CBS3008 : INTRODUCTION TO INTERNET OF THINGS

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a. Utilizing blockchain technology in IoT

1.1 Blockchain-

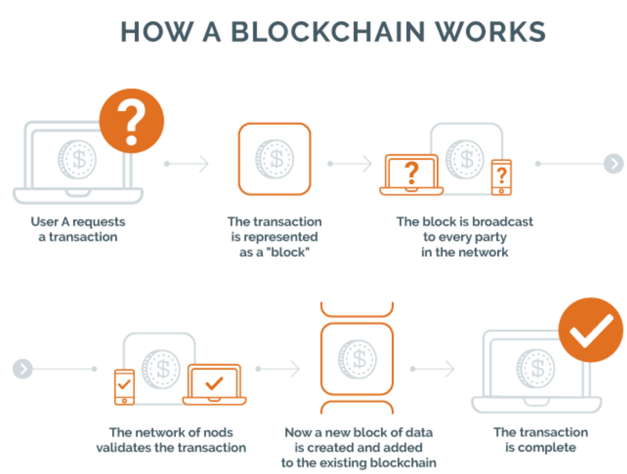
A blockchain is a distributed database that is shared among the nodes of a computer network. As a database, a blockchain stores information electronically in digital format. Blockchains are best known for their crucial role in cryptocurrency systems, such as Bitcoin, for maintaining a secure and decentralized record of transactions. The innovation with a blockchain is that it guarantees the fidelity and security of a record of data and generates trust without the need for a trusted third party.

Blockchain is a combination of three leading technologies:

1. Cryptographic keys
2. A peer-to-peer network containing a shared ledger
3. A means of computing, to store the transactions and records of the network

Cryptography keys consist of two keys – Private key and Public key. These keys help in performing successful transactions between two parties. Each individual has these two keys, which they use to produce a secure digital identity reference. This secured identity is the most important aspect of Blockchain technology. In the world of cryptocurrency, this identity is referred to as 'digital signature' and is used for authorizing and controlling transactions.

The digital signature is merged with the peer-to-peer network; a large number of individuals who act as authorities use the digital signature in order to reach a consensus on transactions, among other issues. When they authorize a deal, it is certified by a mathematical verification, which results in a successful secured transaction between the two network-connected parties. So to sum it up, Blockchain users employ cryptography keys to perform different types of digital interactions over the peer-to-peer network.



1.2 Blockchain architecture -

A Blockchain stores the transaction data in blocks that are linked together to form a chain. As the number of transactions grows, so does the size of the blockchain.Now, the architectural components of a Blockchain have been generalized and then modified by various companies, leading to different blockchain projects like Bitcoin, Ethereum, Hyperledger etc.

Below is a list of the architectural components:

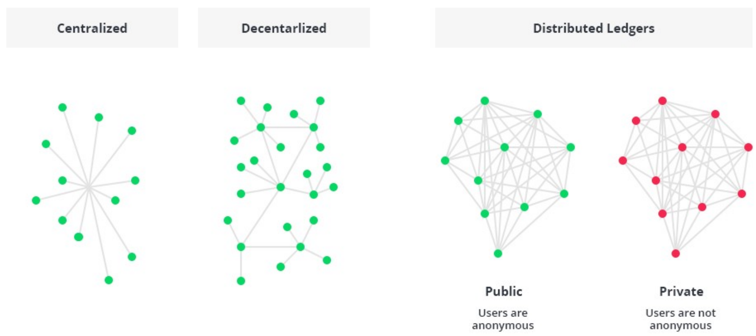
- Transaction
- Block
- P2P Network
- Consensus Algorithm

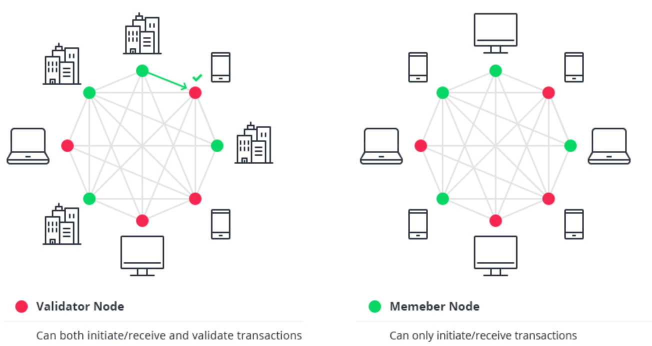
Transaction:
Transactions are the smallest building blocks of a blockchain system. They normally consist of a recipient address, a sender address, and a value. It is similar to a standard credit card statement. The owner transfers the value by digitally signing the hash produced by adding the previous transaction and the public key of the receiver.

Block:
Block contains the information as a block header and transactions. Blocks are data structures whose purpose is to bundle sets of transactions and are replicated to all nodes in the network. Blocks in blockchain are created by miners. Mining is the process to create a valid block that will be accepted by the rest of the network. Nodes take pending transactions, verify that they are cryptographically accurate, and package them into blocks to be stored on the blockchain. Block header is the metadata that helps in verifying the validity of a block.

P2P Network:
The blockchain is a peer to peer (P2P) network working on the IP protocol. A P2P network is a flat topology with no centralized node. All nodes equally provide and can consume services while collaborating via a consensus algorithm. Peers contribute to the computing power and storage that is required for the upkeep of the network. P2P networks are generally more secure because they do not have a single point of attack or failure as in the case of a centralized network. A blockchain network can be a permission-based network as well as a permissionless network. A permissionless network is also known as a public blockchain because anyone can join the network, while a permission-based blockchain is called a consortium blockchain. A permission-based blockchain or private blockchain requires pre-verification of the participants within the network and these parties are usually known to each other. In a typical blockchain architecture, every individual node in a network maintains a local copy of blockchain. The decentralization of blockchain architecture is the sole credit of the P2P network that it is built on.

