“Immutable Me”

A Discussion Paper
Exploring Data Provenance To Enable New Value Chains

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Problem Statement

With the advent of blockchain, is there an opportunity to add a distributed layer between the data value and the consumer of personal data?

Furthermore, does the verification and provenance of the data enable an attestation, provided by a relying party, to eliminate the need to give up Personally Identified Information (PII) at all?

How can we enable people to access all the data they generate with full control of their master record and permission data on their terms using verified attributes without sacrificing their privacy?

The Opportunity

"Up until now the power to capture, analyse and profit from personal data has resided with business, government and social networks. What if you and I had the same power?" Meeco Manifesto 2012[1].

According to the QUT and PwC Identity 3.0[2] white paper:

> *"Developed economies are moving from an economy of corporations to an economy of people. More than ever, people produce and share value amongst themselves, and create value for corporations through co-creation and by sharing their data. This data remains in the hands of corporations and governments, but people want to regain control. Digital identity 3.0 gives people that control, and much more."*

Identity is moving beyond issued instruments like passports, social security cards and ID cards. It is moving towards ***contextual identity*** in which "I can prove who I am" (persona) in the context of what I am doing.

Government issued identity instruments are relatively easy to forge. Every day, stolen identities are exploited through organised crime and on-line hacking activities. Conversely, personal attributes, behaviour, social and reputational data is more difficult to forge, in part because it makes up an immutable timeline of our life.

Increasingly the sum of the parts of our digital exhaust and social presence creates a strong identity. However the opportunity for individuals to use this for their own benefit is limited.

Proposal

The movement from User Centric Identity to Self Sovereign Identity is underway and becoming a key trend for the future of how individuals will control their own attributes.

Using blockchain technology to record data provenance, Meeco is working at the forefront of this movement and currently working on a proof of concept that allows individuals to add verification and provenance attestations to their data attributes. This is in addition to the existing permission management of their attributes.

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1 Meeco Manifesto: https://meeco.me/manifesto.html

2 PWC Report Identity:

http://www.chairdigitaleconomy.com.au/wp-content/uploads/2015/08/Digital_Identity_30_20150831_FINAL.pdf

Meeco aims to be blockchain agnostic (since what type of ledger is used will be use case dependent), thus enabling individuals to link provenance to data/attributes to support a range of personas and enable progressive disclosure. This approach also supports the option for individuals to use private, public, permissioned and permissionless chains.

The identity pieces (data and attributes) can be use-case sensitive, thus create context-based personas through unifying only the relevant attributes across different chains.

Personal control is central to increasing the power individuals hold over the range of attributes and claims that make up their identity. Enabling identity markers to be thin sliced, refined and contextual provides added privacy protection. The combination of attribute, verification and provenance provides the capability for data governance to move from data collection of personally identifiable information (PII), to binary pull requests, i.e. over 18 years (yes/no) versus date of birth.

This approach provides protection as the individual solely has the power to bring these attributes together with the added value of verification. For the relying party, the option exists to store the provenance rather than the attribute on public and private blockchains and distributed ledgers, thus providing an immutable audit trail for assurance without the compliance risk of collecting, managing and holding the data.

Why add Provenance?

Provenance refers to the tracking of supply chains and provides a record of ownership via an audit trail, which can be ordinated (the specific order matters). In the case of attributes and claims it is important that the data can point back to a reliable record (the golden record) and that this is shown to be immutable.

It's important for purposes of integrity, transparency and counterfeiting that this asset and its path be known or provable every step of the way. A supply chain refers to the creation of a network in which an asset is moved, touching different actors, before arriving at a destination. It helps bring time and distance together in a manageable way. The tracking of this asset has real value to the actors involved. This equally applies to identity and all the components that make up that identity.

This approach is a pathway to turning data (single attributes) into networked data flows that compound in value and become assets similar to financial synthetics such as asset backed securities (ABS) as much as anything else in the world considered to be an asset such as Norwegian salmon, diamonds, prescription drugs, or Letters of Credit (LOCs) and Bills of Lading (BOLs).

It is important to note that this is not one master identity (record) token that is tokenized and travels through a network, but rather the attributes associated with that identity that are called upon based on context.

