THE BLOCKCHAIN FOR SCIENCE

Whitepaper 3.0

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ABOUT

The bloxberg infrastructure is a secure scientific global blockchain established by researchers and research organizations to provide science with decentralized services worldwide. It broadens the scientific landscape of regionally and nationally governed blockchain networks, and is the first truly globally maintained scientific decentralized network for scientists.

The bloxberg association (bloxberg.org) aims to foster collaboration among the global scientific community, empowering researchers with robust, autonomous services that transcend institutional boundaries. The excellent reputation of the participating research organizations encourages scientists throughout the world, to utilize the bloxberg network and the applications built on top of the infrastructure.

BLOXBERG FOUNDERS

The bloxberg consortium was initiated in February 2019 at the invitation of the Max Planck Society together with the founding research organizations. Each of the participating research organizations has an in-depth knowledge of the groundbreaking possibilities of DLT in science and recognizes the enormous potential of a truly decentralized global scientific infrastructure like bloxberg for the scientific community worldwide.

With the 11 bloxberg founders, 9 different countries are represented with at least one renowned research organization:

Organization	Country	Contact
Max Planck Society	**Germany**	Sandra Vengadasalam
University of Nicosia	**Cyprus**	Soulla Louca
University College London	**UK**	Tomaso Aste
IT University of Copenhagen	**Denmark**	Roman Beck
University of Kassel	**Germany**	Walter Blocher
Georgia Institute of Technology	**USA**	Vijay K. Madisetti
Carnegie Mellon University	**USA**	Sevin Yeltekin
University of Johannesburg	**South Africa**	Maria Frahm-Arp
University of Sarajevo School of Economics	**Bosnia and Herzegovina**	Zlatko Lagumdzija
ETH Library at ETH Zürich	**Switzerland**	Sven Koessling
University of Belgrade	**Serbia**	Aleksandar Markovic

IRON THRONE

The Iron Throne was the temporal executive of the bloxberg consortium. The concept of the Iron Throne was dropped when the bloxberg Association for the Advancement of Science and Blockchain e.V. (bloxberg Association) was established. The Executive Board of the bloxberg Association takes over the duties of the former Iron Throne.

Iron Throne from 2019 – 2023:

2019 - 2020
Max Planck Society
0xaa84378fa41da83a9b6523ba46e45a664fbebfc8

2020 - 2021
Max Planck Society
0xaa84378fa41da83a9b6523ba46e45a664fbebfc8

2021 - 2022
Max Planck Society
0xaa84378fa41da83a9b6523ba46e45a664fbebfc8

2022 - 2023
Max Planck Society
0xaa84378fa41da83a9b6523ba46e45a664fbebfc8

BLOXBERG INFRASTRUCTURE

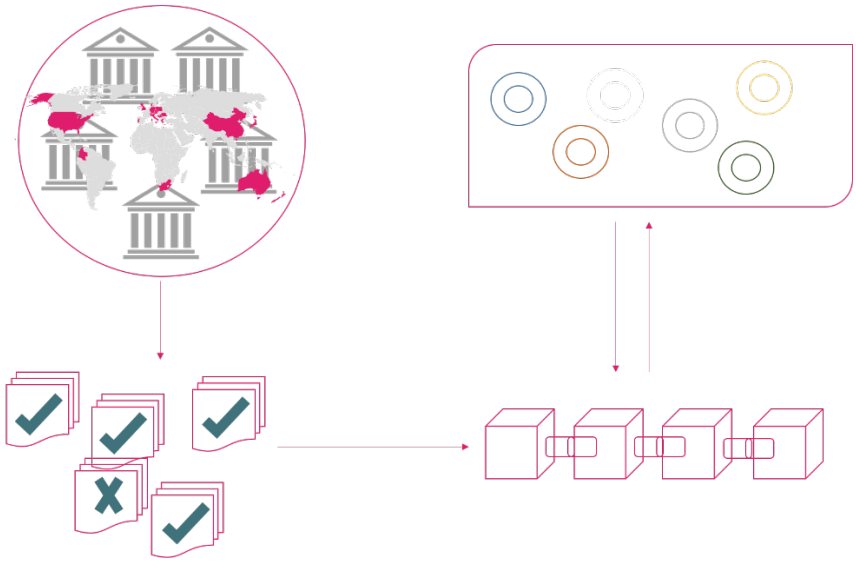
The bloxberg infrastructure consists of the two main components which are explained in this chapter, first the bloxberg technology (nodes, smart contracts, etc.) and second the governance model which defines the ground rules of the network. The bloxberg infrastructure is developed on top of a permissioned Ethereum blockchain network driven by Proof of Authority consensus (see chapter Consensus Algorithm). Ethereum was chosen because it has one of the strongest communities out of any blockchain network and it has been shown to be resilient and stable against many attacks while running on the mainnet. The growing number of productive applications and networks relying on the Ethereum blockchain has proven the readiness of this new technology and has become apparent to handle the requirements of a fully decentralized and global network on a high scale level.

