effect become a generally applicable regulation.

The approach and philosophy of PTEA to give the creator of data ownership of that data, is at a fundamental and intrinsic level GDPR compliant.

That does not necessarily mean that all data stored by TEA would always be GDPR compliant, however, as apps could legitimately supply data, or some data, to other systems out of the TEAecosystem, and that data would then only be as GDPR compliant as the other systems are.

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[1] KYC: Know Your Customer, a finance industry regulatory requirement

[2] AML: Anti-Money Laundering, a finance industry regulatory requirement

[3] CFT: Countering the Financing of Terrorism, a finance industry regulatory requirement

[4] FATF: The Financial Action Task Force which develops standards for financial transactions

[5] GDPR: General Data Protection Regulation, a set of EU regulations

One well known requirement of GDPR is the right to be forgotten, OR the right to erasure, which gives individuals the right to ask organisations to delete their personal data.

This right poses a particular challenge for blockchain systems where data is stored immutably.

However, unlike Bitcoin and Ethereum etc PTEA does include a “delete” option as described in section xx yyyyyyy where delete does not involve deleting an existing entry which remains immutable, but rather in publishing a special delete action to the blockchain. An app which requests the data from PTEA then sees the combination of the original record plus any subsequent delete action ie that it has been deleted. So, although the data does in fact remain in the blockchain, no app will see it. Thus, apps can implement the GDPR right to be forgotten.

Further, in the case of PTEA, as described in section *9 PTEA Database*, an app can choose to make its data viewable only via the TEA Query App which queries the TEA Database for which full CRUD (Create, Read, Update, Delete) database operations are supported. Thus for apps using this option, GDPR’s right to be forgotten can be fully implemented.

7 TEA Data

PTEA supports structured standardised data suitable for business and other applications where transactions may involve numerous app defined fields, not just a single money (crypto) field. Further, some apps will need transactions to be stored in sets, for example double entry accounting entries need to be stored as a set of entries which balance to zero, with part of a set being invalid or incomplete data.

Section *3.5 Transaction Structure* defines the structure of transactions with a header and one or two payloads. This section defines how the payload data is standardised.

7.1 SSIM (Standardised Semantic Information Model)

The Standardised Semantic Information Model (SSIM) is Pacio's way of storing and managing accounting and other data.

SSIM data is standardised to be comparable across entities, jurisdictions/regions/countries, and accounting standards.

SSIM data is semantic because any piece of data can be indexed or referenced by what it is about ie what the item of data applies to, optionally tagged to any required level of detail.

Semantic data via SSIM is a key part of PTEA and its contribution to the web 3.0 future.

SSIM, like the whole TEA protocol, is open source, and will be made available for use by others, and for potential adoption as a standard.

See The Case for the Standardised Semantic Information Model for more about SSIM and the need for it as part of a universal transactional data storage system.

7.2 SSIM Database of Facts

The SSIM Database of Facts shown in the PTEA diagram at the start of this paper, and referenced in the 'The Case for the Standardised Semantic Information Model' document, is intrinsic to how TEA data is standardised and made semantic.

Pacio will create and maintain a public "SSIM Database of Facts" for use with TEA transactions, plus automated data feeds for changing data such as exchange rates

It is proposed that the database will be extended and updated as needed in a Pacio moderated folksonomy[6] like process. It is accepted that maintaining this database will be subjected to some of the issues listed in the 2001 paper Metacrap: Putting the torch to seven straw-men of the meta-utopia but by keeping the information to "generally accepted facts" and moderating the folksonomy process it is hoped to minimise the issues or at least control them.

PTEA will develop governance processes as discussed in section *12 PTEA Governance* which are likely to see evolution in what is proposed here.

The facts database will be built to be reliable and available at all times using distributed database technologies so that apps may depend upon them.

The facts database will grow to become large, but in concept will remain simple. It will be a major part of making SSIM easier to use and understand than other approaches which try to build relevant facts into domain specific ontologies or taxonomies.

[6] Folksonomy is a user driven system of classifying and organizing online content. It was used by Freebase, a large (1.9 Billion triple) public knowledge base prior to its acquisition by Google.