Consensus Algorithm:
The way all these copies of a single ledger are synchronized is due to a consensus algorithm. The consensus mechanism ensures that whatever local copy every individual party has, they are consistent with each other and is the most updated one. The copies that every individual node has are identical or similar to each other. It could be arguably stated that the consensus algorithm forms the core of every blockchain architecture.





<u>1.3 WHAT IS IOT-</u>

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

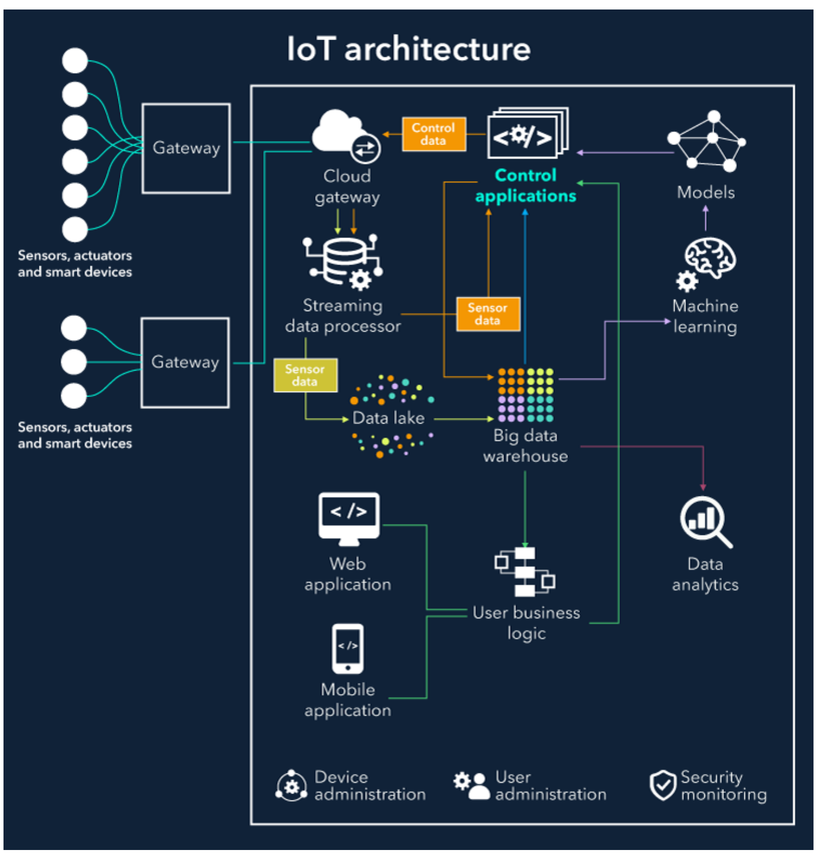
A *thing* in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and is able to transfer data over a network.

Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business

1.4 IOT ARCHITECTURE -

The term IoT is used to describe a broad and diverse ecosystem that includes a wide range of different connectivity types and use-cases. Therefore, it is not helpful to discuss the IoT ecosystem as a whole, and to understand IoT better it is necessary to break it down into layers. The IoT ecosystem has five horizontal layers that are essential elements which is common to all IoT use-cases, regardless of vertical segment.

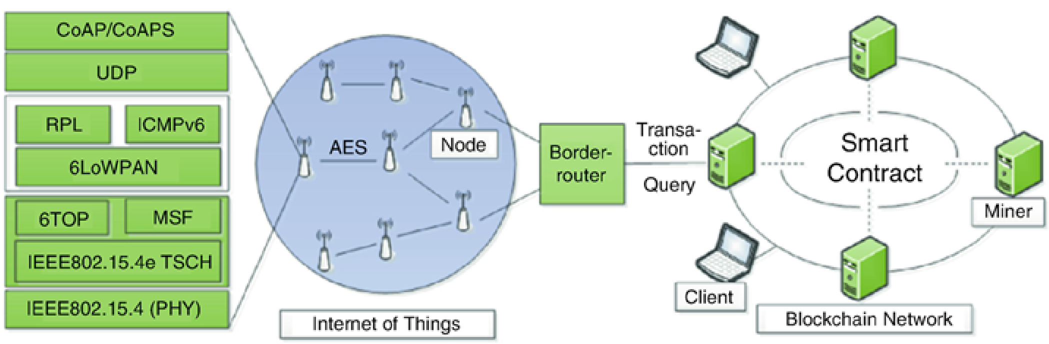
1. Sensors or controllers (embedded in connected devices, the "things" in the Internet of Things)
2. A gateway device to aggregate and transmit data back and forth via the data network
3. A communications network to send data.
4. Software for analyzing and translating data
5. The end application service.



1.6 IOT WITH BLOCKCHAIN -

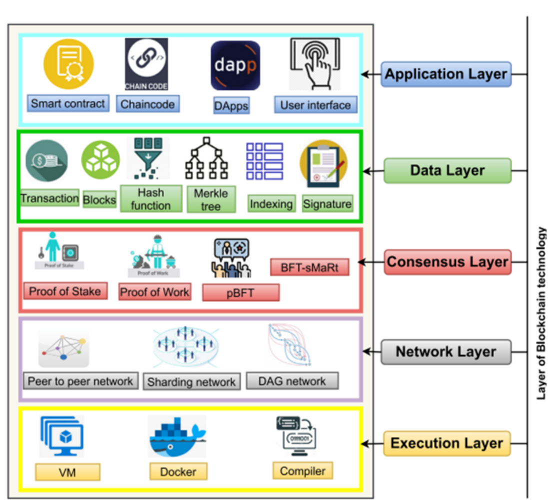
IoT enables devices across the Internet to send data to private blockchain networks to create tamper-resistant records of shared transactions. Blockchain enables your business partners to share and access IoT data with you — but without the need for central control and management. Each transaction can be verified to prevent disputes and build trust among all permissioned network members.

