INTRODUCING

Linnia

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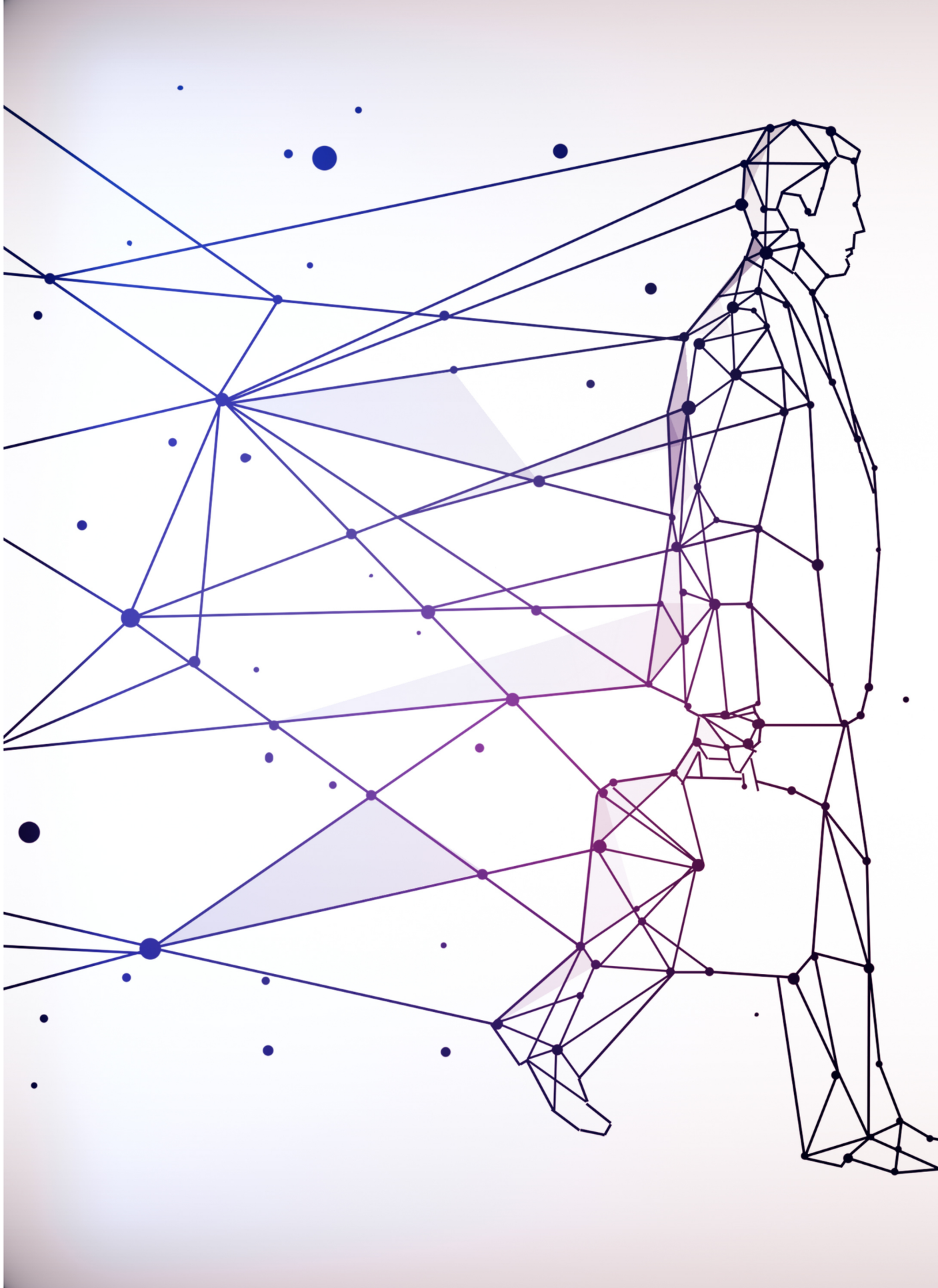
THE OPPORTUNITY FOR DATA SELF-SOVEREIGNTY

Almost every one of our experiences produces data, from our birth (such as date, location), to our daily activities (such as what we do, where we go, what we buy), to our social interactions (such as who we contact, what we discuss), and more. This data is separately captured, owned and controlled by the organizations and devices that surround our experiences and used to further the interests of those entities which collect it. These data silos of Web 2.0 (Google, Facebook, Amazon, etc.) were not initially designed to be corporate monoliths collecting user data for questionable ends. However, they have effectively evolved from their initial pursuits (search, social network, shopping, etc.) to use and profit from our data, with nominal consent, to influence us in ways we cannot see or control. Many users are unaware of the data (and derived value) that they are providing to third-party platforms, and their lack of agency in the process.



