Quant Network / Constellation Network, Inc.
Technical Integration Overview

An Internet for Automation with IoT and Edge Devices

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Overview

The Quant Network and Constellation Network integration will enable companies to build cross-platform and interoperable big data, IoT and AI production,\\nd sandbox test environments. This integration will be powered by Constellation's HyperGraph and Quant Overledger's interoperability capabilities with 11 permissioned and permissionless blockchain networks and protocols. The interconnectivity of the two technologies, powers possibilities of opening up large data sets by HyperGraph to access new users, clients and networks through Overledger. To begin, Constellation will create a hylomorphism, or a recursive and geometric reference to data, and interconnect them with any blockchain through the Overledger Network - allowing any existing blockchain data to be referenced. As clients begin to scale out use cases, they will develop customizable state channels while leveraging Constellation's consensus as a service, called Proof of Reputable Observation (PRO), which easily integrates into existing data management stacks. The new Constellation connector on Overledger will allow any company the ability to truly safeguard their real world data initiatives, like IoT, where billions of sensors are creating, transferring, and making real-time decisions based on data.

For the blockchain industry to realize its full potential, we need to unlock the potential of blockchain protocols and provide an agnostic end-to-end path from testing in closed environments to production ready real-time digital systems.

Quant has developed the world's first blockchain operating system, called Overledger, which allows customers to connect to any supported blockchain with just 3 lines of code. Clients can choose between multiple blockchains and protocols to create multi-chain decentralized applications (mApps). While blockchain has a myriad of use cases and infrastructures, Quant enables companies to abstract the complexity of blockchain technologies with a single gateway connecting to the underlying blockchain infrastructure. This has opened up the ability for organizations to avoid technology and vendor lock-in, have the choice of interoperability and benefit from combining the features of different blockchains to develop rapid prototypes and production applications - appealing to a myriad of use cases in Government, Financial Services, Healthcare and IoT/Mobility.

Constellation provides a secure communication protocol and a network called HyperGraph that is built to process and organize data streams. Constellation provides application support and developer tools that integrate with existing data management and tech stacks, and consensus as a service, based on reputation, for democratic real-time verification of data. By appending the Constellation developer tools to data pipelines, they provide a way to secure those pipelines at scale while creating an immutable audit trail to big data feeds. The Constellation HyperGraph is built to accommodate production ready data environments and are compatible to existing tech stacks like StackPath, MongoDB, Databricks, and Cloudera.

With the proliferation of blockchain solutions, there is a growing desire to take blockchain to the next level and incorporate it widely into real world and scalable environments.

Constellation will create a connector to Overledger and will provide a new set of features to the growing network of protocols, including consensus-as-a-service and the use of PRO (Proof of Reputable Observation), securing data

pipelines, and their HyperGraph network that topologically orders data for high computational needs (artificial intelligence and machine learning). As such, this will further embrace Quant's vision to unlock and utilize the benefits of interoperability of all blockchains and their core features to enable mass adoption.

This relationship will achieve three main objectives:

1. Constellation will create a connector to Overledger enabling sandbox test environments and production ready deployment.
2. Constellation's infrastructure tools will enable data scientists to define every aspect of the data pipeline with a couple transformations of code (minimizing the pre-process step of data engineering).
3. The partnership will allow the creation of a thriving network of IoT, that securely references data sources while providing trusted and validated public data feeds to enrich interoperating connected smart cities.

This partnership and integration will not only provide a scalable infrastructure that supports the real-time verification of streaming data, but will provide developers the necessary tools to create secure data pipelines. Invariably, this will create a complete ecosystem and one-stop place for blockchain solutions while establishing new standards and capabilities for data and the next generation of applications.