1.7 Architecture of IOT and Blockchain

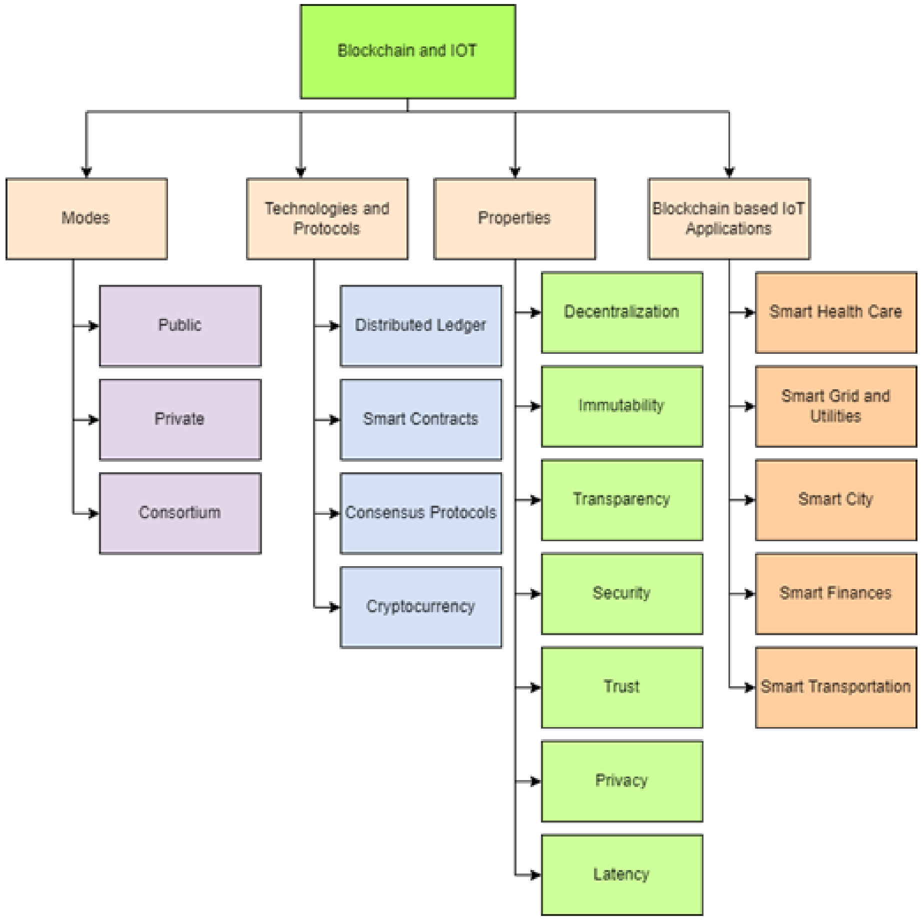


The given diagram above shows a sample implementation of IOT with blockchain technologies. The diagram itself is divided into 2 parts the part to the left of the border router presents the IoT part and the part towards the right of the border router represents the blockchain part. The border router helps convey the transactions between the nodes and the blockchain network. The blockchain network consisting of the miner's client and smart contracts. The leftmost layered diagram is the standard IOT protocol stack which is to be used along with blockchain technology.

Blockchain Layered Architecture:



The two architectures i.e., the blockchain architecture and the IOT architecture form a dynamic duo that can help in a variety of ways. Overall benefits of using IOT with Blockchain involves:



1.8 Benefits of IOT and blockchain

1)Build trust in your IoT data
Each transaction is recorded, put into a data block, and added to a secure, immutable data chain that cannot be changed — only added to.

2)Rely on added security
With the Watson IoT Platform you can select the data to be managed, analyzed, customized, and shared among permissioned clients and partners.

3)Gain greater flexibility
The IBM Blockchain Platform is open, interoperable and is built for your multicloud world, using the latest version of the leading Hyperledger Fabric platform, optimized for Red Hat® OpenShift.

4)Generate new efficiencies
IBM Blockchain streamlines processes and creates new business value across your ecosystem by drawing on the data supplied by IoT devices and sensors.

1.10 Use cases -

Here are a few Blockchain Enterprise use cases on how combining IoT with Blockchain can have a significant impact across multiple industries:

1. Supply Chain and Logistics

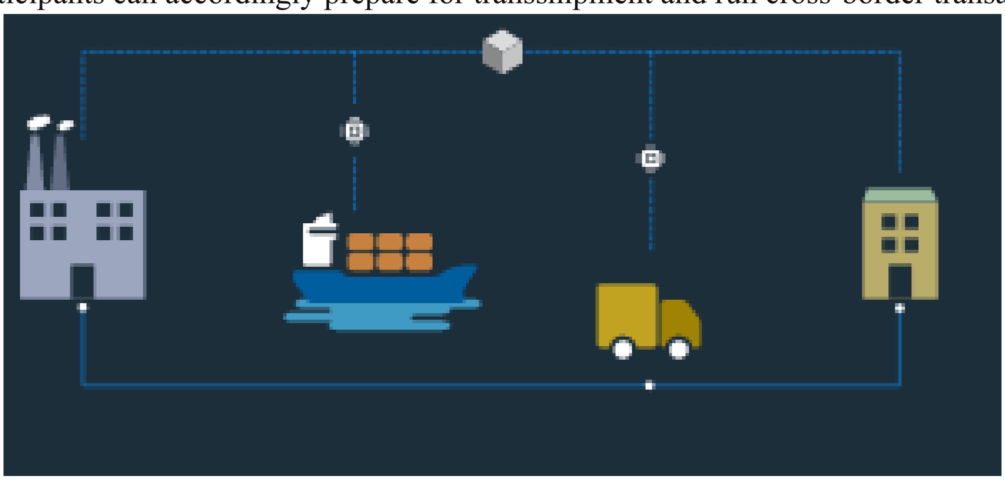
A global supply chain network involves many stakeholders, such as:

- Brokers
- Raw material providers, etc.