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THE OPPORTUNITY FOR DATA SELF-SOVEREIGNTY

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Furthermore, each data silo is limited in its visibility, collecting data only from our interactions within its proprietary environment — merely a partial representation of our behavior, as our digital lives span numerous silos and parts of our physical lives exist beyond the reach of Web 2.0.

We believe that Web 2.0 will be a mere blip on the historical record; a brief interlude between the birth of the Internet and the arrival of our data self-sovereignty, wherein we own and control all of our data, separate from the participation of outside proprietary agents. In the future, third parties will no longer own an individual's data, but rather have to request permission to access it. This sort of independence seemed promising in the early days of the Internet, but corporate data silos quickly made our data independence impossible. Now, we need the decentralized authority of Web 3.0 to realize the full potential of cooperative digital communities and individual independence. Soon, control over our data will form an inextricable part of our own human agency. Users of Web 3.0 will have full autonomy to define which subsets of their data they choose to share, with whom and under what circumstances.

Three foundational components of this Web 3.0 future, required for users to enjoy data self-sovereignty, are: decentralized storage (the ability to store, and perform computation on, data across a network, as with IPFS); self-sovereign identity (the ability to identify individual entities across decentralized platforms - e.g., representing oneself on the blockchain, as with uPort); and, crucially, the ability to affiliate the decentralized data with self-sovereign identities and control access to that data. These components are required to enable a robust ecosystem of decentralized applications that leverage decentralized identities and the data affiliated with them. The first two components, decentralized storage and self-sovereign identity, are already underway and quite developed relative to the maturity of the blockchain ecosystem. The third is yet to be successfully achieved. That's where Linnia comes in.

II.

THE SOLUTION: LINNIA

Linnia is a data protocol built on the Ethereum blockchain that enables self-management over data. It employs a decentralized platform to store and share longitudinal data of any type, affiliating that data with decentralized identities on the blockchain (which can belong to individual users, connected devices and other entities represented by such identities), achieving two objectives: protecting privacy and allowing data to flow freely.

Linnia will allow individuals to engage with their aggregated longitudinal data, creating the opportunity to benefit from sharing that data (which, due to its completeness, offers a remarkably intricate level of fidelity) by demanding compensation in exchange for access by enterprise third parties. Individual gains can also come from using individual data to create novel services, tailored to users' needs and desires in a more quantified and precise manner than is possible today.

With Linnia, not only will individuals be able to independently interact with their data separate from proprietary third parties, they will also have the opportunity to meld it with others' data into a common pool that reflects the experiences of many individuals. Being able to engage with vast data sets far in excess of the information currently available will allow third parties to understand individual and population-level dynamics with notable granularity, while maintaining an unprecedented amount of privacy and security.

II.

THE SOLUTION: LINNIA (CONT'D)

Today, the costs of data aggregation are borne, and the benefits subsequently enjoyed, by centralized authorities. Individual users have a black and white decision — opt in or out, choosing to either participate in modern society or forfeit their data with no negotiation of the terms. As we move toward Web 3.0, a more equal distribution of both costs and benefits will level the playing field in the Linnia-enabled data marketplace. Enterprises or third parties can participate by contributing or requesting access to data, but only with explicit consumer permission and potentially only with consumer incentives. This new role for enterprises will require adjustment, as the total control over consumer data they enjoy today will wane. If enterprises evolve to suit the decentralized future, the wealth of opportunity is virtually infinite.

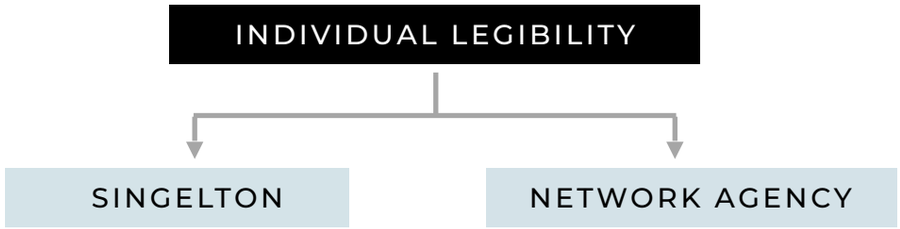
Linnia offers a broad range of potential implementation opportunities. Though we began in the health world, the protocol's data type-agnostic role can enable many instances of data aggregation and sharing in other verticals. We are currently developing a document to establish the breadth and variety of use cases for Linnia, which will be released as a separate paper. In this development process, we welcome the community's suggestions and input on these use cases and more.