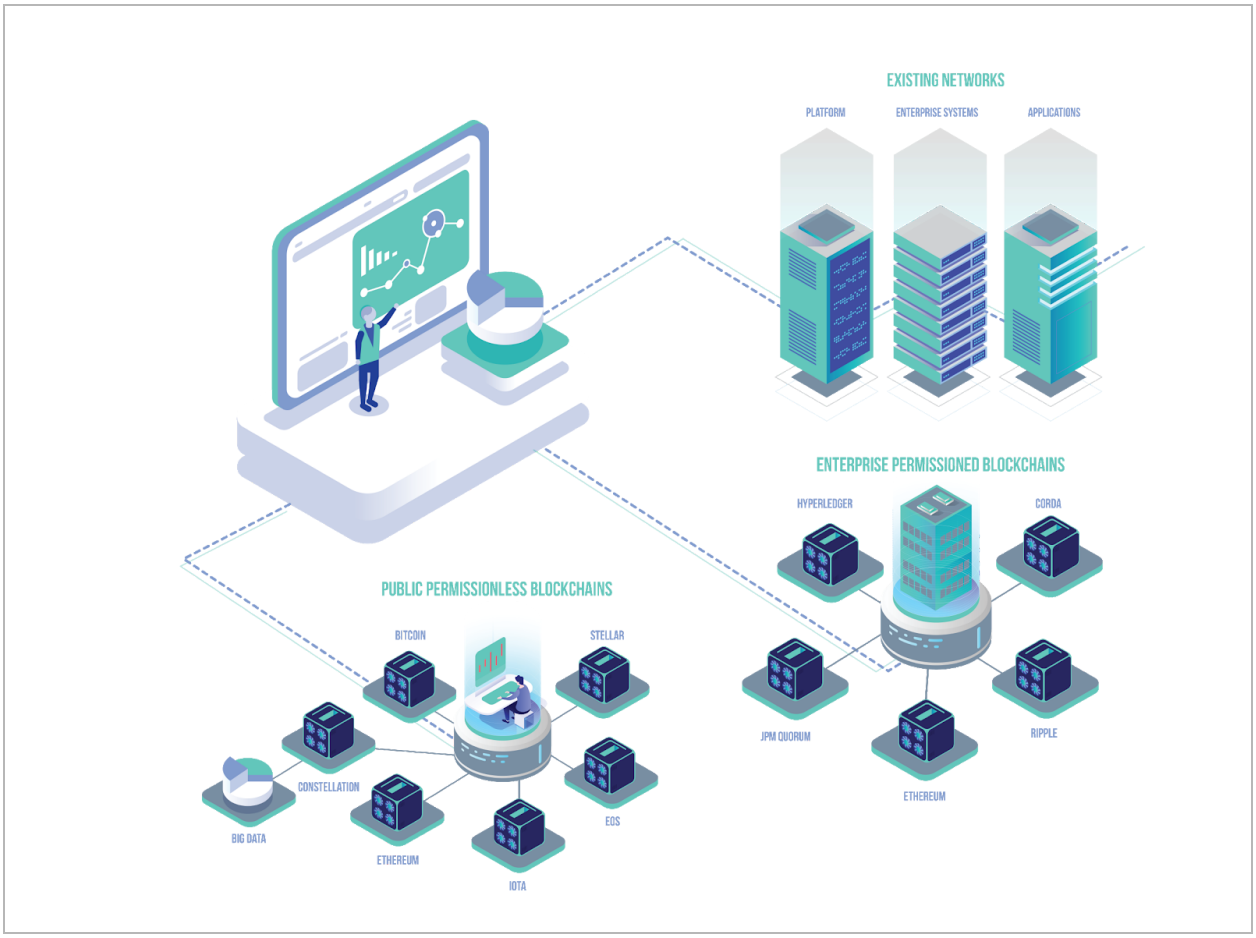

Figure 1. Overledger and Constellation Interconnectivity Architecture

Problem: Rethinking the Architecture for a Secured Internet of Things

The IoT (Internet of Things) market is projected to be $1.6T by 2025 with nearly 28B devices coming online by 2022, which backs out to nearly 4 devices per person creating nearly. Currently, there are 2.5 quintillion bytes of data created every single day and it is estimated that in 2020 we will be creating 1.7 megabytes of data every second by every person (DOMO 2018). With 90% of the worlds data being created in the last two years (IBM Marketing Cloud 2017), our current infrastructure is not built to support the vision of a securely connected IoT and AI (artifical intelligence) world. Additionally, connected cities will require third party validated data sets and insights to enrich an interoperable ecosystem to make them smarter and more advanced systems. With this, the next major hack will come in the way of tampering and spoofing of IoT data which will manipulate and impact the autonomous world (Figure 1). Current data breaches are exposing an organization's centralized security vulnerabilities and are costing organizations billions of dollars. The next wave of hacking will not solely come in the overt takeover and pirating of data, but instead will include submissive attacks that tamper and spoof data pipelines over extended periods of time.

