

INSIGHT: DISTRIBUTED LEDGER TECHNOLOGY.

**NETWORKED COMPUTERS COME
TO AN AGREEMENT**

WHY READ THIS ARTICLE?

2008 the first DLT (Distributed Ledger Technology) concept was announced in a white paper by an anonymous person or group, so called Satoshi Nakamoto. The concept was used to build the first cryptocurrency based on a blockchain. Today known as Bitcoin. Over the years, DLT's found their way to market in various blockchain and similar DLT technologies.

In the beginning a playground for some enthusiasts, DLTs changed parts of the financial sector within a few years. Cryptocurrencies based on blockchains became a new asset class and new markets originated. Beside the financial sector other markets found advantages using DLTs and adopted the technology for their own needs. The possibility to store data securely and unchangeable, making it available for others, are used in various markets today.

Let's talk about that.

THE DLT ITSELF.

For a better understanding of DLTs, let's have a look at two popular variants.

One, the so called blockchain DLT, connects "Blocks" directly to each other. Used for Bitcoin, Ethereum and many more DLTs today. The other variant, a [Directed Acyclic Graph \(DAG\) DLT](#). But let's do it step by step.

Blockchain

A blockchain DLT is a chain of blocks (files), where the last block contains all or some of the most recent transactions which were not recorded before and a hash which leads to the next block in the chain. The information is stored permanently within a block and can't be changed or removed.

Let's take the Bitcoin blockchain to have an example from a real-life use case. The information to which address a Bitcoin (or a part of it) was sent and to which address it belongs now, is stored in the Bitcoin blockchain and can't be changed anymore when it is written to the block.



Similar like sending money from a bank account, but instead of storing the information within the banking network, the information is stored unchangeable and traceable within the Bitcoin blockchain. Figure 1 shows a very basic view on the method.

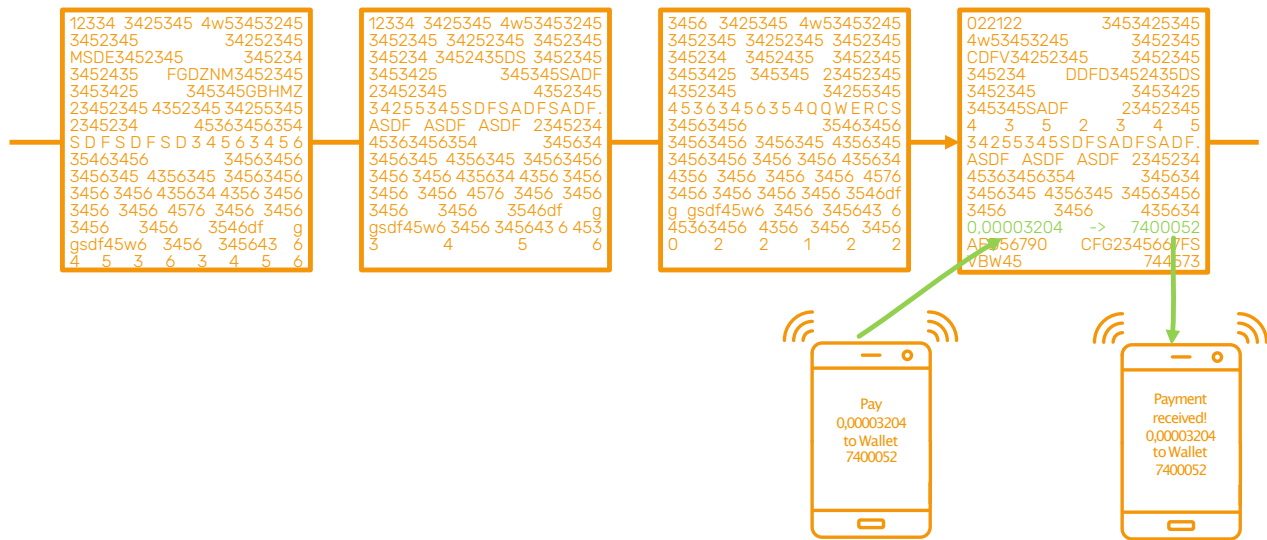


Figure 1: Basic view on a blockchain transaction.