It complicates the end-to-end visibility. The supply chain can also extend over months of time and consist of many payments and invoices. Due to the involvement of multiple stakeholders, delivery delays have become the biggest challenge.
Therefore, companies are working on making the vehicles IoT-enabled to track the movement throughout the shipment process. Due to the lack of transparency and complications in the current supply chain and logistics, Blockchain and IoT combined can enhance the network's reliability and traceability.
Crisp details about shipments' status can be provided by IoT sensors, like:

- Motion sensors
- GPS
- Temperature sensors
- Vehicle information
- Connected devices, etc.

Sensor information is then stored in the blockchain. Once the data is saved on the Blockchain, stakeholders listed in the Smart Contracts get access to the information in real-time. Supply chain participants can accordingly prepare for transshipment and run cross-border transactions.



Golden State Foods(GSF) is a diversified supplier, well-known for manufacturing and distributing food products. Serving more than 125,000 restaurants, GSF is aimed at producing and delivering high-quality products.
GSF is working with IBM to optimize business processes using Blockchain and IoT. Sensors data collected on the blockchain ensure the issues are addressed and reported automatically before they create serious problems.
With blockchain's help, GSF can create a secure, immutable, and visible ledger accessible by different stakeholders to improve:

- Accountability
- Transparency

2. Automotive Industry

Nowadays, digitization is a competitive demand. Automotive industries are using IoT-enabled sensors to develop fully automated vehicles.
Connecting Industrial IoT solutions in the automotive sector with the decentralized network enables multiple users to exchange crucial information easily and quickly.
The automotive industry is an exciting blockchain IoT use case, where the combined technology can disrupt:

- Automated fuel payment
- Autonomous cars
- Smart parking
- Automated traffic control

NetObjex has demonstrated the smart parking solution using blockchain and IoT. The integration eases the process of finding a vacant space in the parking lot and automates the payments using crypto-wallets.
The company has collaborated with a parking sensor company "PNI" for real-time vehicle detection and finding the parking area's availability.
IoT sensors calculate the parking duration charges, and the billing takes place directly through the crypto-wallet.

3. Smart Homes

Smart IoT-enabled devices play a crucial role in our day-to-day lives. IoT blockchain enables the home security system to be managed remotely from the smartphone.
But the traditional centralized approach to exchange information generated by IoT devices lacks the security standards and ownership of data.
Blockchain could elevate the smart home to the next level by:

- Solving security issues
- Removing centralized infrastructure

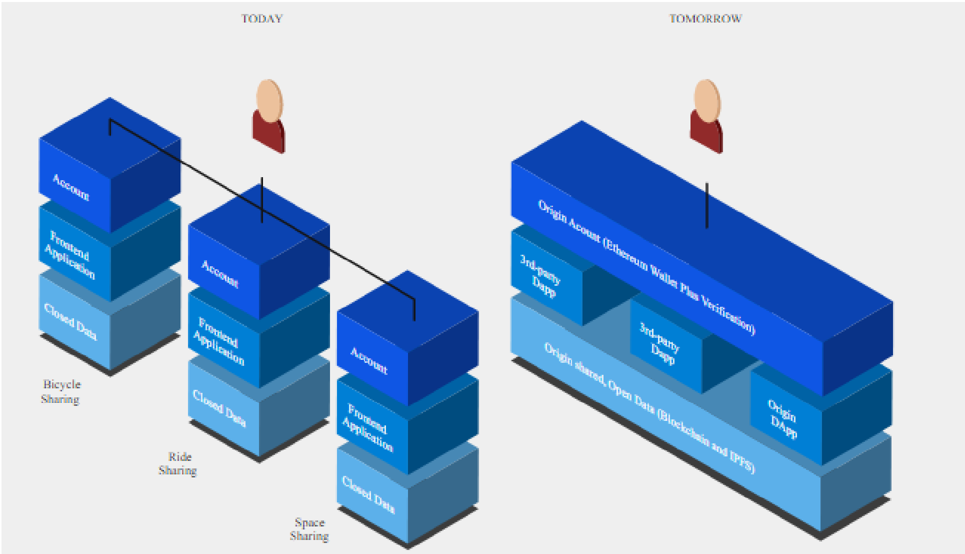
Telstra, an Australian telecommunication and media company, provides smart home solutions. The company has implemented blockchain and biometric security to ensure no one can manipulate the data captured from smart devices.
Sensitive user data is stored on the blockchain for improved security, such as:

- Biometrics
- Voice recognition
- Facial recognition

Once the data is saved on the blockchain, it cannot be modified, and the access is only provided to the right person.

4. Sharing Economy

The sharing economy has become a widely adopted concept around the world. Blockchain could help create decentralized, shared economy applications to earn considerable revenue by sharing the goods seamlessly.
Can you imagine an Airbnb apartment that leases itself? Slock.it is doing it precisely by using Blockchain IoT.



Slock.it is using blockchain technology for sharing IoT-enabled objects or devices.
They have planned to develop a Universal Sharing Network (USN) to create a secure online market of connected things. With USN, any object can be rented, sold, or shared securely without requiring intermediaries.

