IV. BLOCKCHAIN & IOT

IV.1. Challenges and opportunities[1]

The problem with the current centralized model

Current IoT ecosystems rely on centralized, brokered communication models, otherwise known as the server/client paradigm. All devices are identified, authenticated and connected through cloud servers that sport huge processing and storage capacities. Connections between devices have to exclusively go through the internet, even if they happen to be a few feet apart.

While this model has connected generic computing devices for decades and will continue to support small-scale IoT networks as we see them today, it will not be able to respond to the growing needs of the huge IoT ecosystems of tomorrow.

Existing IoT solutions are expensive because of the high infrastructure and maintenance cost associated with centralized clouds, large server farms, and networking equipment. The sheer amount of communications that will have to be handled when there are tens of billions of IoT devices will increase those costs substantially.

Even if the unprecedented economic and engineering challenges are overcome, cloud servers will remain a bottleneck and point of failure that can disrupt the entire network.

Decentralizing IoT networks

A decentralized approach to IoT networking would solve many of the issues above. Adopting a standardized peer-to-peer communication model to process the hundreds of billions of transactions between devices will significantly reduce the costs associated with installing and maintaining large centralized data centers and will distribute computation and storage needs across the billions of devices that form IoT networks. This will prevent failure in any single node in a network from bringing the entire network to a halting collapse.

However, establishing peer-to-peer communications will present its own set of challenges, chief among them the issue of security. And as we all know, IoT security is much more than just about protecting sensitive data. The proposed solution will have to maintain privacy and security in huge IoT networks and offer some form of validation and consensus for transactions to prevent spoofing and theft.

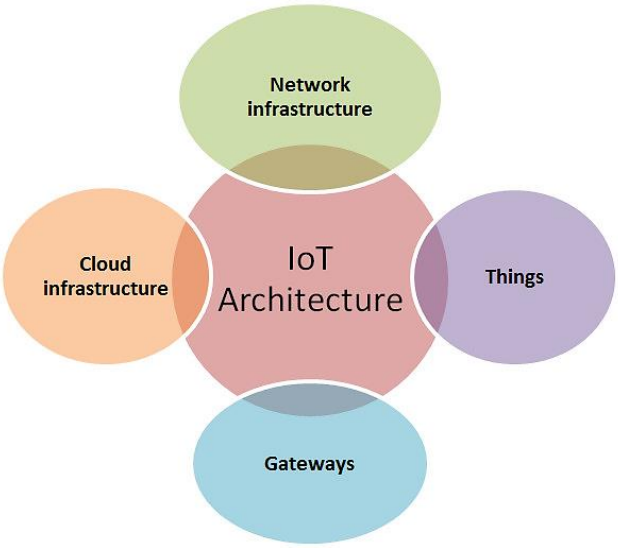
[1] https://iot.ieee.org/newsletter/january-2017/iot-and-blockchain-convergence-benefits-and-challenges.html

To perform the functions of traditional IoT solutions without a centralized control, any decentralized approach must support three foundational functions:

- ✓ Peer-to-peer messaging;
- ✓ Distributed file sharing;
- ✓ Autonomous device coordination.

The blockchain approach

IoT architecture can be represented by four building blocks:



IoT architecture can be represented by four building blocks. Source: https://iot.ieee.org/newsletter/january-2017/iot-and-blockchain-convergence-benefits-and-challenges.html

Things: These are defined as uniquely identifiable nodes, primarily sensors that communicate without human interaction using different connectivity methods.

Gateways: These act as intermediaries between things and the cloud to provide the needed connectivity, security, and manageability.

Network infrastructure: This is comprised of routers, aggregators, gateways, repeaters and other devices that control and secure data flow.

Cloud infrastructure: Cloud infrastructure contains large pools of virtualized servers and storage that are networked together with computing and analytical capabilities.