To make sure the transaction can be done and is correct, various mechanism check the information and verify the information before it will be stored permanent within the blockchain. Depending on the blockchain used, there are different mechanism which check transactions and the data stored, so a coin can't be spend twice, the credit of the account is sufficient or if the transaction format is correct for example. The approval is done by separate units within the network, the miners and nodes, which will be explained later when we address the network components.

Here we have a simple picture of a blockchain. One block follows the other and is filled with transactions which have not been stored in another block before.



Figure 2: Blockchain DLT

Directed Acyclic Graph DLT (DAG)

Compared to the blockchain, as described before, the DAG architecture is more like a tangle due to the muddled look. While the blockchain has one string where the blocks are lined up and filled with transactions, the DAG DLT stores each transaction in a single "block" so called "tips" which works in parallel. An advantage of the DAG DLT is, it works without a separate unit to approve a

transaction. The work for the necessary approval includes the work to confirm at least two other transactions. This mechanism of approval accelerates the DAG, the more transactions, the more transactions get confirmed quicker. The mechanism isn't less secure, just because it is not as power and calculation time consuming like the one within the blockchain DLT, so it can be done by micro devices with a small calculation power as well. Alternatively, the work can be done by a trusted device too, so there's no need to be a high-end system to send data or transactions to the network.

Figure 3 shows a DAG DLT. The white blocks are confirmed transactions, while the gray ones on the right side are unconfirmed. If you look at the arrows, which show which transaction confirmed which one you can see the direction very well.

DAG DLT

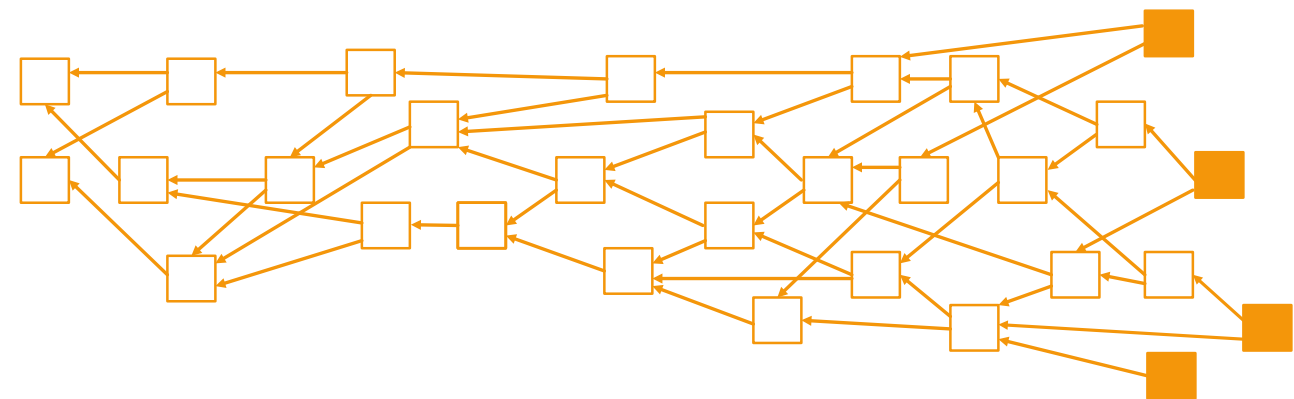


Figure 3: DAG DLT - Tangle (Source <https://www.iota.org>)

For now, it is enough to keep in mind, there is a medium where we can store and read data and this data is unchanged since the moment it was added. Independent if it is a blockchain DLT or a DAG DLT.

OK, let's go on and have a look at the network components which store the DLT itself, keep the data up to date within the network and the clients which send and receive data.