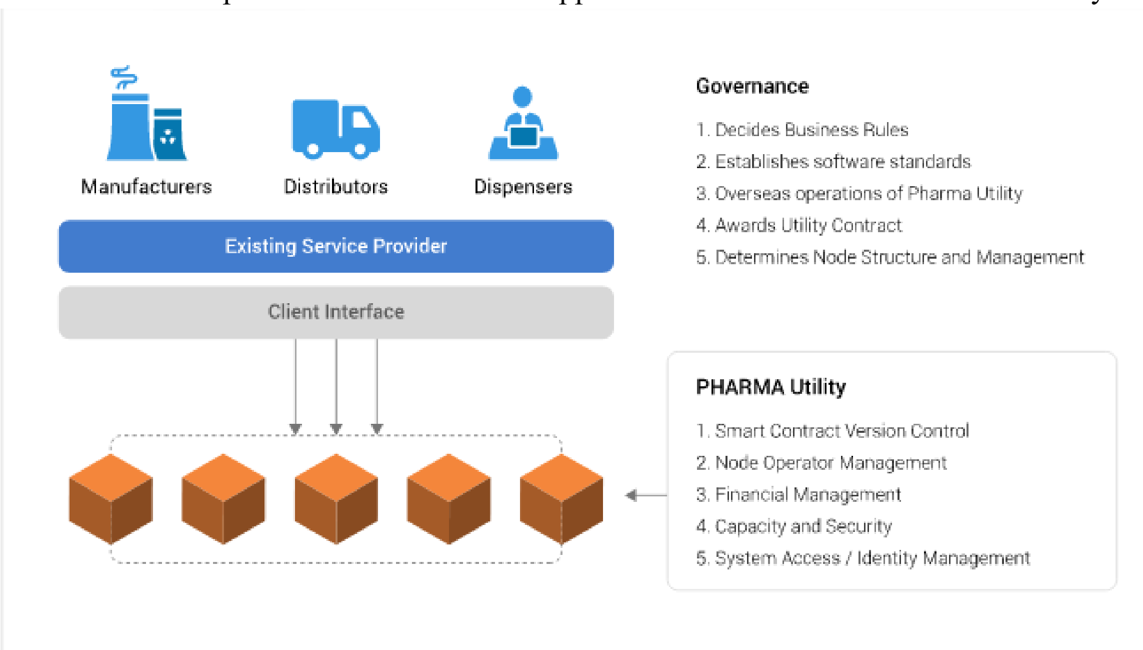
It could be possible for third-parties like manufacturers to onboard any object to the USN without seeking permission. Smart contracts ensure data privacy and transparency by controlling access to information.

5. Pharmacy Industry

The issue of counterfeit medicines in the pharmaceutical sector is increasing with every passing day. The pharmacy industry is responsible for:

- Developing drugs
- Manufacturing drugs
- Distributing drugs

Therefore, tracking drugs' complete journey is difficult.
The blockchain technology's transparent and traceable nature can help monitor the shipment of drugs from its origin to the supply chain destination.
Let's discuss one potential IoT blockchain application based on the healthcare industry.



Mediledger is a blockchain IoT use case designed to track the legal change of prescription medicines' ownership. Transparency and traceability are essential when it comes to monitoring sensitive healthcare products.
The data stored on the distributed ledger is immutable and timestamped, accessible to:

- Manufacturers
- Wholesalers
- Dispensers
- End-customers

Mediledger is a blockchain based platform, offering:

- Simplified payment processes

- Controlling users access
- Stopping counterfeit drugs from invading the supply chain

1.12 Conclusion

There are significant advantages that IoT along with blockchain can provide us which has been revealed via the document above. The various IoT structures shown above can be easily expanded to various other blockchain concepts thus making a secure decentralized network. Hence IoT and blockchain is a dynamic duo that will be an area of intense research in the upcoming future because of the potential opportunities it can open up.

b) Business Intelligence in IoT

2.1 Business intelligence-

BI(Business Intelligence) is a set of processes, architectures, and technologies that convert raw data into meaningful information that drives profitable business actions. It is a suite of software and services to transform data into actionable intelligence and knowledge.
BI has a direct impact on an organization's strategic, tactical and operational business decisions. BI supports fact-based decision making using historical data rather than assumptions and gut feeling.
BI tools perform data analysis and create reports, summaries, dashboards, maps, graphs, and charts to provide users with detailed intelligence about the nature of the business.
It refers to the procedural and technical infrastructure that collects, stores, and analyzes the data produced by a company's activities.BI is a broad term that encompasses data mining, process analysis, performance benchmarking, and descriptive analytics. BI parses all the data generated by a business and presents easy-to-digest reports, performance measures, and trends that inform management decisions.

Business intelligence software provides business leaders with the information they need to make more informed business decisions. Business intelligence is used as a foundation for strategic decision-making eliminating as much of the guesswork and gut-feeling from the decision-making process as possible. The data sources used to build business intelligence include customer relationship management (CRM) systems like Salesforce.com, supply chain information, sales performance dashboards, marketing analytics, contact center call data and metadata i.e. information describing data. Business intelligence applications help companies to bring all these disparate sources into a single unified view providing real time reporting, dashboards, and analysis.

2.2 Working of Business Intelligence -

BI platforms traditionally rely on data warehouses for their baseline information. A data warehouse aggregates data from multiple data sources into one central system to support business analytics and reporting. Business intelligence software queries the warehouse and presents the results to the user in the form of reports, charts and maps. Data warehouses can include an online analytical processing (OLAP) engine to support multidimensional queries.

2.3 IOT for business -

A system of interconnected devices and systems is known as the Internet of Things (IoT). There has been a large growth in the usage of smart devices by businesses to enhance their operations.Businesses can increase their revenue and quality of services by using IoT apps. In order to increase business productivity, businesses offer training to all employees, enhancing their work efficiency and avoiding skill mismatches.

2.4 Steps of using IOT in BI-

5 Steps to Connect Business Intelligence to IoT Solutions

1. Create a Plan

The first step requires determining what information to collect and analyze from IoT solutions into a visual dashboard.