Blockchain technology is the missing link to settle privacy and reliability concerns in the Internet of Things. Blockchain technology could perhaps be the silver bullet needed by the IoT industry. It can be used in tracking billions of connected devices, enabling the processing of transactions and coordination between devices; this allows for significant savings for IoT industry manufacturers. This decentralized approach would eliminate single points of failure, creating a more resilient ecosystem for devices to run on. The cryptographic algorithms used by blockchains would make consumer data more private.

The decentralized, autonomous, and trustless capabilities of the blockchain make it an ideal component to become a foundational element of IoT solutions. It is no surprise that enterprise IoT technologies have quickly become one of the early adopters of blockchain technology.

In an IoT network, the blockchain can keep an immutable record of the history of smart devices. This feature enables the autonomous functioning of smart devices without the need for centralized authority. As a result, the blockchain opens the door to a series of IoT scenarios that were remarkably difficult, or even impossible to implement without it.

For example, by leveraging the blockchain, IoT solutions can enable secure, trustless messaging between devices in an IoT network. In this model, the blockchain will treat message exchanges between devices similar to financial transactions in a bitcoin network. To enable message exchanges, devices will leverage smart contracts which then model the agreement between the two parties.

One of the most exciting capabilities of the blockchain is the ability to maintain a duly decentralized, trusted ledger of all transactions occurring in a network. This capability is essential to enable the many compliances and regulatory requirements of industrial IoT (IIoT) applications without the need to rely on a centralized model.

Blockchain can help alleviate the security and scalability concerns associated with IoT in the following ways[2]:

1. The distributed ledger in a blockchain system is tamper-proof and this removes the need for trust among the involved parties. No single organisation has control over the vast amount of data generated by IoT devices.
2. Using blockchain to store IoT data would add another layer of security that hackers would need to bypass in order to get access to the network. Blockchain provides a much more robust level of encryption that makes it virtually impossible to overwrite existing data records.
3. Blockchain provides transparency, by allowing anyone who is authorised to access the network to track the transactions that happened in the past. This can provide a reliable way to identify a specific source of any data leakages and take quick remedial action.
4. Blockchain can enable fast processing of transactions and coordination among billions of connected devices. As the number of interconnected devices grows, the distributed ledger technology provides a viable solution to support the processing of the large number of transactions.
5. By providing a way to enable trust among the stakeholders, blockchain can allow IoT companies to reduce their costs by eliminating the processing overheads related to IoT gateways (for e.g. traditional protocol, hardware, or communication overhead costs).

Smart contracts, an agreement between two parties that is stored in the blockchain, can further allow the execution of contractual arrangements among stakeholders

[2] https://www2.deloitte.com/ch/en/pages/innovation/articles/blockchain-accelerate-iot-adoption.html

based on certain criteria being fulfilled. For example, smart contracts can authorise payments automatically, without any need for human intervention, when the conditions for providing a service have been fulfilled.

IV.2. Applications for IoT and Smart Systems

Blockchain combined with IoT can improve the traceability of the supply chain network. IoT sensors like temperature sensors, motion sensors or GPS connected to the vehicles provide information about the shipment status. Data fetched from the sensors gets stored in the blockchain, bringing traceability, auditability and transparency in the system.

Smart Homes

IoT devices allow the home security system to controlled remotely from the smartphone. But the centralized model for exchanging information generated by IoT sensors lack ownership of data and security standards. By moving the data gathered from IoT devices to the blockchain can solve security issues.

Parking Solutions

A company named NetObjex has come up with an idea of a smart parking solution with IoT and blockchain. Using IoT sensors, it can become easier to find the empty parking space and pay automatically with crypto wallets.

IoT sensors installed in the parking area can fetch information such as time for which car remains parked and vehicle number to obtain the linked wallet address. The data gets stored in the blockchain and triggers smart contracts to automate payments.

Numerous industries have started to experiment with the potential of blockchain in IoT networks. As a blockchain development company, we can help you understand how Blockchain IoT combined can transform the various sectors.