THE NODES

To make the data available to users or to write the data to the network, there has to be an address to make the network reachable. These core components are so called "Nodes" within the DLT jargon. Available on the network, the clients connect to and send and receive their information. A node is similar to a database, which is reachable over the internet. In case of a DLT there are many nodes running which communicate to each other and sync between each other. Theoretically one node is enough to keep a DLT network running. De facto most of the active DLT's have hundreds of nodes, provided by companies, foundations and/or private persons which use the network or want to participate to the network. A node is basically a server with a piece of blockchain software on it which is constantly replicating the new data between each other and make it available to

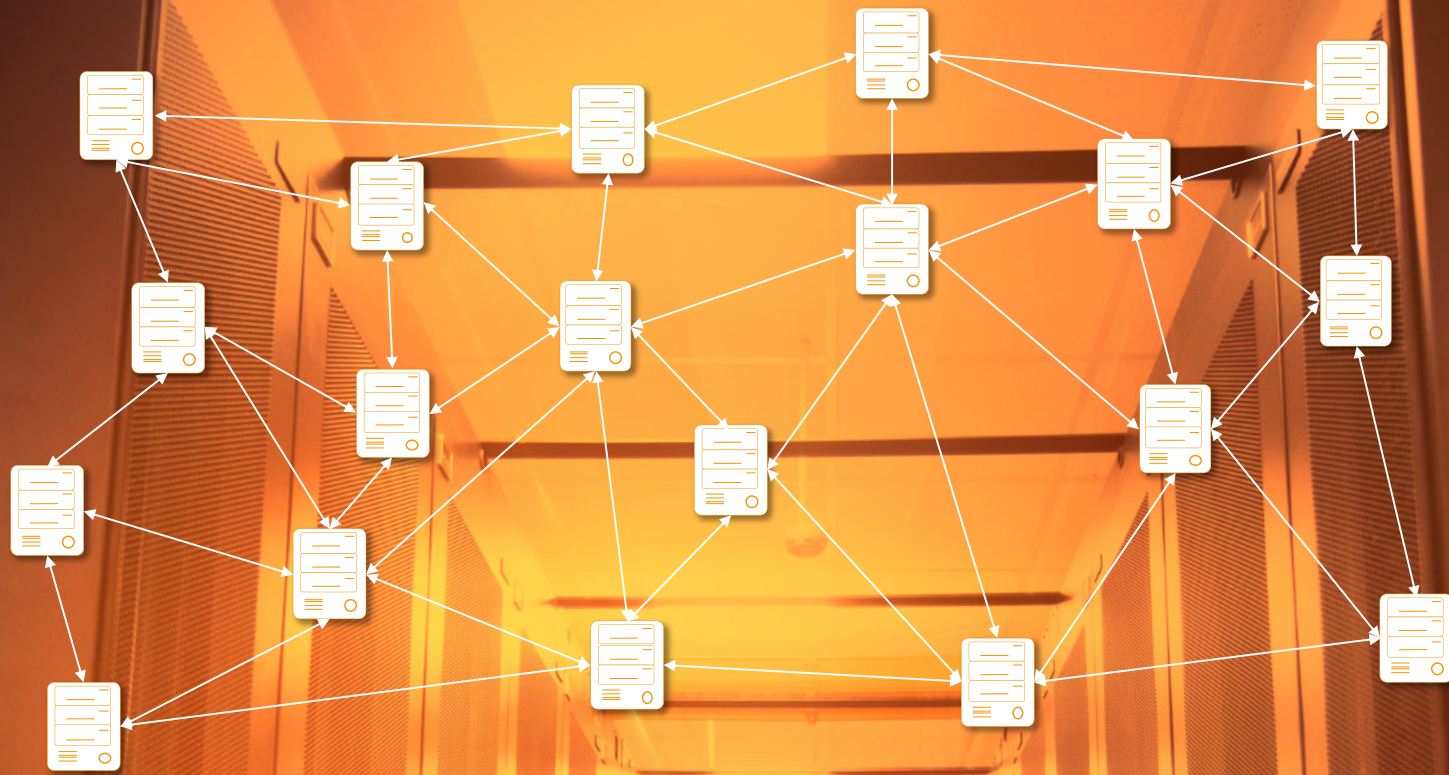


Figure 4: Node Network

Open Source and crowd support as a key factor.