For example, a trucking company may want to ensure that their trucks are maintained and drivers are safe on long, cross-country trips. They can add low-energy tire pressure sensors to each vehicle. The data can be sent to an IoT hub for analysis. Then, the data can create mobile-accessible reports that truckers and staff can access whenever and wherever needed.

This all starts with a plan for how an organization plans to use the data collected. The organization can then decide how the data will best be distributed and displayed to those that need it.

2. Store Data in the Cloud

The next step to turning IoT solutions into valuable data is having a place to store it. The leading cloud storage services for business intelligence are Azure, AWS, and Google Cloud. Each service tool makes it easier to visualize the data it stores.

For example, the Microsoft Azure Data Factory is a serverless tool, which uses ETL (extract, transform, and load) processes to upload data from IoT devices to the cloud. Healthcare organizations can use cloud services like Azure Data Factory to store massive amounts of data collected from wearable devices that monitor many chronic conditions such as heart disease, diabetes, depression, and seizures.

3. Prep and Train the IoT Data

Data stored in the cloud is static. If an organization wants to make sure they can turn the data into more than a pile of numbers or statistics, the organization needs to prep and train the data to work based on your requirements.

Tools like Amazon SageMaker uses machine learning tools to understand data sets. Organizations can use machine learning to simplify how they receive the data from IoT devices into specific models that make it easier to visualize the data.

Plastic companies, for example, can connect a service such as SageMaker to a business intelligence platform to detect defects. Business intelligence visualization tools show where issues are occurring in their manufacturing process. They can optimize the products they deliver with the same workforce.

4. Analyze Data

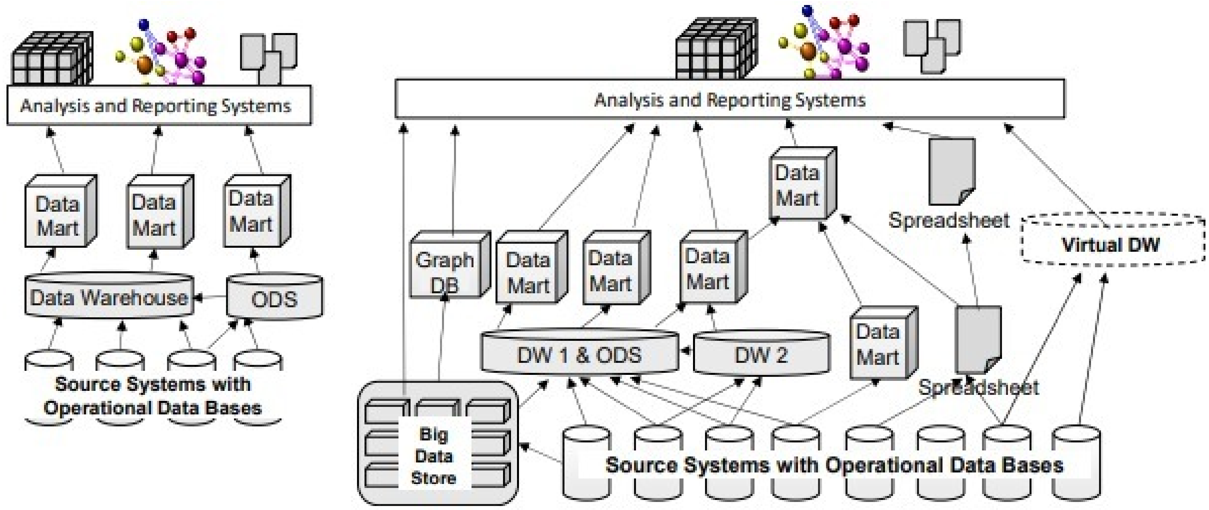
Data analytics programs like Azure Synapse Analytics model the data, so it is ready to visualize. Essentially, the software makes it possible to search for specific information to analyze the data at scale. Furthermore, they provide powerful analytics to ensure your organization can understand their data.

Many types of manufacturing firms can benefit from these analytics. Synapse Analytics can connect to business intelligence software to provide up-to-the-minute analytics. This way, executives at a manufacturing company can read instant results from the IoT devices on the plant floor.

5. Visualize Data

Once the data is stored, prepped, trained, and modeled, the next logical step is to turn this data into something useful. Business intelligence excels at turning data into something organizations can review and evaluate to make more strategic decisions with the most current data.

2.5 Architecture of Business intelligence with IOT-



The Figure illustrates the text-book layout of a DW-based architecture and an exemplary sketch of an actual architecture how it can be found in many companies. The deviations from the ideal have manifold causes like a) the inflexibility and the inherent complexity of DW architectures despite increasing agility pressures b) operations across enterprise borders (Baars and Kemper 2011), c) highly specific and latency-intolerant business requirements and d) new approaches to store and analyze data under the label "Big Data" . All these factors materialize in an increasing decentralization of BIA architectures with the risk of unwanted parallel DWs, unsupervised data marts, spreadsheet-based reporting, and/or an uncontrolled raw data access

2.6 Advantages of iot in business intelligence -

1. Improved customer satisfaction

BI, in conjunction with IoT, empowers businesses to explore and mine consumer-generated data to better understand and anticipate customer needs. Armed with accurate data on individual customer preferences, businesses can offer highly-tailored marketing and promote products that match individual tastes and lifestyle's thereby improving customer experience and loyalty.

By monitoring passenger behavior, TfL aims to be able to react to passenger needs by, for example, informing people of where congestion is, optimizing traffic lights and ensuring more efficient boarding at tube stations.

2. More efficient business operations

The scope for improving business operations, through granular analysis of those operations, is endless and extends across sectors. Manufacturing can use IoT to optimize production and supply chains – taking advantage of connected devices within the production and supply chain processes themselves – in order to monitor efficiencies. Similarly, farmers can use connected sensors to monitor crops and cattle to improve operational efficiencies.