The bloxberg infrastructure relies on the Proof of Authority (POA) consensus algorithm which assures the greatest combination of security, efficiency, and decentralization, available on the Ethereum chain. Efficiency is achieved because the amount of Authority nodes processing transactions is kept relatively low, so block confirmations happen quickly, without the long confirmation times commonly see in other blockchains. Security is guaranteed through the fact that Authority nodes are distributed among different entities and are numerous enough that they prevent against a malicious 51% attack. Finally, decentralization is realized through limited control of the chain from any single institution, once more Authority nodes which joined the network can vote and add other Authority nodes independently of the Max Planck Society (see chapter governance model). Candidate institutions will be vetted through a peer review process from entities already part of the network.

BLOXBERG PROTOCOL

The bloxberg blockchain is a public, permissioned implementation of Ethereum, featuring smart contract functionalities and using the network of nodes from the bloxberg Association.

The bloxberg Association runs and maintains the bloxberg network and approves transactions by the Proof of Authority consensus algorithm. Independent dApps or Apps can be built on top of the bloxberg network by using the open bloxberg API.



Decentralized applications running on top of bloxberg can be developed by third parties, association members or scientists, amongst others. The bloxberg Association fosters the development of applications who benefit the scientific ecosystem.

bloxberg API: Scientific dApps communicate with the bloxberg blockchain to provide services to scientists and researchers

bloxberg consensus: The Proof of Authority consensus was chosen based on consistency, availability, performance, and previous use in large networks. A detailed protocol audit is available for review.

bloxberg protocol: The blockchain itself is based on a permissioned implementation of Ethereum.

NODES

The bloxberg network consists of two types of nodes; Validator nodes and non- Validator nodes.

The bloxberg Association run the Validator nodes, ensuring a global distribution of nodes among their members. Validator nodes carry out the computational activities in the network to validate and store blocks and transactions of the distributed ledger of the bloxberg blockchain. All Validator nodes in the bloxberg blockchain are considered equal and use the same consensus protocol to remain consistent.

Non- Validator nodes communicate with the network. Every entity can run a non- Validator node and connect it to the bloxberg blockchain, e.g. a 3rd party company, running an application on bloxberg.

CONSENSUS ALGORITHM

The bloxberg consensus is governed by Proof of Authority (PoA) based on the Authority Round (AuRa) algorithm (https://wiki.parity.io/Aura). This algorithm was chosen based on consistency, availability, performance, and previous use in large networks. A detailed protocol audit is available for review (https://github.com/poanetwork/wiki/wiki/Aura-Consensus-Protocol-Audit).

A PoA consensus algorithm does not depend on nodes solving arbitrarily difficult mathematical problems (mining), but instead uses a set of "authorities" – nodes (in bloxberg called Validator nodes) that are explicitly allowed to create new blocks and secure the blockchain. The chain has to be signed off by the majority of authorities, in which case it becomes a part of the permanent record (finalization). Some advantages of a PoA consensus compared to a PoW consensus:

- Increased security (a node which is not registered as a Validator node or a hacked Validator node cannot overwhelm the network, potentially reverting all transactions)
- less computationally effort (no mining required)
- more performant (Aura consensus provides lower transaction acceptance latency)
- more predictable (blocks are issued at steady time intervals)

Block creation and signing

The Validator node, who is next to create and sign a block, is called the primary. All Validator nodes in the network keep track of the steps in the chain. A step is the unix-time divided by the current block creation time. The primary is calculated from the step modulo the number of all Authority nodes in the network.
Primary = (unixtime / block creation time) mod #Validators

Example:
Primary = (1579169080 / 7) mod 11 => Validator *node number 3 creates and signs the next block*

Finality
Finality in AuRa is defined by a simple majority vote. Finality is reached when at least 51% of all Validator nodes signed the same chain twice.
If there is a valid chain *Chain1* where #signedValiatorNodes > #allValidatorNodes / 2, then *Chain1* and all of its ancestors are finalized.