Many of the available DLT solutions in the market are open-source projects, where community is a key factor for development, availability and performance. The networks are done by people who provide nodes, people who run mining systems or contribute with code to the DLTs itself. The main idea behind is to share the components to keep the network alive and make it more solid. As long one node and one miner are available or transactions are sent to the network, the exchange between the clients connected is possible. On February 08, 2021 8.835 Bitcoin nodes were available within the Bitcoin network.

the clients. Besides that, the nodes take care the data integrity is given, and the data is available for connected clients.

Miner

Let's have a look on the miners within some blockchain DLTs. Basically, a miner is a device which confirms transactions by solving cryptographic puzzles or mathematical tasks and creates the blocks. To create a block, the miner has to calculate a hash sum of the transactions within the block and need to verify it with another mathematical task. The first miner who got the correct hash, which need to be verified by all other miners, can add it to the blockchain. A difficulty, added to the protocol is increasing regularly, which make it more difficult to find blocks.

On February 9th, 2021 the Website <https://www.blockchain.com/de/charts/hash-rate> estimated a calculation power of 165 Million Tera hashes per second within the Bitcoin network.

The Clients

The other side of the network, the client, need to be separated in two different types. One for the payment functionality a software called "wallet" and one for the data transactions, which can be a device, an DLT explorer, a website or whatever should display the information requested from the DLT. The wallet has no other job then authenticating the user to the DLT, submitting transactions to a node and reading data from the DLT.

If we use the payment functionality from the blockchain technology, to make it a bit more tangible, the "Wallet" is your banking account where you can send and receive money. With the little difference, there is no bank, just a piece of software which connect to the blockchain. And if you send a value from your wallet to another wallet, you send the information to the blockchain.

A bit more complex it gets if we look on the data side. Depending on the DLT, there are various ways to add data to a DLT. But basically, it's nothing else then a piece of software which connects to the DLT and add data. Some DLTs already has components which automatically request APIs and send the data to a DLT.

On the other side, if you want to get the information from the DLT, there are also various ways to receive them and use it or display it. Most of the DLTs available are developed Open Source and offer various variants to use them on client side.

ADDITIONAL FEATURES & USAGE

Now we have a view on how DLTs basically work and we know there's a medium where we can send data and receive data. Based on this, over the years some more functionalities were developed. Let's have a look on these functionalities and also on some use cases, the DLT is used for already.



Smart Contracts

Shortly explained, smart contracts are software-based contracts which can initialize an action if one or more defined conditions are fulfilled. Storing the conditions in the DLT allow the system to rely on the data, stored once securely and trust the data, because it comes from a source the system was told to trust.

As a simple example we can use a temperature sensor which is sending his data to a DLT. Based on the temperature within the DLT a smart contract could send an activation signal to a heater to turn on or off if it is getting too hot or too cold, based on the values defined within the smart contract.

The above case needs just once interaction from a user, who needs to define the temperature range within which the room should be, everything else is done automatically in future. For sure this is possible today and done in a proprietary way by many companies, but with a standardized interface to DLTs, this would work manufacturer independent and other devices could add information easily. Let's extend the example a bit, if the smart contract knows where the people using the room are located actually, the smart contract could adjust the temperature within the room dynamically if a person is moving in direction of the location of the sensor or not.

Digital Twins

Within a digital world, real world assets and persons can get a digital twin which is nothing else then a unique identifier to whom all the information of an object in the digital world are connected to. This could be a digital twin for a machine for example, which stores information about the date build, the maintenance intervals, parts, owner and other values. Beside the all-time valid information, there can be also dynamic information added by the machine itself and can be stored connected to the digital object like actual temperature, actual position and so on.

A variant for a digital twin is a Decentralized Identifier described by the W3C. (<https://www.w3.org/TR/did-core/>)

This information could be stored within the database from the manufacturer or within a DLT where the data could be used from other systems connected to the DLT.