All of our documentation is organic and living; we plan to keep writing and speaking on potential use cases, and encouraging others who do so as well. Linnia is just a protocol: the services, applications and ideas on what to do with it will mostly emerge from others.

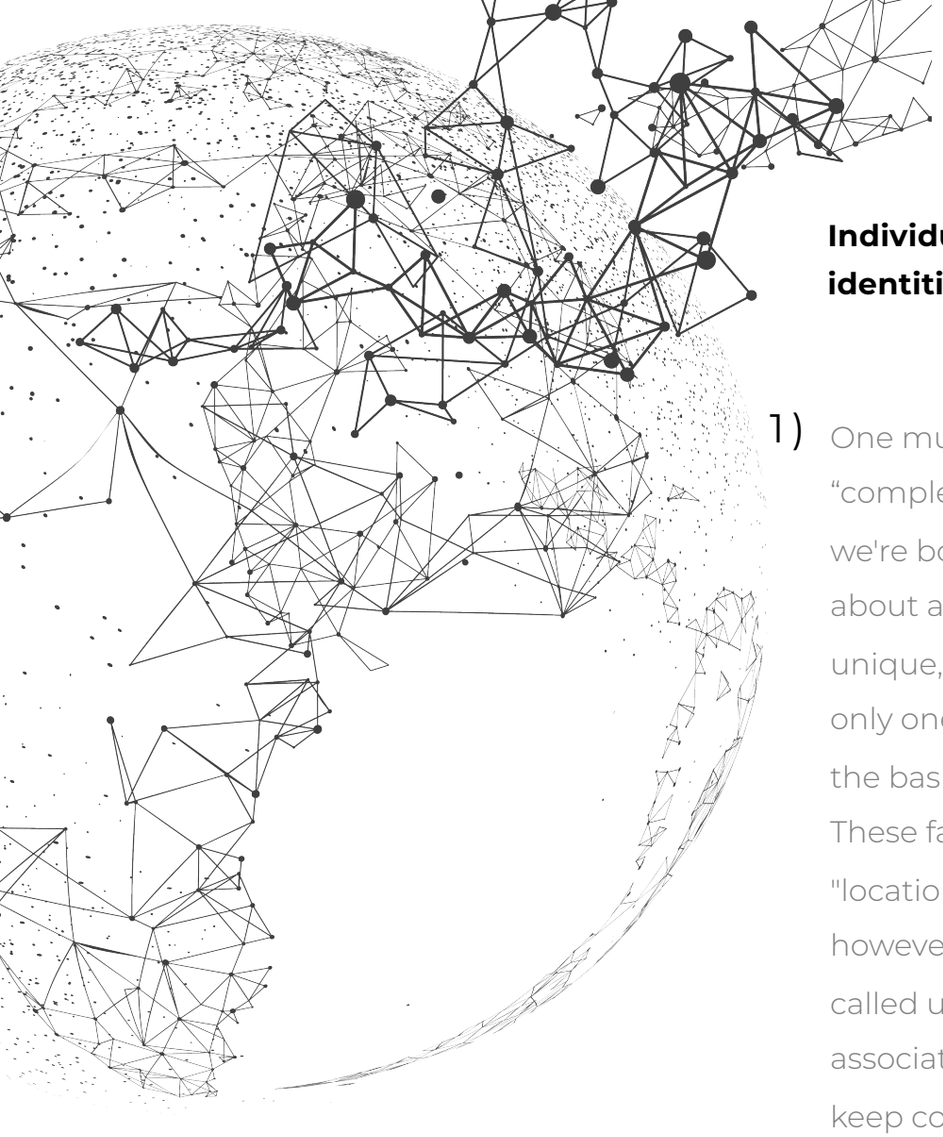
III.