While bad data is currently costing the world nearly $3T a year, malicious bad data could lead to an economic catastrophe that is nearly unidentifiable as the threat vector is not overt. Redundancies across blockchain integrations, alternative consensus mechanisms, and the ability to secure streaming data pipelines will become a new standard.

Figure 2. Smart City Threat Vectors

Most of the vision seen in IoT's potential has been completely unrealized as most data is created and sent to the cloud for storage. The vision of IoT includes interoperable and autonomous learning of smart devices that are connecting and communicating with one another. This process is primarily done over cell networks and is costly, slow, and presents security risks associated with centralized data storage. NoSQL databases are being used to accommodate changing data sets that are structured, semi-structured, unstructured and polymorphic data. As such, graphs - like DAG- (Directed Acyclic Graphs) are being used to order data to be referenced. While these huge advancements are enabling solutions like MongoDB's Single View, security threats still exist to the spoofing of data pipelines around data in-use. Interoperability between data systems and devices in IoT and connected cities will require security for data in-use, in-transit, and data in-rest.

Use Case: An Internet for Automation with IoT and Edge Devices

As we progress building smart cities with the explosion of IoT devices, machine-to-machine communication is the foundation for a hyper-connected world. We need to evolve the technology to build with interoperability at its core, enabling any device running on any network to be able to communicate with all networks at scale. We can't afford to build walled gardens and proprietary data islands of the past. The vision for the hyper-connected world is to

provide openness, interoperability and choice. The desire is to power an ecosystem that innovates with the latest advances in distributed and IoT technologies, interconnects networks and devices at scale and interoperates across protocols and technologies. This will usher in a new wave of applications and business use cases that contribute to these networks.

Connected cities, leveraging existing IoT infrastructure, rely on private entities processing input data using closed networks with no visibility and only the reputation of the private network to serve as validation. This is basically how institutions used to handle IT before the internet was born, which truly empowered digital communication. This same evolution needs to occur to empower edge automation, the backbone of the vision of connected cities. Furthermore, and if edge computing is to take place autonomously, we need to secure and validate each data pipeline/device/source while running concurrent consensus' across these data sources. Closed networks are not an option as many threat vectors occur to the data in-use and in-transit.

Constellation's type classes are smart contracts for orchestrating data pipelines. Therefore, a new internet for topological data is created and can serve as a direct input to autonomous algorithms deployed at the edge, with a measure of accuracy that ensures the confidence and security required to enable edge automation for mission critical (life or death) systems. The Constellation network is essentially a new layer to the internet that hosts and serves topological data using a secure communications protocol - an internet for automation with IoT and edge devices.

Constellation uses Type Level verification to verify and validate composite state data across networks. They define a snapshot of the state across networks as a type class, using type preserving operations. Specifically for the typeclass snapshot of a given state across networks, the Constellation solution employs the use of the hylomorphic and metamorphic recursion schemes, which are direct inverses of each other when parameterized by functor algebras and coalgebras. This property allows one to define leaves in the call tree as compositions or combinations of other type classes because the call tree follows a covariant/contravariant type hierarchy.

A "state channel" is a consensus protocol the validates composite state data across other networks (blockchain/dags, data sources, other state channels). Verification occurs by the creation of a non-linear API call graph across networks, and the formation of a graph of cryptographic signatures across the result of each API call which is it's own typeclass (Note, the nodes in this graph can be the combination of typeclasses from concurrent API calls; or thought of as multi-node edges, thus actually forming what's called a, "HyperGraph"). Validation occurs during the execution of the non-linear API call graph, where logic embedded within the typeclass defines how to proceed with the next level of the graph.

To implement a Constellation state channel explanation above, a typeclass is defined by writing anamorphism and a catamorphism functions that build the recursion schemes, in terms of functor algebras and coalgebras. This typeclass is the resulting data type of verification, or the API call graph which is executed by the recursion scheme. The logic for validation and decision for the next steps in the graph is defined in algebras and coalgebras. The typeclass represents the data schema, the algebra/coalgebra is a lense for how to interpret it. This is similar to the interface for creating Map/Reduce (hylomorphism) and streaming join processes (metamorphism) with tools like Spark or Flink, where data transformation is orchestrated implicitly and merely executes user defined functions.