7.2.1 Transaction Type

Every TEA transaction has a type which is its Id in the SSIM Database of Facts. Examples are:

- Transfer of FIAT money
- Transfer of a token
- An invoice
- A purchase order
- A message code eg I have sent you an invoice
- An “email”
- Etc for hundreds and eventually thousands of transaction types

Each transaction type entry defines:

- the fields making up the transaction
- the data types of the fields
- whether any of the fields can repeat in a set eg line items of an invoice
- whether the transaction is subject to compliance requirements
- whether the transaction has jurisdictional restraints
- whether the transaction has time range restraints

7.2.2 Data Type

In a standardised semantic environment, every item of data needs to be classified, whether that be a knowledge base entry about the universe, or a business record (invoice, purchase order, journal etc). Classification has two main attributes, what the item is in a generic sense (number, word, file etc), and a description of what the content is about. Example: the item could be “currency number with 2 places of decimals” for which the description is “USD, rent”. The Data Types Directory defines the possible types of data items to be classified by SSIM.

This directory will help with standardisation by defining data types in one place for use by all SSIM components, including the more complex ones described in following sections, without those components needing to repeat the definitions for the data types they use.

A data type can be:

- a single item such as a number, a currency/money item, a datetime, or some text etc
- larger items also such as document, image, video, file … any digital thing
- a code eg a 3 letter country code
- a number of items eg a money amount, a quantity number, an activity units number, a barcode (inventory) reference etc as needed.
- fields repeated n times for periodic data as for financial data in monthly or other periods, where the periods and dates of the periods are an entity property
- optional restrictions eg number must be positive, or must have 6 digits etc according to rules or patterns, but done without using complicated regular expressions that most people wouldn’t understand
- formatting information where relevant, potentially varied according to country or jurisdiction and/or human language.

A data type is referenced by an Id into the SSIM database.

7.2.3 Real-world Facts

To complete the standardisation of data the SSIM database defines the allowable values for specific data types. For example, for a data type of “currency code” the “facts” entries in the database are the allowable country codes.

A business app will choose the correct currency from the currency entries, and it will choose appropriate further facts such as “sale” or “rent” to complete the description of the transaction. The Facts entries are intended to cover or model business (and human) activities and interests.

These entries will include date/time ranges for the validity of a fact. This could be for a extended period eg when the UK is or was a member of the EU and when not. Or the fact could change frequently as for exchange rates.

Directories will use existing classifications where possible eg ISO country codes.

All directories will allow for groupings or classes within them eg Asian countries.

All facts will allow for language and jurisdictional variations.

Facts can be flexibly combined as a set of references and relationships which results in a single SID as described in the next section.

The vast majority of directory uses, certainly for business needs, will be for the simple description of an item of data using one or more references without need for the complicated semantic syntax of systems such as OWL (Web Ontology Language). An example is “this is an XCD money rent expense”.

Relationships

The relationship for a data item being described with a “fact” will usually be self evident as adjectival (descriptive), or “is a”, “is in”, “has the property of”, “is a member of”, or “has as a member” according to the data type of the item and the type of the fact. Adjectival and “is a” are the commonest. For “this is an XCD money rent expense”, the data type would be “money” with “XCD”, “rent” and “expense” all being descriptive or having a “is a “relationship to the data item.

For “Saint Lucia is a country in the OECS (Organisation of Eastern Caribbean States)” the relationship of Saint Lucia to the OECS is understood to be “is a member of” because OECS would be defined as a fact that is a group or collection of countries. Whereas “OECS” plus the fact “Saint Lucia” are linked by a “has as a member” relationship.

Such simple self-evident relationships, or relationships derived from the data type of the item and the type of a fact, meet business reporting needs, if not all those of other more esoteric domains such as metaphysics, pure mathematics, or religion. SSIM development will start with just these simple relationships.

Support for other relationships such as “is not”, “is not a member of set/class x“, plus logical combinations using “and” or “or” could be added as requirements arise or are defined. The reason for deferring such additions is that some other semantic and data description languages have suffered from trying to define everything at the start, with the result that options became over complicated and have never been used in practice, resulting in later specifications advising against their use, and their ultimate deprecation. With SSIM the approach will be to add more complicated options only if there is proven to be a real need for them.

Database Entries

Entries in the database will grow progressively to cover the following areas and probably others over time:

- Transaction types as per section *7.2.1 Transaction Type*

- Data types as per section *7.2.2 Data Type*
- Compliance requirements for those transaction types which need this as described in section *6 PTEA Compliance*
- Countries, states/provinces, jurisdictions, regions, cities/towns, and groupings of these
- Human languages
- FIAT currencies
- Crypto currencies and their blockchains or other distributed ledger systems
- Activities – all business and human activities eg 'retail sale', 'accounting', programming, exercising etc, keyed to units where applicable eg truck driving and tonne kilometres, for use with TARI®
- Functional roles – expense, sale, equity, fixed asset etc
- People's roles and occupations - director, partner, officer, remote worker etc
- Entity types from sole proprietorship to public limited company including charities, NGOs, and Government Departments/agencies, for all the variations in the world
- Stock and futures exchanges where public companies may be listed
- Crypto exchanges
- Industry/business classifications
- Units of weight and measure
- Product categories eg household appliances > climate control appliances > fans > ceiling fans
- Product barcodes including UPC (Universal Product Code), EAN (International Article Number, previously European Article Number), ISBN (International Standard Book Number), Code 128 etc. Of the order of 200 million such codes exist with new ones being created constantly. They may be accessed via online APIs for use by SSIM.
- Service types – accounting, auditing, legal work etc
- Facts and terms relevant to ESG (Environmental Social Governance) reporting
- Report names or headings such as "Balance Sheet"
- Colours
- Materials
- Terms for the sciences: physics, chemistry, biology, botany, geology, genetics, mathematics, astronomy, palaeontology, ecology, oceanography, meteorology, zoology etc
- Medical terms
- Religions
- Product names
- People names
- Dynamic facts from data feeds eg exchange rates, stock prices, crypto prices …
- Imported facts from knowledge graphs and public datasets such as those listed in the 'Knowledge Graphs and Public Datasets' section of The Case for the Standardised Semantic Information Model
- Other groupings of facts that people may be interested in and are prepared to help build

7.2.4 SSIM ID or SID

Any item of data is classified or semantically described using a single 64 bit (8 byte) number called an SSIM ID or SID. SIDs allow totally flexible data description in just 8 bytes, which will help make data storage and processing efficient. No long or variable length tags are involved.

A SID is a key into a global database of sets of references or keys into the SSIM Database of Facts, and optionally for data or an app using it, an ontology or taxonomy reference.

Each set of references used by an app results in a single SID. A SID provides context and semantic content information.

A SID provides the equivalent of XBRL context plus concept tags and attributes.

64 bit SIDs allow for 2^{64} - 1 or 18,446,744,073,709,551,615 different sets of references which is 1.8 Billion for every person on earth at projected peak population of 10 Billion people. That should cover the world's needs for decades. If ever that limit should be approached, then extending SIDs to just 10 or so bytes would allow for centuries of reference combinations.

SIDs once used will exist "forever". They may become deprecated or no longer valid for new data, but will be kept indefinitely for historical analysis purposes.

The SID database will be a critical component of SSIM. Additions and updates will be logged for security and to enabling rebuilding in the event of catastrophic loss of the database.

A SID by itself would not tell a human observer anything, but software will easily show its references via the Pacio SID Service. Applications will be able to search or query by facts using indices.

SIDs could be shown as QR codes if an application wished to publish them.

SIDs are not specific to Pacio ie they can also be used by non-Pacio systems.

8 TEA Tokens

PTEA supports any number of both fungible tokens, including any kind of currency, and non-fungible tokens (NFTs), all defined by their apps, with PAC as the intrinsic PTEA token, and no gas fees).

The rules for a token are defined when it is created and are stored in a genesis transaction.

The rules applicable to any token used by a wallet are stored within the wallet by copying from the token genesis transaction. Most apps which define tokens will use the optional PTEA DB to make this easier and faster.

PTEA includes a *Create Token App* which can be used to create any type of token, though other apps may also create special purpose tokens.

8.1 Fungible Tokens

Fungibility is the property of a good or a commodity whose individual units are essentially interchangeable and each of which is indistinguishable from another. Fiat currencies such as the US Dollar are fungible, as are crpyo currencies such as Bitcoin and Ethereum.

Each fungible token like Bitcoin has the same value (1) and is interchangeable with another.

The PTEA create token process of defining the rules applicable to a fungible token embodies the equivalent of the well-known Ethereum ERC20 standard.

Fungible tokens can be minted in any quantity the app or creating user specifies, whereas only one of a non-fungible (unique) token can be created.

Just as for dollars, fungible tokens may be subdivided or accumulated in accounts. The token rules specify the number of decimal digits the token uses, and thus what the smallest unit can be.

If the token rules so allow, new or additional tokens may be minted to increase the supply.

If the token rules so allow tokens may be burnt or destroyed to decrease supply.

The PTEA *Transfer App* allows a user to transfer (send) a value (amount) of any fungible PTEA token held within an account wallet to another PTEA account, optionally with a validation time.

8.1.1 PTEA (PAC) Token

PTEA includes an integrated fungible cryptocurrency also named PTEA (PAC) which can optionally be used by PTEA apps that charge a fee, typically a micropayment.

PAC is created and used just like any other PTEA fungible token.