Asset Tokenization

The digitalization of assets and the value they generate is another use case for DLTs and the possibilities behind. Explained in short, instead of getting a credit from a bank, parts of an asset are sold and can be bought.

Let's use an apartment as an example. Instead of getting a bank credit shares, stored in a DLT, will be sold where each share is representing a part of the apartment. These shares are called "token" which represent a unique piece within the DLT.

Compared to the bank, many people could give money by buying one of the tokens or even more and would own pieces of the apartment in this way. In exchange for the money the people invested they get back a rental fee from the persons using the apartment. The token owner could sell the token to get back his money quick or keep it and earn money by receiving regularly the agreed fee or the money the apartment is rented for.

This could be done with nearly every asset which is available and can be used by someone else. Using the DLT in combination with smart contracts, even temporary rentals could be realized without human interaction.

Digital Data Marketplaces

Another usage of DLTs could be a so called "Digital Data Marketplace" where sensors and devices can sell data by itself. This data can be bought by people, applications or services on demand.

To make it a bit more tangible, we will use an antenna of a 5G network. The antenna within the 5G network knows where itself is located and pretty exactly where a client is. Basically, it needs the information for itself to optimize the beamforming. Let's assume the antenna do not only use the information itself, but it also publishes to a digital marketplace based on a DLT.

What do we have now within the digital marketplace. We have the information where a mobile is and if there is more than one mobile, the information how many mobiles are in a region.

The digital data marketplace will automatically charge devices or persons which request the data with a pre-configured price.

Someone who is selling display time on advertisement displays can increase or lower the price for an advertisement displayed in this location based on the information or turn off the display if there are not enough potential viewers which lowers the costs, based on smart contracts even automatically without human interaction.



Digital Supply Chain Management

Widely used are DLTs within the digital supply chain management sector. Based on a digital twin, a product can be followed while the whole manufacturing process. Depending on how much information should be shared, even a customer can watch the details when he scans a QR code which lead him to the according information of the specific product.

Here we can do a shiny example. Diamonds are normally identified by a number engraved on the diamond itself. Some manufacturers already use the DLT to ensure the number and the diamond fit together and the data of the diamond is valid. They store the data from a stone in a DLT combined with the number when it is engraved to the stone, to make sure no one can use this number for another stone and document the whole process. In addition, they store the information where the diamond come from and certify it.

E-Voting

Another use case for DLTs is electronical voting. Each voter is getting a unique token number, securely stored with his ID number within an DLT. Independently if the voter is doing a personal vote or a digital, his token number in combination with his personal ID identifies him. As soon he received his voting paper or is giving his vote on a website, his token number will be marked as voted and he can't vote a second time. Beside that it would be immediately clear how many voters joined the election.

Links

Finally, some links, leading to additional information explaining DLTs and projects where DLTs are used already or will be used and are developed actually.

<https://www.bosch.com/stories/blockchain-technology-explained/>

https://en.wikipedia.org/wiki/Smart_contract

<https://www.investopedia.com/terms/b/bitcoin-mining.asp>

<https://www.bdli.de/innovation-der-woche/corona-check-blockchain>

<https://iottechnews.com/news/2021/jan/11/frankfurt-airport-using-iota-verify-covid-19-test-results/>

<https://www.etogruppe.com/en/news/news-from-eto/eto-gruppe-develops-traffic-infrastructure-sensors-funded-by-german-federal-ministry-of-transportation-and-digital-infrastructure-bmvi-within-project-alfried.html>



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ABOUT SITICOM

siticom is a technology innovation company founded in 2010 with a focus on the digital transformation of infrastructure and networks of tomorrow. siticom's portfolio is geared towards the complex technological challenges of the future. The solutions and services range from technical and strategic advice to engineering services for planning and realizing network infrastructures in communication networks and corporate networks. Thanks to a highly innovative, flexible grid of system partners, siticom is able to implement high-quality solutions at short notice. The combination of consulting, design and architecture bundled with the assumption of system and implementation responsibility as well as test-automation distinguishes siticom as an independent system integrator.

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