SMART CONTRACTS

The bloxberg consensus algorithm and the bloxberg governance model are computed into smart contracts and were deployed on the bloxberg Genesis.

All smart contracts for the bloxberg network are open source (https://github.com/bloxberg-org):

- bloxberg genesis file
- bloxberg consensus algorithm smart contract
- Voting application compliant with the bloxberg governance model

Additionally, research organizations, developers, and users of the chain are free to deploy smart contracts as they see fit.

BERG – THE BLOXBERG CURRENCY

bergs (△ U+25B3) are the currency of the bloxberg network. In order to interact with bloxberg blockchain applications or to deploy smart contracts, bergs are utilized for these interactions. The berg symbol stands before the value, e.g.: △0.00134

The smallest unit is called a 'brox'. The full table is:

Unit	brox Value	brox
brox	1 brox	1
Kbrox	1e3 brox	1,000
Mbrox	1e6 brox	1,000,000
Gbrox	1e9 brox	1,000,000,000
microberg	1e12 brox	1,000,000,000,000

milliberg	1e15 brox	1,000,000,000,000,000
berg	1e18 brox	1,000,000,000,000,000,000

bergs are not traded; all transactions in the bloxberg blockchain are free of charge. The bloxberg blockchain provides a faucet app to distribute bergs among all entities who wish to build on the bloxberg network or utilize the functionality of bloxberg apps.

GOVERNANCE MODEL

Compliance:
All members in the bloxberg blockchain must follow the guidelines; not following the guidelines may result in exclusion.

Stakeholders

Stakeholders are the main entities, which participate in the bloxberg network and are relevant for defining governance rules.

bloxberg Association members

bloxberg Association members form the governing body of bloxberg and are responsible and accountable for the directing and control of the bloxberg blockchain. bloxberg Association members are equal, no hierarchy exists by design. Institutions and individuals can apply as a bloxberg Association member if they are a:

> *'scientific organization or organization that is mainly research-oriented, contributing to the body of science and is align with the purpose of the association'*

bloxberg Association members can be a natural person (affiliated with an institution), or a legal person (the institution itself). Each institution can only be represented by one entity in the network, either a natural or a legal person. All members are known and identified on the bloxberg homepage (https://bloxberg.org).

Decision Making

Decentralized decision-making processes are essential for the sanity and growths of bloxberg. bloxberg differentiates between two basic decision-making processes. Governance decisions, carried out off-chain, after intensive discussion, as the nature of governance decisions are more likely to be groundbreaking and fundamental for the Association, and proposal decisions, are made by an on-chain voting.

Governance Decisions

Governance Decision Voting Model

one member – one vote
(Members representing the same institution must choose a single member to vote on their behalf.)

Governance Model Changes

1. Changes of the governance model are discussed off-chain at the annual bloxberg summit.
2. The bloxberg Association requires a quorum of >50% of the participating organizations to execute a valid voting, but a minimum of seven voting organizations.
3. For changing the governance model, the proposal needs >50% of acceptance.
4. The voting is executed off-chain by the Executive Board.

Solving Conflicts & Forking

bloxberg Association members are urged to solve conflicts in the best manner for the good of the network. The Executive Board of the bloxberg Association can be called as a mediator on demand. Intractable disagreements in the Association can be resolved by initiating a 'fork'.

Proposal Decisions

Proposal decisions are executed via an on-chain voting through bloxbergs voting application (https://voting.bloxberg.org/). Proposals can be set up at the beginning of every month and are up for voting during the period of one month. The voting on proposals is executed according to the Proposal Decision Algorithm.

Proposal Decision Voting Model

The proposal decision-voting model follows the proposal decision algorithm to incentivize Association members to execute their duties in the bloxberg network. All bloxberg founding members started with a voting power of 25% (100 voting weight), new bloxberg Association members will start with a voting power of 0% (0 voting weight).