8.2 Non-Fungible Tokens (NFTs)

Unlike fungible tokens, each NFT is unique. An NTF has a unique address (ID), but also its value and content are unique. An NTF cannot be swapped with another NTF in an equal barter.

“Technically, an NFT is a discrete information set written into a blockchain by way of standardized software code to represent an asset, and to allow transfer of that asset subject to a predetermined set of rules. The asset associated with the NFT can be anything and could be stored in the NFT itself, stored electronically somewhere else, or a physical tangible asset.” [7]

Interest in NFTs has soared in 2021 with some NFTs being sold for millions of dollars. That interest sparked many NFT sites and hundreds of articles such as The Real Power of the NFT (Despite the

[7] Josh Lawler: Non-Fungible Tokens

hype, NFTs are a gateway to a truly decentralized future for economic participants of all types) and NFTs on Holochain? Easy as passing the ball.

When NTFs are used for digital artworks, a copy of an image/text/video/etc and a unique contract of ownership attached to it can be stored in the NFT itself. The contract is usually a certificate that symbolises that the encoded content is the original. PTEA can make such NFTs better by use of PTEA IDs to uniquely identify creator and owner, or any other parties who may be involved. (This has proven to be problematic with NFTs on other systems.)

Initially NFTs were not considered to be securities subject to SEC interest, but from mid-2021 questions have arisen about that. See Are NFTs Securities? And why are some of them trying so hard to be?

If the attached contract to the NFT represents ownership over an asset that meets the criteria of the Howey-test[8], it might be considered a security by the SEC. The main criteria is that the asset was purchased with the intention to sell and profit from a rising price. The Howey-test is defined so loosely that it can easily be applied to every existing and every future asset, hence there is no plausible deniability for new asset classes.

The US issued a new addendum to its AML laws in late 2020 that brought changes relevant to NFTs[9]: The SEC now labels “art dealers” a “financial institution” from which it can be derived that buying and selling art as NFTs on a platform (a third party) is a security and needs a broker-dealer license[10]. In this case, the NFT is practically an STO[11]. It is further notable that buying or selling a fractional piece of an artwork-NFT might be more likely considered a security than the whole NFT[12]

But an NFT has a second use-case: a contract or a certificate without an underlying asset that can be sold with a profit. Such non-fungible tokens are currently in the testing-phase for university degrees. Naturally, this version of an NFT should not be classified as a security. Nevertheless, to avoid confusion, a project should avoid using the term “NFT”.

In Ethereum, a fungible token (Eth) is modelled in the ERC20 standard, a non-fungible token in the ERC721 standard[13]. The PTEA token create process allows for setting rules equivalent to these Ethereum standards.

On a technical level, a non-fungible token has similar properties to an ERC-20 token (having a contract attached) but is not a means of payment ie is not money. This aids a project by avoiding money-transmitter scrutiny. We can assume that using the technical framework of a non-fungible token is both technically and legally the safest way to encode contracts and transactions in a PTEA network.

[8] If it acts like a duck, quack likes a duck; it’s probably a duck…
[9] Can an NFT Platform be Considered a Financial Institution Under Anti-Money Laundering Act of 2020?
[10] Thinking of Buying or Minting an NFT? Here’s What You Need to Know
[11] Security Token Offerings (STOs) for NFTs?
[12] The SEC's 'Crypto Mom' Hester Peirce says selling fractionalized NFTs could be illegal
[13] Difference between ERC20 and ERC721 Tokens

9 PTEA Database

The PTEA Database (PTEA DB) is a distributed NoSQL database of PTEA data which allows for far faster and better reporting than is possible via the DHT and data stored in the source chain on user devices. DHT/source chain data does not include indices so normal database queries are not possible unless performed in a brute force very slow way.

The database is maintained via the DB App, which is a tools app called by user interfacing apps.

The database is queried for reporting purposes via the Query App.

What is stored in the PTEA DB and what can be seen by whom is defined by the app creating the data, in accordance with its privacy settings.

The PTEA DB allows for cross app querying and reporting subject to app/user permissions.

Full CRUD (Create, Read, Update, Delete) database operations are supported. This means that if the world's view of an app's data is only via this database and the Query App, then GDPR's right to be forgotten can be fully implemented.

Use of the PTEA DB is optional. An app could, for its own data, do things its own way. However, use of the PTEA DB provides an easy readymade solution for app developers which permits fast and flexible cross app reporting, subject to permissions.

The PTEA DB and the two apps provide capability similar to that provided by Infura for Ethereum, but with greater flexibility and privacy control.