These typeclasses are geometric representations of referential data. A cryptographically secure concurrent representation of the verification and validation of the meta-state across many stateful networks. Moreover, the geometry of these typeclasses encode the entire topology of a typical data aggregation or transformation pipeline,

into a few user defined functions. Data scientists create increasingly expensive and complex data transformation pipelines to preprocess data into a useable format to be consumed by their algorithms. This topological data can be preprocessed into these geometric representative type classes directly verses having to build and maintain and entirely separate networks.

This completely eliminates the need for complex preprocessing required for online machine learning models (which power automation in physical systems such as connected cities) that require entire engineering departments to build infrastructure for and maintain. Constellation performs these pre-processing data pipelines using the typeclass itself, ensuring quantifiable verification and validation using a secure communication protocol.

Incorporating Public Data Feeds to Enrich IoT Data

To fully realize the vision of a connected city, one has to explore beyond interoperability between devices, buildings, cars, lights, and sensors. IoT will need to tap into various public and paid for data feeds, like transit data or financial data, and use that external data to enrich data sets created from the connected city. In turn, this will create a smarter and more autonomous IoT network.

To do this, Constellation's HyperGraph network is an ecosystem of state channels that are maintained and validated by node operators. These node operators form the decentralized HyperGraph. The state channels can be created by developers, or node operators, and the validated data managed by the state channel can then be given away for free (in the event of a public data feed) or licensed (paid for by cryptocurrency). A licensed state channel might govern various data types that create a unique or enriched data set that can be used for machine learning algorithms and integrated and incorporated into a connected city.

Cryptocurrency Utility: $DAG and $QNT

The solutions and integrations outlined by Constellation and Quant will leverage the respective cryptocurrencies in the following ways:

- $QNT to $DAG to ensure the creation and throughput of a scalable audit trail of production ready IoT data.
- Enterprise clients will be able to purchase licensing and services through Quant; validated and trusted data across the Constellation HyperGraph to enrich IoT data sets.

QNT Utility Token

The pillars of security are Confidentiality, Integrity and Availability. To enforce confidentiality and integrity, QNT are used to validate with the option to **sign and encrypt** every transaction that flows through Overledger. Every enterprise client, developer, user and application (mApp) validates each transaction using their QNT linked to their mAppID and bpiKey.

- No transactions can flow through Overledger without being securely validated by QNT.

- No 3rd party can view or tamper with transactions and their contents, including Quant when signed and encrypted.
- Consumption fees and Developer Licenses will be payable in QNT based on the volume and usage of transactions.

$DAG Utility Token

The future of interoperability will rely on open networks where devices, systems, and state channels exchange data, create an immutable audit trail around certain data sets (ex. maintenance logs, transaction logs, transfer of data), and secure throughput when certain data sets have dependencies on other data sets and applications.

HyperGraph, Constellation's Network, consists of hundreds of node operators that validate the data piped in through API's. Our scalable network uses $DAG in the following ways:

1. Ensure high throughput on the network while cryptographically securing certain data sets.
2. To buy and sell validated data (ex. purchasing validated transit data to enrich a connected city).
3. Enterprise pricing may be conducted in USD on a message/event/api pull basis (standard billing practices by hosting providers) but will be converted into $DAG by Constellation on behalf of the client.

One of the main components of Constellation is to ensure scalability through technology but also through procurement methods. By pricing on an event/message basis, Constellation creates enhanced functionality to existing cloud service and hosting providers. This makes it easy for businesses to bake Constellation into existing financial models. Furthermore, this will ensure a seamless integration and migration path with Quant's business model and clients.

Conclusion

The Quant and Constellation integration and partnership lays the foundation for a connected ecosystem for any business application and use cases looking to use blockchain technology and cryptocurrency beyond a financial instrument. The goal is to make it easy to procure blockchain technology, create sandbox test environments, while providing the ability to migrate to a production ready environment that can scale to existing technological thresholds and beyond. The aim is to create a one-stop shop for anyone looking to incorporate added layers of security to future proof data and the connected channels that are impacted by data. Constellation and Quant believe that this will be the start of establishing new standards around data and applications for the future.