IV.3. Challenges[3]

In spite of all its benefits, the blockchain model is not without its flaws and shortcomings:

Scalability issues pertaining to the blockchain that might lead to centralization, which is casting a shadow over the future of the cryptocurrency.

Processing power and time required to perform encryption for all the objects involved in a blockchain-based ecosystem.

Storage too will be a hurdle. Blockchain eliminates the need for a central server to store transactions and device IDs, but the ledger has to be stored on the nodes themselves. And the ledger will increase in size as time passes.

Lack of skills: few people understand how blockchain technology really works and when you add IoT to the mix that number will shrink drastically.

[3] https://iot.ieee.org/newsletter/january-2017/iot-and-blockchain-convergence-benefits-and-challenges.html

Legal and compliance issues: It's a new territory in all aspects without any legal or compliance code to follow, which is a serious problem for manufacturers and service providers. This challenge alone will scare off many businesses from using blockchain technology.

IV.3. Blockchain-IoT players and their use cases[4]

Atonomi

"Atonomi provides a new security protocol and infrastructure to enable billions of IoT devices to have trusted interoperability for both data and commerce."

Chain of Things

A consortium that is exploring the role blockchain may have in providing security for the Internet of Things.

IOTA

IOTA is a revolutionary new transactional settlement and data transfer layer for the Internet of Things. It's based on a new distributed ledger, the Tangle, which overcomes the inefficiencies of current Blockchain designs and introduces a new way of reaching consensus in a decentralized peer-to-peer system.

IoTeX

"A decentralized network for Internet of Things (IoT) powered by a privacy-centric blockchain."

IoT Chain

IoT Chain (ITC) is developed as a lite operating system using the blockchain concept and implementing PBFT, DAG, SPV and CPS technology, allowing data to be layered and stored in a decentralised manner and providing protection with the combined strength of the millions of IoT nodes within the network.

Integrate Watson IoT Platform with Blockchain

The Watson IoT Platform has a built-in capability that lets you add selected IoT data to a private blockchain.

Supply Chain Focused

Ambrosus

Ambrosus is a blockchain-powered IoT network for food and pharmaceutical enterprises, enabling secure and frictionless dialogue between sensors, distributed ledgers and databases to optimise supply chain visibility and quality assurance.

Waltonchain

Waltonchain (沃尔顿链 in Chinese, or WTC for short) is a genuine, trustworthy and traceable business ecosystem with complete data sharing and absolute

[4] https://www.postscapes.com/blockchains-and-the-internet-of-things/#background

information transparency. It is created through a combination of the RFID and blockchain technologies,

OriginTrail
OriginTrail is Blockchain-Powered Data Exchange Protocol for Interconnected Supply Chains

Data Marketplaces

Streamr
Streamr is making these data streams tradeable. We provide a single interface for realtime data delivery and payment, using our cryptographic token, $DATA.

Hardware / Connectivity Focused

Slock.it
Slock.it brings the benefits of the Blockchain - transparency, security and auditablity - to real-world objects.

BlockMesh
The BlockMesh platform is a platform supporting mesh based devices focusing on communication and the IoT.

Helium
Helium's decentralized machine network simplifies connecting anything to the internet through a blockchain, wireless network, and open-source software.

Moeco
Moeco is a decentralized protocol for M2M communication, relying on the ultra-low power and long-range network infrastructure.

FOAM
The FOAM Proof of Location protocol empowers a permissionless and autonomous network of radio beacons that can offer secure location services.

Fysical
Location Data Market Protocol. Provides infrastructure for the transparent and compliant exchange of location data; foot traffic sensor readings, store visit information, commute routes.

Energy Market

Grid+
Grid+ leverages the Ethereum blockchain to give consumers direct access to wholesale energy markets, responding intelligently to changes in energy prices.

Power Ledger

Power Ledger is a distributed, interoperable energy trading platform that supports an extensive suite of energy-focused applications.