The database holds:

- public transactions
- whatever info an app choses to publish for private transactions, optionally in homomorphic[14] encrypted form
- state for app chosen variables
- balances for app chosen variables eg for fields updated by business transactions eg money (debits, credits), inventory, activities, hours etc

Fee

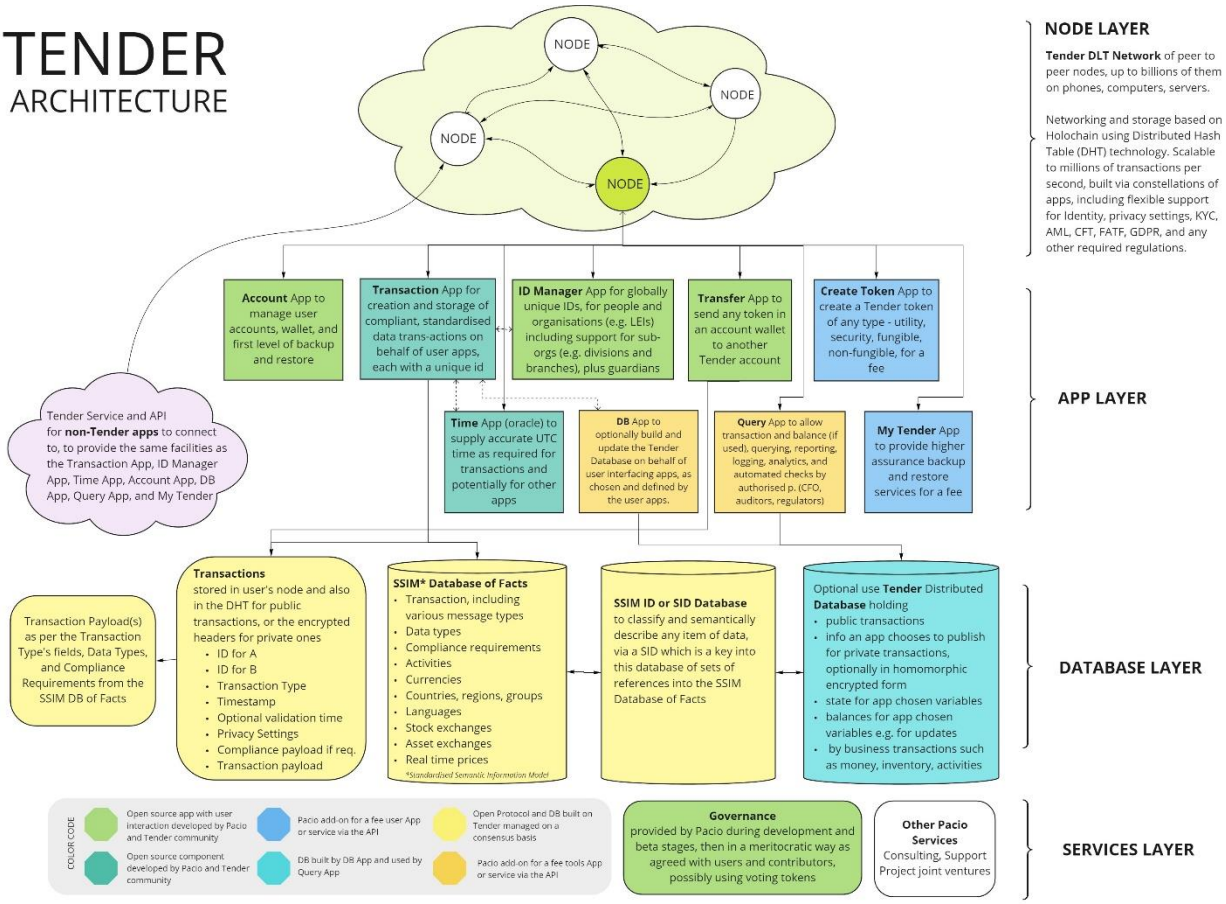
A small (microcurrency) fee eg the PAC equivalent of US$0.001 payable to Pacio by the app (app developer) per create or update operation will apply. Whether the app charges the user of the app or not is an app choice.

Read (query) operations will be free for casual use of say up to 1,000 per day, but be subject to a fee for higher volume use.

[14] From Wikipedia: Homomorphic encryption is a form of encryption that permits users to perform computations on its encrypted data without first decrypting it. These resulting computations are left in an encrypted form which, when decrypted, result in an identical output to that produced had the operations been performed on the unencrypted data. Homomorphic encryption can be used for privacy-preserving outsourced storage and computation. This allows data to be encrypted and out-sourced to commercial cloud environments for processing, all while encrypted.