For each voted on proposal, weight is added to the current voter weight. Each missed proposal results in a deduction of weight. The function that governs the adjustment of voting weight per proposal is:

$$CurrentVoterWeight \pm \frac{100}{TotalProposalsinBatch}$$

The maximum possible voting power of one organization is 100% (400 voting weight); the minimum possible voting power is 0% (0 voting weight).

Voting for new bloxberg Association member

1. Applicant fills out a form on the official (bloxberg.org) website.
2. The Executive Board adds the applicant to the voting application.
3. The voting is executed on-chain after an off-chain discussion.

4. The voting is executed according to the proposal decision algorithm.
5. The bloxberg Association needs a quorum of > 50% of all voting power, to execute a valid voting, but a minimum of 3 voting organizations.
6. If > 50% of the valid votes are yes, the new member is accepted. If not, the new member is rejected and can reapply at a later time.

Voting for exclusion of a bloxberg Association member

1. A voting for exclusion will be triggered if a bloxberg Association member does not fulfill his or hers accountability.
2. The voting is executed off-chain.
3. The voting is executed according to the proposal decision algorithm.
4. The bloxberg Association needs a quorum of > 50% to execute a valid voting, but a minimum of seven voting organizations.
5. If > 50% of the valid votes are yes, the member is excluded.
6. The Executive Board removes the member from the bloxberg network.
7. The excluded organization can reapply for a bloxberg Association membership.

bloxberg Improvement Proposal

1. Every bloxberg Association member can create a BLIP (bloxberg improvement proposal).
2. Every BLIP must contain the voting option ‚reject'.
3. The voting is executed on-chain after an off-chain discussion.
4. The voting is executed according to the proposal decision algorithm.
5. The bloxberg Association needs a quorum of > 50% of all voting power, to execute a valid voting, but a minimum of 7 votes.
6. The option with the most votes wins.

Inclusion & Transparency

All bloxberg Association members are fully included in the decision-making processes of bloxberg, as they can:

1. create a BLIP (bloxberg improvement proposal) at https://blips.bloxberg.org/
2. initiate governance decisions at a bloxberg meeting

The decision-making process of bloxberg is fully transparent for all bloxberg Association members, as:

1. information on new member votes is provided by the Executive Board and discussed in the Association meetings.
2. all bloxberg Association members can access the voting application of bloxberg to see upcoming votes and the results of past votes.
3. BLIPs are published on https://blips.bloxberg.org/ .

Accountability

Accountability is particularly useful for permissioned blockchains where all parties know each other, and hence, accountability incentivizes all parties to behave in a way that benefits the whole network.

Validator Node

1. bloxberg Association members must furnish and maintain up-to-date contact and node information to the Association, (https://validators.bloxberg.org). Members must furnish and maintain cryptographic information, identifying the respective node that they maintain, to the bloxberg Association.
2. Every bloxberg Association member should run a node
3. The node may not be offline longer than three months.
4. The Association member performs necessary security updates on the nodes, takes reasonable actions to prevent spamming of the network and implements certain protocols, promulgated from time to time by the Association.
5. The Association member will perform updates and install releases as decided by the bloxberg Association.

Legal Implications

A bloxberg Association member is responsible for the legal compliance in the respective jurisdiction, for running a bloxberg Validator node.

A bloxberg Association member shall not be liable inside and outside the Association for the transactions and content, which are distributed to the network through its node, and in this regard be indemnified and held harmless by the bloxberg Association.

Incentives

Incentives influence the system participants to behave in a way that benefit the whole network.

Consortia participation

1. Members of the bloxberg Association proposal voting will be incentivized by an increase of voting power.
2. Members of the bloxberg Association gain 'bergs' for running a Validator node and processing transactions.
3. Members give a strong statement towards decentralized and autonomous services to support science and the global scientific community.

BLOXBERG CONNECTIVITY

Scientific dApps and Apps communicate with the bloxberg blockchain to provide services to scientists and researchers. Therefore, various research institutions will run a hosted node (bootnode) to provide access via an API to the blockchain for interested parties to connect to. An initial access point can be found on the bloxberg website (https://bloxberg.org/developers-hut/) with more to come. It is expected that individual applications will run their own non- Authority node to communicate with the bloxberg blockchain to ensure performant communication.