INDIVIDUAL LEGIBILITY: THE FUTURE OF DIGITAL INTERACTION

The Linnia project involves creating a new way for individuals to cooperate, which rests on the following concepts:



Individual legibility: The ability to collect, store and share our data under our control, in a trusted way, without a central authority. Since it is decentralized, it is similar to our human roots in collecting, storing and sharing our data within our social relationships — how we operated in primitive, tribal society. This behavior comes naturally to us, but there are two main differentiators from that historical behavior: individual legibility allows for much more precise control over sharing permissions through technology; it also allows for cooperating with others at a scale far beyond what's possible when we are limited only to those intimate human relationships we can maintain socially. People don't scale, but code does.



Individual legibility requires the capacity to affiliate decentralized data with self-sovereign identities and control access to that data. In order to achieve these objectives:

1) One must first be able to define the scope of all the data that can be associated with an identity — a “complete data set describing the identity,” the sum total of our unique data selves, or singleton (a term we're borrowing from our technical vocabulary which means “all of the things that can be expressed about an object without needing to create another class of object” - and so its contents are entirely unique, just like the data that represents us). Just like there is only one "you" in real life, there must be only one "identity object" representing you on the blockchain - your singleton. This collection of data is the basis for collecting and then disclosing facets of our identity (i.e. types or specific subsets of data). These facets are defined not only by type, but also by context. Our mobility/travel data is part of our "location" identity, just as a our government-issued home address is part of our location identity; however, in a different context, the data describing the walks around the neighborhood we take can be called upon to form part of our "health" identity, just as our blood pressure data might. Your singleton is associated with your decentralized digital identity, and stored in a decentralized manner so that you can keep control over it at all times, enforcing your legibility.

2) Secondly, one must have the ability to make decisions about that data, controlling it and selectively granting access to it (or network agency). Network agency is more expansive than just self-sovereign identity — it requires that our individual legibility be functional. It must both aggregate our data, and give us agency when interacting in a network with others, allowing each singleton to freely exchange trusted data with other singletons in order to generate cooperation. However, network agency is limited by the agency of those with whom we interact; we agree to circumscribe our agency in order to produce win-win outcomes in the game. It is also emergent: the agency of the network is the result of cooperation between the agents in a network. Network agency implies that there is a direction to network behavior towards some attractor, or likely game outcome (the so-called "equilibrium" in economics).

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THE OPPORTUNITY FOR DATA SELF-SOVEREIGNTY

(CONT'D)

This individual legibility entails creating a singleton (1 from above): all of the things that can be expressed about an object without needing to create another class of object. This collection of data is the basis for collecting and then disclosing facets of our identity (i.e. types or specific subsets of data). These facets are defined not only by type, but also by context. Our mobility/travel data is part of our "location" identity, just as a our government-issued home address is part of our location identity; however, in a different context, the data describing the walks around the neighborhood we take can be called upon to form part of our "health" identity, just as our blood pressure data might.

Second, the singleton must be able to exchange trusted data with other singletons in order to generate cooperation (2 from above). We call this ability for a singleton to freely and functionally interact with others network agency. Our network agency is limited by the agency of those with whom we interact. We agree to circumscribe our agency in order to produce win-win outcomes to the game. Network agency is emergent: the agency of the network is the result of cooperation between the agents in a network. Network agency implies that there is a direction to network behavior towards some attractor, or likely game outcome (the so-called "equilibrium" in economics).

I V .
ELEMENTAL LINNIA COMPONENTS

The Linnia protocol leverages attributes of the Ethereum blockchain to create both a singleton and network agency. Linnia's consumer-facing UX allows individuals to collect, store and share their tracked digital expression in order to create singletons that have network agency.

Linnia will bring this vision to life with two components:

1. A decentralized **Linnia data exchange protocol**
    - This allows users to leverage their data in a data marketplace which facilitates the ability of these users to control third-party access to their data and allows third parties to request permission to access and interact with that data
2. A user-facing **Linnia control center** user experience
    - This user-facing experience to bring the promise of Ethereum to individuals, uniting their decentralized identity platform of choice with tools to allow them to engage directly with their data.

A timeline for these efforts is detailed in the accompanying Linnia Technical Paper.

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Linnia works by sitting on top of a decentralized self-sovereign identity layer. The identity platform manages the singleton's private keys and provides a means for tying reputation to an identity in order to create functional pseudonymity on the blockchain. The identity layer therefore should allow for trusted interaction between identities based on a limited set of attributes (i.e. a reputation role or specific role). Existing identity platforms, such as uPort, can fill this role.

However, interoperability among identity platforms is essential. Linnia users should have the autonomy to choose any identity and key management platform they want. Linnia is not in the business of providing wallets or solving the problem of key custody. The identity layer is the engine of encryption, and therefore the guarantor of privacy. Linnia's responsibility is to maintain that encrypted privacy unless and until the user decides to use their private key to provide access to data.