In order for data provenance to be effective (from a technology standpoint), it must fulfill certain requirements and characteristics that would upgrade supply chain management and monitoring. According to Sabine Bauer in his paper titled "*Data Provenance in the Internet of Things*" they are:

> **Completeness:** Every single action, which has ever been performed, is gathered.
>
> **Integrity:** Data has not been manipulated or modified by an adversary.
>
> **Availability:** The possibility to verify the collected information. In this context, availability is comparable to auditing.

Confidentiality: The access to the information is only reserved for authorized individuals.

Efficiency: Provenance mechanisms to collect relevant data should have a reasonable expenditure.

Additionally Meeco believe these requirements require the additional characteristics of:

Privacy: the ability to control the access, permission and visibility of personal attributes.

Unlinkability: a state where this personal data must be secure and not get into the wrong hands.

Transparency: of the chain and total traceability of the transactions, particularly when it comes to actions and modifications.

A Blockchain fulfills all of these requirements.

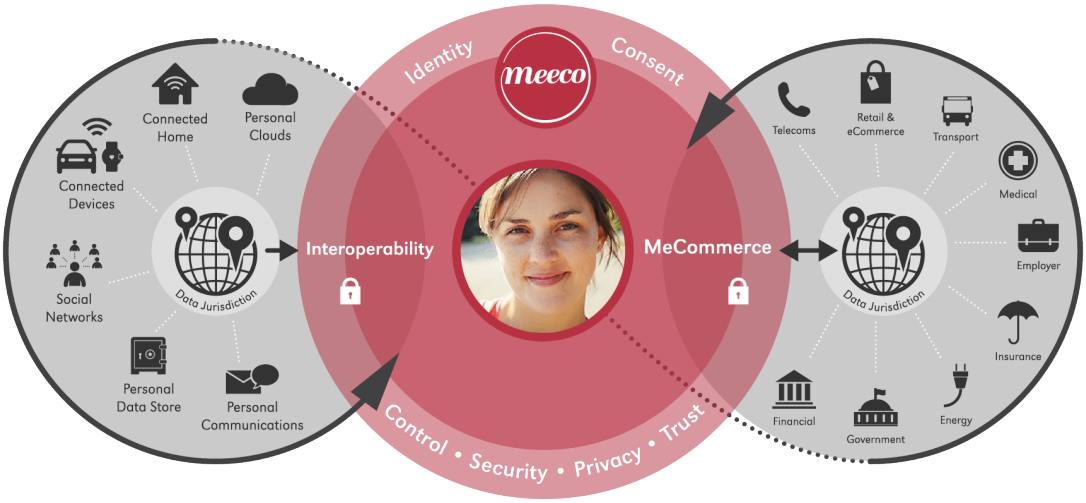
How Will Meeco Link Data Provenance To Attributes on a Blockchain?

Blockchain allows for Digital Identity 3.0 Quoted from the PWC paper:

> *Digital identity 3.0 is a private and integrated master record that exists independently of any immediate commercial or legal context. It empowers people to create new attributes, share these attributes selectively as they connect with others, and create experiences and value beyond what can be predicted.*

Master Record

For preservation of privacy there must be some way to protect the master record and the range of attributes which can be associated with a master record where explicit permission has not been granted.



The primary purpose of a master record is to create value specifically for the individual. However, the existence of this verified master record can in return, if permissioned, create significant value for receiving parties; i.e. organisations, enterprises, institutions and other individuals.

It is not intended for the master record will not be stored or visible on the blockchain. The intention is not to permission the master record, but to reference back to its immutable

existence. This way the master record can support infinite links to data attributes of association, without linking all the attributes in one chain. This master record will have an anonymous unique identifier that is only known to the owner via private keys.

Once these attributes are created they can be put on a supply chain without the need to share the entire identity only the value that is needed in order to validate the integrity of it.

The Value of Provenance For Privacy Preservation.

Tracking the origin and movement of data across a supply chain in a verifiable way is a difficult thing to do. In supply chains stretching across time and distance, all of these items could suffer from counterfeiting and theft. Establishing a chain of custody that is authenticated, time-stamped and replicated to all interested parties is paramount to creating a robust solution.

The problem can be addressed using blockchains in the following way:

1. When the data is created, a corresponding digital token is issued by a trusted entity, which acts to authenticate its point of origin (the attribute).
2. Then, every time the data changes hands that is the attributed associated with that identity (persona), the digital token is moved in parallel, so that the real-world chain of custody is precisely mirrored by a chain of transactions on the blockchain.
3. A tokenized attribute, is an on-chain representations of an item of value transferred between participants. In this case proof of the golden record.