10 Initial PTEA Apps

This section lists the initial PTEA Apps to be developed by Pacio in launching PTEA. They are shown in the PTEA diagram in the Vision section at the start of this paper, repeated here:



10.1 Free User Interfacing Apps

10.1.1 Account App

The Account App will manage user accounts, wallet, and provide a first level of backup and restore, as described in *TEA Accounts*.

10.1.2 SOS App

The Pacio SOS App manages globally unique IDs for people and organisations (eg LEIs) including support for sub-organisations (eg divisions and branches), plus guardians to assist with recovery.

10.1.3 Transfer App

The Transfer App allows a user to transfer (send) a value (amount) of any fungible PTEA token held within an account wallet to another PTEA account, optionally with a validation time.

PTEA non-fungible tokens may also be transferred but then no value is involved – just the NFT itself.

Initially only PTEA tokens would be supported by the Transfer App but over time support for transferring non-PTEA tokens will be added.

10.2 Fee Based User Interfacing Apps

10.2.1 Create Token App

The Create Token App allows a user to create a PTEA token of any type - utility, security, fungible, non-fungible, for a PAC fee.

The process involving defining the token properties including its name and then instantiating the token.

The rules for a token defined when it is created are stored in a genesis transaction.

The rules applicable to any token used by a wallet are stored within the wallet by copying from the token genesis transaction. Most apps which define tokens will use the optional PTEA DB to make this easier and faster.

Fungible tokens can be minted in any quantity the app or creating user specifies, whereas only one of a non-fungible (unique) token can be created.

Though the Create Token App can be used to create any type of token, other apps may also create special purpose tokens.

The fee is partly to discourage frivolous use. The user/entity which creates a new fungible token should do so only if there is intent to put the token to use via an App.

10.3 Free Tools Apps

10.3.1 Transaction App

The Transaction App builds, stores, and processes compliant transactions on behalf of apps which call it. The app:

- checks to see that required data according to transaction type has been passed to it
- checks that the data is in SSIM form according to fields defined for the transaction type
- checks to see that the required compliance data has been passed to it, if the transaction type involves compliance, for inclusion in the transaction's compliance payload
- builds the transaction
- processes signing by the counter party if applicable
- saves the transaction to the local source chain and to the DHT in full or just header form according to whether the transaction is public or private
- adds the transaction to the PTEA distributed database if the calling app is using that, and processes state and/or balance updates if applicable
- at the appropriate time processes transactions subject to a time delay whether for the optional; validation time, compliance confirmation from the recipient ot recipient's agent, or a transaction that is a member of a set

10.3.2 Time App

The Time App is an oracle to supply the current UTC time. This is not simple because of internet latency and transmission delays, and the need to solve this issue goes back to 1985 with the Network Time Protocol (NTP) which is a networking protocol for clock synchronization between computer systems over packet-switched, variable-latency data networks.

The Time App could use NTP as a PTEA oracle, or it could use a timestamp authority such as freeTSA.org as described in the article Blockchain-Based Document Timestamping and Verification, or it could make use of an already available timestamp oracle such as the one provided by Chainlink.

The Transaction App will call the Time App, and so should any other app running on PTEA which needs time.

Time App Evolution

One reason for having a separate app for time is that providing accurate time for devices is a field that is evolving since very accurate time is needed for the GPS system which are now a part of everyday life.

As the Economist article "Satellite-navigation systems such as GPS are at risk of jamming" article says:

> To turn the clock back properly, however, some people are trying to revive the idea of land-based navigation beacons similar to the Loran (long-range navigation) towers used by the American and British navies during the second world war. According to George Shaw of the General Lighthouse Authorities of the UK and Ireland, which runs the British Isles' coastal-navigation system, several countries are now constructing enhanced "eLoran" networks. These include China, Iran, Russia, Saudi Arabia and South Korea. And, on a smaller scale, private enterprise is interested, too. NextNav, a firm based in Silicon Valley, is building in San Francisco a network of about 100 small beacons that will broadcast timing and position signals around the city. This network's density, and the fact that it can draw power from the grid rather than relying, as GNSS satellites do, on solar panels, means that the signals are roughly 100,000 times stronger than those from such a satellite—and thus hard to jam or spoof.

Thus the PTEA Time App is likely to evolve too, which is part of why it is a separate callable tools app.

10.4 Fee Based Tools Apps

10.4.1 DB App

The DB App tools app allows participating apps to build and update the *PTEA Database*, as chosen and defined by the user app.