Linnia manages the repository for the self-sovereign identity's data. It are also not a decentralized storage solution, in the way that IPFS or Swarm are, but rather a way for individuals to manage what goes in and out of that storage as they interact in a network.

Specifically, Linnia handles sets of longitudinal data (lifetime time series data) that is trackable at an acceptable cost. This data can include: images, social connections and interactions, mobility (a time series of trips), health, browsing data, purchases, documents and spreadsheets, music and video history, etc. In addition to “primary data,” or data that we generate as a byproduct of our daily lives, Linnia provides a way to track "secondary data,” or data that others assign to us in the form of digitally signed attestations. These attestations could be initiated by humans or by the output of an algorithm (i.e. through computation).

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ELEMENTAL LINNIA COMPONENTS

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With Linnia, data is not trapped in a single silo, within a specific vertical. As discussed above, the concept of a singleton requires that identity be expressed in context. Therefore, "purchases" can have an economic context (such as managing our budgets), and a subset of the purchases, such as food and grocery purchase data, can simultaneously be part of our "personal aesthetics" identity, and our "health" identity.

Linnia supports an ecosystem of singletons that seek to interact with an individual. These entities can request permission to access subsets of an individual's data, or to contribute data about the individual. These entities fall into five broad categories:

- Social groups or communities
- Connected devices (IoT, Bluetooth) owned by the singleton
- Central authorities hosted on digital platforms (i.e. apps)
- Central authorities hosted on physical platforms using IT (i.e. doctors, government)
- Decentralized applications (dapps)

Each singleton has a common set of functions on the platform, regardless of their classification. This is the set of functions needed to create both a singleton and network agency. The basic functionality enables individuals to collect, encrypt, store and share data on a one-to-one basis. Beyond that, networked cooperation presents a search problem. Potential cooperators have to find each other in order to exchange information. The basic search parameters are principally identity metadata (reputation); and more general metadata (provenance, data type). Further, a search can proceed through computation (algorithmic functions) applied to data. Lastly, the Linnia token will creates incentives that align the interests of searchers and searched to produce cooperation (a separate, forthcoming paper will describe Linnia token design in greater detail). All of these contributing factors lead, ultimately, to the emergence of an n-sided data marketplace where search creates the ability to monetize data and channel it to its best use.

Not all of the above functions are available today (i.e. encrypted search and computation), but enough are ready to kick Linnia off and to create significant value in network use cases (described in the appendix). The Linnia team has a roadmap that enables central authorities to stand in for those functions until decentralized alternatives arise. Linnia has also launched its own R&D effort; it shares research with other teams at ConsenSys (the venture production studio of which Linnia is a part); and it looks to bring in external R&D, both through partnerships and through relationships with academic efforts.

The end result of the platform is data liquidity: released from silos and collected as part of a singleton, data can flow across a decentralized network fueling cooperation and emergence.

V.

FOUNDATIONAL TECHNOLOGIES

As a data exchange protocol, Linnia will leverage the combined sources of both new and existing technologies. The following modules represent aspects of the problems that Linnia is trying to solve, and identifies verticals in which existing solutions will likely be invoked.

- *Decentralized Identity:* One of the core aims of the Linnia protocol is to bring back the sovereignty of data to the user. Linnia will be decentralized identity-agnostic, not tailored to a single platform but rather interoperable among the main user-facing solutions (uPort, Civic, etc.).
- *Contextual attestations:* Attestations (either on or off-chain) are a powerful tool which enables any Ethereum account to endorse any other piece of data. However, its usability is limited to a context. Linnia will provide a way to contextualize these attestations and make them useful to third-party applications.
- *Decentralized storage:* It wouldn't be possible to let users own their data if it's stored on a closed-off, proprietarily-owned third party server. Here, the usage of decentralized storage solutions (IPFS, Swarm), will play a major role.
- *Data and Metadata:* In a decentralized application, linked data will face different challenges that the Web 3.0, that should be covered in order to make the content addressable, and measure the underlying quality.
- *Quality scoring:* Linnia provides an algorithm to calculate the underlying value of the data uploaded by the user, which is denoted as IRIS (InfoRmantion Integrity Score). More detail is available in the Linnia technical paper.

The specific roles and interaction of these verticals are detailed in the Linnia Technical Paper.