3. Greater profitability

The vast amount of information produced via smart, connected devices – in terms of both new and rapidly growing data types and sources – means that organizations have the opportunity to use BI to become more profitable. Data-based insights can be used to improve existing products and services.

4. Forecast new trends

BI represents an opportunity to discover patterns, predict trends and forecast with greater confidence than ever before. BI gives access to these patterns across the entire organizations, meaning that relevant users and departments will be kept in the loop on new trends.

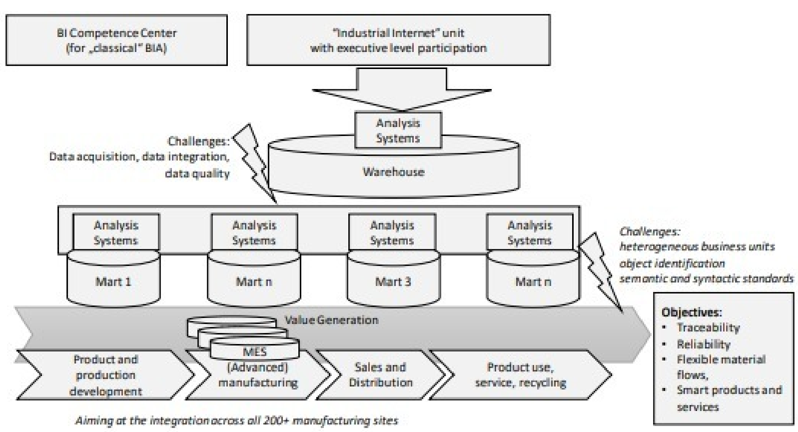
2.7 Challenges-

The main challenges associated with the implementation of the IoT are:

- Inability to link all the data together and process it effectively.
- Incompetence in establishing same technology standards to make all connected devices 'understand' each other.
- Inability to deal with security and data privacy threats.

2.8 Real time case studies -

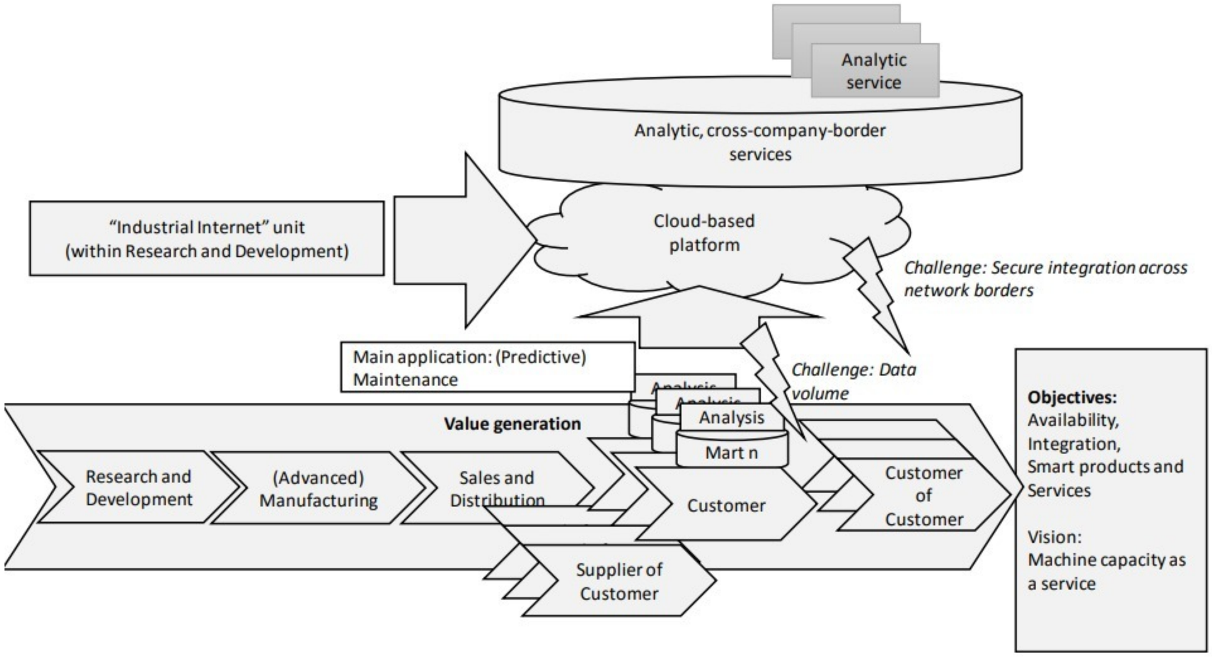
Case 1: Cross-site ecosystem for Advanced Manufacturing



The company in the first case is a leading supplier for high-end transmission systems with about 200 globally distributed production sites and more than 50,000 employees. It was decided to bundle a variety of local Advanced Manufacturing and Industrial Internet projects under the umbrella of a company-wide strategy. A responsible Industrial Internet unit was formed that includes members from the executive level. Data integration and analysis are considered core parts of the pursued strategy.The conceived and implemented applications particularly aim at achieving a traceability of objects across sites as well as root cause analysis when problems arise and that aim at an increased quality and reliability (esp. with the help of predictive maintenance). “In case a problem arises, our customers want to know if we can guarantee availability and if we can fix the root cause. That is a competitive advantage in our industry!”. Further objectives were more flexible material flows and in parts the provision of smart services. An overview of the situation of the company and its BIA ecosystem is given in Figure 3.In order to harvest the benefits of the necessary analytical and managerial applications, data from novel “cyber-physical systems” (CPS), i.e. smart production and logistics machinery equipped with digital sensors and Intranet/Internet access, and heterogeneous data formats have to be integrated across sites and with data and documents from other business units, esp. research and development,