This token is acting as a virtual 'assertion of identity', which is far harder to steal or forge than a piece of paper. Upon receiving the digital token, the final recipient of the physical item; whether a bank, distributor, retailer or customer; can verify the chain of custody all the way back to the point of origin.

This digital identity token can also act as a mechanism for collectively recording and notarizing and linking *any* type of data back to the master record. A blockchain can provide a distributed database by which all the records and assertions about an attribute are written and linked, accompanied with a timestamp and proof of origin that ties back to the golden record token in a most verifiable way. An example could be a hash of a record that a certain element of my attribute or claim was verified when engaged in a certain type of action. This distributed database also stops corruption and theft by storing the multiple pieces of our attributes in a highly distributed manner that require the proper keys to open and put back together.

This approach is designed to counter the current problem of how companies collect personally identifying data and then use it to track individuals without explicit or informed consent. The data is used to target individuals with the aim to mold and influence behavior. This current approach of tracing our identity does not afford individuals to control their attributes or the elements that link them, as a result we don't get to realise the value of, or monetize the data companies collect on us.

How Will The Data Get Stored?

The Multichain blog[3] eloquently describes how data can be optimally recorded on the blockchain and this approach is informing how Meeco is approaching proof-of-concepts:

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3 Four genuine blockchain use cases

http://www.multichain.com/blog/2016/05/four-genuine-blockchain-use-cases/

"In terms of the actual data stored on the blockchain, there are three popular options:

1. ***Unencrypted data**. This can be read by every participant in the participating blockchain, providing full collective transparency and immediate resolution in the case of a dispute.*
2. ***Encrypted data**. This can only be read by participants with the appropriate decryption key. In the event of a dispute, anyone can reveal this key to a trusted authority such as a court, and use the blockchain to prove that the original data was added by a certain party at a certain point in time.*
3. ***Hashed data**. A "hash" acts as a compact digital fingerprint, representing a commitment to a particular piece of data while keeping that data hidden. Given some data, any party can easily confirm if it matches a given hash, but inferring data from its hash is computationally impossible. Only the hash is placed on the blockchain, with the original data stored off-chain by interested parties, who can reveal it in case of a dispute."*

For the purpose of Meeco, option (3), hashed data is our area of focus. Meeco advocates the data be at rest in a disturbed network, e.g. financial data might remain with the issuing bank, medical records with a physician and student records with the school admin system. In turn all these records can be augmented by the individual records, stored in personal clouds with read and write access based on permissions.

Where the Meeco API-of-Me is used for a direct implementation between peers (individuals and organisations) connected parties can benefit from real-time, read, update, and audit records. Only the individual has the ability to federate attributes into a single context specific view.

Data at rest can reside in a personal cloud and/or enterprise data store. The value created is how these data sources interoperate through an audit trail and order of tasks, aligned to a specific outcome, in a specific context using the minimal number of attributes required to disclose at each step of the process.

It is the sum of the parts that creates a strong, sovereign and immutable series of records. When backed by assertions, verifications and provenance, this master record of records becomes a value personal asset. In this scenario individual will enjoys the same rights and value that governments and institutions currently have.

The ultimate aim is to provide individuals with the means to collect and connect attributes that strengthen their personal and context based assertions. This may include 'I am' statements such as:

- I am a citizen of
- I am a qualified professional in the field of
- My income can support my application for
- I am old enough to access this service
- My delivery address for today is
- I can be discovered by.

Conclusion

As we enter what some are calling the 4th phase of the Internet[4], defined by the right of individuals to assert their sovereignty. In this context we are moving beyond send, search and social to the vantage point of self-sovereignty.

A blockchain or distributed ledger will act as an enabler and supporter of realizing this value.

This approach supports the concept of 'minimum viable identity information'. This is dependent on the situation, use-case and context. This is why personas become so critical as a means to protect identity, minimize the cost of collection, increase compliance and enable new networked value flows. This network of values flows enables individuals to engage in transactions for a particular need at a particular point in time for a particular desired outcome.

This is the vantage point by which the individual generates identity through every day activities, assertions, attributes, claims and context. By placing the individual above the attributes collected by and about them, they are able to orchestrate a value flow across the silos of their life, enabling new value chains.