10.4.2 Query App

The Query App allows transaction and balance (if used), querying, reporting, logging, analytics, and automated checks of the *PTEA Database* by authorised people such as CFO, auditors, consultants, regulators etc.

11 Applications Platform

The PTEA network or system is the sum of all activity by people or entities using PTEA, and that activity happens via applications or apps. Thus PTEA is an Applications Platform.

PTEA apps inherit all the features and abilities of Holochain described in the Holochain core concepts Application Architecture page, plus they have access to ***Error! Reference source not found.***, as described in previous sections. These extensions add greatly to the capability of PTEA apps.

PTEA apps are truly distributed – they run on a user's node, with no central server or cloud involved. As an example, if Snapchat were a distributed app, you and your friends would all have the app on your phone, and when you send a photo, it would be sent directly to your friends and only to your friends. No intermediary servers. No intermediary blockchain. No cloud.

PTEA will provide app development tools, and app support tools.

PTEA profits from cooperation. In a network effect every application profits from the user base of suitable or compatible others. User adoption will be boosted by earning opportunities provided via the network.

The zero-fee transactions, privacy, security, unlimited scale and stability of PTEA allow for a wide range of real-world applications. While the network is open to every use case, we project that the first set of applications will focus on micro transfers – from donations to gaming to IOT.

Data immutability, security and privacy makes PTEA ideal for business-critical use cases too: payments systems, remittances, accounting, financial reporting, payroll, exchanges etc.

Use cases are discussed in greater detail in the *Use Cases* section.

11.1 Simple Applications

Simple apps such as (micro-)money transfer ones can run on a phone or desktop. Apps will be available from an app store. If the phone or computer isn't already running a PTEA node, installing an app will automatically start a light node running – a node sufficient to sign transactions and do local network maintenance.

11.2 More Complex Apps

More complex or sophisticated apps with database or other requirements will run on a computer or server in a wasm (web assembly) machine with a full DHT (distributed hash table) node. Such apps could have either a web user interface, or a mobile phone app one, or both.

11.3 High Throughput

Some PTEA apps such as IoT ones and some business one will have high transactional throughput needs of the order of 50,000 tps per node. To handle this Pacio is optimising node processing sped with local (to the node) DB storage and load balancing.

11.4 Database Requirements

PTEA apps can use the NoSQL *PTEA Database* via the DB and Query apps for their database requirements. This will cover most app needs, including querying, reporting, and logging.

However, for applications requiring an SQL (relational) database in addition to the PTEA DB capabilities, app hosting providers could configure a cluster of database nodes to ensure scalability and data security using a database such as TiDB.

12 PTEA Governance

PTEA Governance will involve:

- Decisions about network and protocol evolution
- Maintenance of the *SSIM Database of Facts*

The two governance aspects are quite different and likely to be of interest to different people or organisations.

Network and protocol decisions will be relatively few, but require in depth knowledge of the whole PTEA ecosystem for inputs to be valuable ie most app end users would not have the knowledge or be interested.

Whereas maintenance of the SSIM Database will involve many small updates with new facts or edits to facts being proposed. Followed by some form of consensus or voting as to which news facts or edits should be accepted. In this case only knowledge of the domain of a particular fact is required, not detailed knowledge of PTEA or its operation.

Given how different the two governance aspects are, different mechanisms will be required, though both should be open, meritocratic, and include means of avoiding or resolving disputes or disagreements.

Striking the right balance to ensure openness and meritocratic design making, while avoiding the risk of sectional but motivated interests driving change in their direction to the detriment of PTEA as a whole, will be tricky.

Rather than try to design governance schemes in advance, it is planned that Pacio will fulfil the roles during development and beta launches, then establish full public governance once there are sufficient users to provide feedback on the options.

Network and Protocol Governance

Some possibilities with details to be defined to avoid abuse are:

- A foundation like the Ethereum Foundation
- A voting token from a “mint” that every x weeks or months checks current usage of the network, burns tokens from owners that have not used the network and awards tokens to those who have.
- A voting token similar to the above but for app developers or app developer organisations rather than users

SSIM Database of Facts Governance

The *SSIM Database of Facts* section proposes a folksonomy approach to maintenance of the database.

It might be appropriate to consider a meritocratic voting token awarded for proposals which are accepted, and which expire only after years, rather in weeks or months as for the proposed network voting tokens.

13 Use Cases

All of the elements described in the previous sections come together as the open PTEA Distributed Ledger Technology (DLT) network and applications platform, a common good, which can scale to millions of zero cost transactions per second to support apps involving transactions, especially those with a finance, business, or management focus.