BLOXBERG SUMMIT

In February 2019, on the initiation of the Max Planck Society, leading research organizations from around the world came together to formally constitute the bloxberg consortium for the ground-breaking and secure bloxberg network to build truly global, decentralized and autonomous services to advance science.

The bloxberg Summit is an annual meeting of all Association members to discuss the governance model; future challenges and define synergies and strategies for further consortia cooperation.

BLOXBERG APPLICATIONS

The aim of bloxberg is to instantiate the bloxberg network and promoting the implementation of applications on top of it, that will benefit scientific research. bloxberg will host a suite of scientific applications in order to enhance research. The vision of bloxberg is to have sufficient representation from globally distributed scientific entities participating in the network, such that the network itself can replace traditional scientific infrastructure like closed-access publishing amongst others.

BLOXBERG HOMEPAGE

www.bloxberg.org. contains detailed information on the bloxberg project, the technology and the Association members. Utilizing the bloxberg website it is also possible to see the suite of apps developed by the bloxberg Association and third parties.

APPS/DAPPS

Third parties, Association members, and scientists, amongst others, develop apps or dApps running on top of bloxberg. The aim of the bloxberg Association is to encourage the development of apps that benefit the scientific ecosystem. The bloxberg Association provides the blockchain infrastructure for the suite of applications that take advantage of blockchain technology. The following applications are ensuring the bloxberg network core services. For a full overview of applications on the bloxberg blockchain visit the bloxberg website (https://bloxberg.org/apps/).

Certify and Verify
With bloxberg, research claims need not be limited to one institution alone, but can be confirmed by the whole trusted network. Additionally, researchers can leverage bloxberg to create a transparent footprint of their work, without revealing its content. You can then generate a certificate that proves you uploaded this data at a certain time, therefore protecting you from being scooped or IP stolen. At a later date, this application can be utilized to confirm that research data was certified at an earlier time (Proof of Existence).

bloxberg Faucet
The faucet dApp is primarily for providing bergs (the bloxberg currency) to users of the blockchain. In order to interact with blockchain applications or deploy smart contracts, bergs are utilized for this interaction. The faucet guarantees that people who wish to build on bloxberg or utilize the functionality of the apps will be able to do so.

bloxberg Explorer
Here you can see a wealth of information detailing current transaction status such as pending or confirmed, smart contracts that have been deployed and can be interacted with, and a detailed and transparent look into the overall activity of the network.

bloxberg Validator
The bloxberg validator app can be utilized to connect authority public addresses to basic information about each validator, for instance the research institute, address, and research field of each responsible member.

FUTURE OUTLOOK

Ultimately, the vision of bloxberg is to be the foundation for a suite of applications utilizing blockchain technology to benefit the entirety of the research process. These could include applications like innovative ways of research funding, a decentralized journal, expanding and securing the peer review process, and much more. Association members, third-party organizations, and scientists are encouraged and invited to build on top of the bloxberg infrastructure – secure in the fact that it is run by scientists, for science.

APPENDIX

The bloxberg Research Data Certification

bloxberg

Research Object

Certificate

This bloxberg certificate serves as a proof of existence that the data corresponding to the cryptographic identifier were transacted on the **bloxberg** blockchain at the issued time.

Cryptographic Identifier

620c00d82bb9e49e4dead633d8791aa37fb58a058793056bdc2f1f893bbfb39b

Transaction ID

0xc09d14494b7fc93bf5af166aaa183dfd4c787add6fd58dbd73d720e1199ccdf4

Timestamp

2022-06-29T07:10:21.882713

Merkle Root

9afe0347dbf26acf2e21acf1ca422684f49e9cae7e95930b2cd993f43a2751b6

View the transaction at https://blockexplorer.bloxberg.org

Verify the certificate at https://certify.bloxberg.org/verify

The annual bloxberg summit


Fourth bloxberg Summit
for Consortium Members
May 3 - 4, 2022
UCL | London | United Kingdom
Couch | Home | Worldwide
bloxberg
The Novel Blockchain Consortium for Science


Fifth bloxberg Summit
for Consortium Members
October 26 - 27, 2022
Protaras | Cyprus
Couch | Home | Worldwide
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SAVE THE DATE
Sixth bloxberg Summit
October 26 - 27, 2023
Faculty of Organizational Sciences | Belgrade | Serbia
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THE ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND BLOCKCHAIN