Given the increasing security, fraud and counterfeiting issues associated with the current model of collecting and storing personal data, compliance and risk mitigation will drive the opportunity for individuals to control and permission their personal data.

Digital Identity 3.0 together with blockchain and distributed ledger technology takes us towards the vision that we (humans), may become the custodians, issuers and provenance providers of our identity.

4The Fourth Order Effect : Or HOW the Next Big Wave of the Net Will Work Out & WHY? By Brian Grimmer
https://briangrimmerblog.wordpress.com/2013/12/19/the-fourth-order-effect-or-how-the-next-big-wave-of-the-net-will-work-out-and-why/

Glossary

The following terms are relevant to this article. These are just a subset of the terms generally used to discuss digital identity, and have been minimized to avoid unnecessary complexity. The below definitions come from the blog of Christopher Allan, unless otherwise referenced: *http://www.lifewithalacrity.com/2016/04/the-path-to-self-sovereign-identity.html*

Attributes
Every Digital Identity has zero or more identity attributes. Attributes are acquired and contain information about a subject, such as medical history, purchasing behaviour, bank balance, age and so on.[4] Preferences retain a subject's choices such as favourite brand of shoes, preferred currency. Traits are features of the subject that are inherent, such as eye colour, nationality, place of birth. While attributes of a subject can change easily, traits change slowly, if at all.

Authority
A trusted entity that is able to verify and authenticate identities. Classically, this was a centralized (or later, federated) entity. Now, this can also be an open and transparent algorithm run in a decentralized manner.

Claim
A statement about an identity. This could be: a fact, such as a person's age; an opinion, such as a rating of their trustworthiness; or something in between, such as an assessment of a skill.

Credential
In the identity community this term overlaps with claims. Here it is used instead for the dictionary definition: "entitlement to privileges, or the like, usually in written form"23. In other words, credentials refer to the state-issued plastic and paper IDs that grant people access in the modern world. A credential generally incorporates one or more identifiers and numerous claims about a single entity, all authenticated with some sort of digital signature.

Identifier
A name or other label that uniquely identifies an identity. For simplicity's sake, this term has been avoided in this article (except in this glossary), but it's generally important to an understanding of digital identity.

Identity
A representation of an entity. It can include claims and identifiers. In this article, the focus is on digital identity.

Permission / Permissionless
A **permissioned** system is one in which identity for users is whitelisted (or blacklisted) through some type of KYB or KYC procedure; it is the common method of managing identity in traditional finance.67 In contrast, a **permissionless** system is one in which identity of participants is either pseudonomyous or even anonymous. Bitcoin was originally designed with permissionless parameters although as of this writing many of the on-ramps and off-ramps for Bitcoin are increasingly permission-based.
http://www.ofnumbers.com/wp-content/uploads/2015/04/Permissioned-distributed-ledgers.pdf

Personal Data
The definition of personal data is evolving. Traditionally, that definition was pre-determined and governed through the use of a binary approach: In most jurisdictions, the use of personally identifiable information (PII) was subject to strict restrictions whereas the use of non-PII was often uncontrolled. However, what is considered personal data is increasingly

contextual; it changes with personal preferences, new applications, context of uses, and changes in cultural and social norms.

Traditionally, organizations have used a variety of techniques to de-identify data and create value for society while protecting an individual's privacy. Such data was not subject to the same rules as PII, as an individual could not be identified from it. But technological advances and the ability to associate data across multiple sources is shifting boundaries of what is or is not PII, including potential re-identification of previously anonymized data.

This issue is the subject of significant debate with some arguing that this means that all data is effectively personally identifiable and should be treated as such. Others urge caution, arguing that this would curtail many of the beneficial uses of anonymous data with minimal gains in privacy. A shift in approach to thinking less about the data and more about the usage could offer a way forward. If the usage impacts an individual directly it would require different levels of governance than data which is used in an aggregated and anonymized manner.

http://www3.weforum.org/docs/WEF_IT_UnlockingValuePersonalData_CollectionUsage_Report_2013.pdf

Links

- http://db.cis.upenn.edu/DL/fsttcs.pdf
- https://en.wikipedia.org/wiki/Provenance
- http://siis.cse.psu.edu/pubs/tapp10.pdf
- http://siis.cse.psu.edu/provenance.html
- http://www.cse.psu.edu/~sem284/pubs/acsac-2012.pdf
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