and service and distribution. The forceful diffusion of CPS comes from the realization that “variability, dynamics, and individual customer requirements cannot be handled with flexible hardware and mechanics in particular”.Due to the heterogeneous nature of the supported units, as well as the data volume and velocity of the newly collected CPS data, it was decided to follow a federated approach with both local and central data storage and analysis sub-systems. There is a variety of data analysis applications on machine, plant, and company levels. The amount of structured production data per plant is currently already at 6 TB for an average plant. This is increased dramatically by the inclusion of more and more semistructured data: “For a sub-aspect on the subject ‘quality’, we came to an additional volume of 3 TB for one plant alone. […] And I wished we had one quality system only in the group. But it will probably never come to that.” The monitoring and root-cause-analysis requirements increase the challenges: “We have products that deliver 3,000 parameters that we have to trace and analyze in a really short time frame as soon as a certain threshold is met.”Currently, only data on events and developments (e.g. exceptions, averages) is shared across sites. The linking pins between the shop-floor and the higher order systems are formed by Manufacturing Execution Systems (MES) (MESA 1997; Kletti 2007) that combine functionality for production steering, data collection, (operational) reporting, and partly also more advanced analytics.The core challenges of the approach result from bringing together heterogeneous divisions, business functions, and sites. This particularly comes with issues regarding data and system integration and the interoperability of the systems.

Case study 2:



The company in the second case is a leading machine tool manufacturer that employs more than 10,000 people at more than 10 sites. This company also established an Industrial Internet unit. Unlike the first case, this unit is reporting to research and development. The reason for this stems from the fact that sensor technology, Internet integration, and analytic functionality are considered central features of the own products. The concepts for integrating the respective technologies are entering the product design in the very early phases of the product lifecycle. While IoT approaches are also used in-house, the focus here is more on the post-sales stage.

The new data gathering capabilities are particularly used for offering Predictive Maintenance services to customers. Examples are laser-cutting machines with special sensors for detecting lens abrasion. If a lens degrades in quality, the machines first counter the resulting effects with recalibration and later order in-time replacements, thus sparing the customer both waste and downtime. Respective machine based services are heavy on data volume and velocity with the core data processing being executed onsite. The idea of making the machines "smart" in order to provide new services has led to the conception and implementation of a customer-spanning platform that utilizes Cloud Computing technology for analytical services. Given the customer requests it, the analysis is controlled remotely by the machine tool provider under consideration of both customer and machine tool provider data. This particularly allows cross-company analysis e.g. on machine reliability and efficiency – across all participating companies willing to share their data in an anonymized fashion: „Of course I can execute reporting and analysis services [with the platform] for a single unit. But I can also say: In comparison with similar companies, your efficiency lies at 90% or 110%." The next planned steps are the integration of third-party machines, services for product flow steering that go beyond the individual machine as well as the provision of data integration and analysis services that include material suppliers and customers of customers. The chosen approach is depicted in Figure 4. There is a strong transformational side to this IoT application: The roles of both the machine tool manufacturer and its customer change drastically, with the machine tool manufacturer moving into the direction of a supply-chain integrator. The long term vision are services for "machine capacity on demand" – based on BIA features. Even more than in case 1, data volumes are considered to be issues that prevent a singular central data store. Due to restrictions on the data capturing and storage side, a machine analysis is currently often limited to sensor data from the last couple minutes for immediate data processing.

2.8 Cloud BI Services-

Cloud-based business intelligence, or cloud BI, describes **the process of transforming data into actionable insights either partially or fully within a cloud environment**. Cloud BI gives organizations the information they need to make data-driven decisions without the cost or hassle of physical hardware.

2.9 Real time applications of IOT with BI-

1) Altair offers an open, scalable, unified, and extensible data analytics platform with integrated data transformation and predictive analytic s tools. Desktop-based data preparation is available via Altair Monarch, while Knowledge Hub features team-driven data prep and a centralized data marketplace to speed collaboration and governance. Machine learning and predictive analytics are made available inside Knowledge Studio. Altair Panopticon houses the company's streaming processing and real-time visualization capabilities.
2) Alteryx is a self-service data analytics software company that specializes in data preparation and data blending. Alteryx Analytics allows users to organize, clean, and analyze data in a repeatable workflow. Business analysts find this tool particularly useful for connecting to and cleansing data from data warehouses, cloud applications, spreadsheets and other sources. The platform features tools to run a variety of analytic jobs (predictive, statistical, spatial) inside a single interface.
3) AnswerRocket offers a search-powered data analytics platform designed for business users. The product enables you to ask business questions in natural language, and no technical skills are needed to run reports or generate analysis. AnswerRocket features a combination of AI and machine learning, as well as advanced analytic functionality. The platform can also automate manual tasks and answer ad hoc questions quickly. AnswerRocket is mobile-friendly and includes native voice recognition.
4) BOARD combines business intelligence, performance management, and predictive analytics into one platform. As a result, any change to data, data models, security profiles or business rules is immediately propagated to every application. The solution provides all the tools required to create and update databases, data presentations, analyses, and process models. The company also offers BOARD Cloud, a SaaS version of the platform, backed by Microsoft Azure.

5) Hitachi's Pentaho analytics platform allows organizations to access and blend all types and sizes of data. The product offers a range of capabilities for big data integration and data preparation. The Pentaho platform is purpose-built for embedding into and integrating with applications, portals, and processes. Organizations can embed a range of analytics, including visualizations, reports, ad hoc analysis, and tailored dashboards. It also extends to third-party charts, graphs and visualizations via an open API for a wider selection of embeddable analytics.

2.10 Conclusion

From the given applications we can see the impact that BI along with IOT can make in any domain. One of the highlights of this technological integration is that it is not specific to any single domain, as the architecture shown above can be adapted to different applications like health, government etc, the technological integration of BI and IoT helps open up various opportunities that can actually help resolve a lot of existing issues in the present era.