PTEA permits innumerable possible use cases or applications. A few are listed in the following sections. All these applications will greatly profit from a flourishing PTEA Economy.

13.1 Built-in Apps

PTEA includes built-in apps described in section *10 Initial PTEA Apps*:

- Account Management, Digital Id, and Transfer apps
- The optional small fee Create Token and My PTEA apps
- Tools apps for Transaction processing, Time, DB maintenance, and QB querying/reporting

13.2 Zero-Fee and Micro Currency Transaction Apps

Zero-fee and micro currency transactions will enable many applications, including:

Microdonations

PTEA will bring the first donation service that can do 1-cent donations. Without fees.

Paywall

Why not make a micro-paywall? Users pay 1 cent per pageview. Or 10 cents per day.

Better Payments and Remittances Systems

PTEA will support better payments and remittances systems tailored to the needs of users in their own country or region, with everything being done by phone or computer plus agents or exchanges for fiat conversions. In M-Pesa countries, M-Pesa can act as the of the on/off ramps.

These PTEA apps will truly bring “banking” to the world’s unbanked.

Gambling

Lotteries and sports betting are ideal applications for PTEA. Players transact only the active stake and don't have to trust the application owner. Gains are immediately transferred. All bets or entries can be recorded, not just some anchoring ones, so making everything completely transparent. No hidden house advantage.

Gaming

Zero fee currency is ideal for in-game purchases and transfers.

IOT

IOT applications will not gain traction if their underlying transaction currency comes with a fee and has very limited speed and scalability.

Secure Email

Micro fee emails could finally be the breakthrough for spam free and secure email services.

Streaming Money

Payroll by the minute. Microwork applications. Pay services by the second.

13.3 Pacio Applications

Pacio has its core in the business-data field and will develop applications in the following fields:

Triple Entry Accounting

Pacio will enable Triple Entry Accounting or TEA, to become the norm and thereby contribute to improving or even saving the world, by making a TEA Engine app built on PTEA available to all business/accounting systems. The Pacio article BlockchainTech: Can Triple Entry Accounting Save the World? expands on the TEA story.

Target Average Rate Index - TARI®

TARI®, invented and developed by Accounting Professor, Dr Keith Cleland, and his IT partner Trevor Watters, Pacio co-founders, has been shown to significantly boost the bottom line of businesses, large and small, some dramatically so.

Pacio will provide a TARI® Service built on PTEA to handle all the mechanics, to allow business apps to easily incorporate TARI® to improve their offerings and thereby provide real business improvement help, giving actionable business improvement insight right where and when it is needed – at the action point.

Semantic Data and Financial Reporting

The Standardised Semantic Information Model (SSIM) used by PTEA will allow better financial reporting using the SSIM data.

13.4 Other Applications

Some of the other applications or fields in addition to those listed above that will benefit from PTEA and potentially the Pacio apps are:

- Business apps of all types eg supply chain management, inventory management, invoicing, quoting, payroll, ecommerce, financial reporting, auditing, business and management apps incorporating TEA and/or TARI®….
- Banking
- Sovereign Money – CBDCs (Central Bank Digital Currencies)
- Crypto currencies
- Stable currencies
- Utility tokens
- Security tokens
- NFTs (Non-Fungible Tokens)
- Fintech apps of all kinds
- Legal services including smart legal contracts as per Trillions of Smart Legal Contracts May Be Expected Annually Says Senior UK Judge. Just one trillion contracts per annum is 32,000 per second plus more for the interaction with those contracts. That is “easy” for PTEA but 2,000 times greater than current Ethereum capacity.
- Publishing
- Streaming Video and Audio Services
- Tokenisation of assets of all kinds including derivatives
- Work - re remote working and how work is paid for
- Multicurrency-exchanges
- Ad-networks / earn-to-read

- Crowdsourcing
- A Verified Linkedin
- A better Patreon
- VR apps
- 5G – many high speed 5G services will benefit from the high capacity but low cost of PTEA
- Autonomous car apps
- “Adult” services
- Better (safer and private) social media
- ….

14 The Whole

In total PTEA will enable better currencies; better payment systems; better data management; better privacy for people and entities; better identity management; better compliance with regulations; better content management; better monetisation of original work; better games; and better more fraud resistant accounting (Triple Entry Accounting or TEA) plus better management systems including TARI® for the world’s businesses and entities, all as part of a better, fairer, and more secure internet.

PTEA will do all that with ubiquity and inclusiveness as the ability to run on any device from smart phones up means that most people in the world will be able to take part in the PTEA network, transparently or unconsciously in most cases with PTEA and apps just being there and working without fuss.

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