Dr. Christian Baumann, 17.10.2018

Air Quality Chain – Environmental data on the blockchain

The "Air Quality Chain" is a system for logging, immutable storage and decentralized distribution of environmental data based on the Blockchain technology. Currently, the measurement data of the air monitoring network of the city of Vienna, the current ozone data of Austria and the data of the radiation early warning system are periodically queried and stored in a block chain, which was set up for this purpose. The data includes: temperature, humidity, wind, nitrogen oxides, ozone, sulfur dioxide, carbon monoxide and particulate matter.

Stream: aqc-messdaten – 1000 of 7530 items with key: KEND

Publishers	MC2.0a@FRA (1AW7CVnQwpKPvxM7Hun3EYzfZKDZPfDNdpHSE3)
Key	KEND
Data	{"station":"KEND","zeit":"2018-09-03T11:00:00+02:00","werte":{"WG":1.73,"WR":140.23,"NO2":28.91,"NOX":34.3,"PM10":12.88,"PM25":10.45}}
Added	2018-09-03 09:15:02 GMT

Publishers	MC2.0a@FRA (1AW7CVnQwpKPvxM7Hun3EYzfZKDZPfDNdpHSE3)
Key	KEND
Data	{"station":"KEND","zeit":"2018-09-03T10:30:00+02:00","werte":{"WG":3.43,"WR":105.15,"NO2":26.74,"NOX":32.69,"PM10":12.33,"PM25":10.51}}
Added	2018-09-03 08:45:01 GMT

Publishers	MC2.0a@FRA (1AW7CVnQwpKPvxM7Hun3EYzfZKDZPfDNdpHSE3)
Key	KEND
Data	{"station":"KEND","zeit":"2018-09-03T10:00:00+02:00","werte":{"WG":2.61,"WR":124.64,"NO2":37.42,"NOX":46.46,"PM10":15.37,"PM25":12.47}}
Added	2018-09-03 08:15:02 GMT

Figure 1: Example of storing measurement data in a blockchain stream

The blockchain is designed so that there are subscribers ("nodes") with different permissions. Institutions or companies that provide data have write permissions. Participants who just view or evaluate the data, have read permissions. The digital signature performed on each write transaction clearly indicates which participant has logged which data. Due to the immutable storage of the data no subsequent manipulation, deletions, etc. can take place. If erroneous data was written, it can not be deleted, but supplemented by corrected data. The decentralized architecture of a blockchain ensures that the nodes themselves synchronize the data between all nodes and provide redundant, failsafe storage.

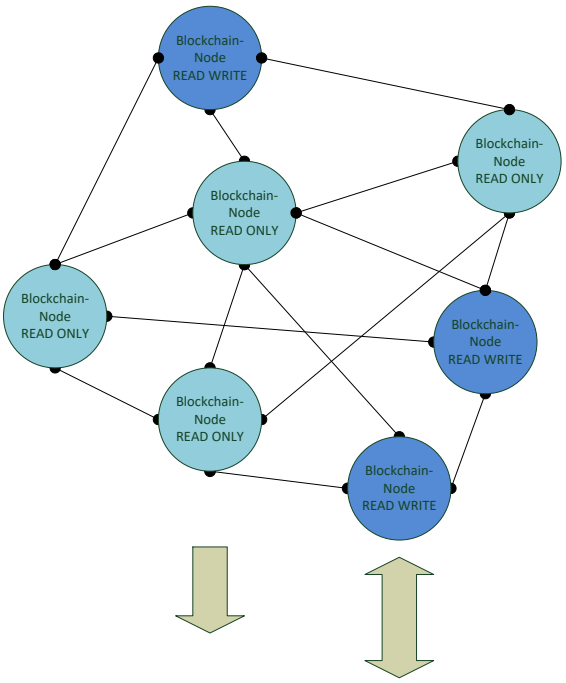

Figure 2: Block chain network with different access permissions

All used software components are open source, the data of the official measuring points are published as Opendata.

As part of the project, several examples of the use of the data have been implemented. Graphical representations in the form of time series or as a map display can be reached at the following link: https://www4.baumann.at/umweltmessdaten-auf-der-blockchain/.

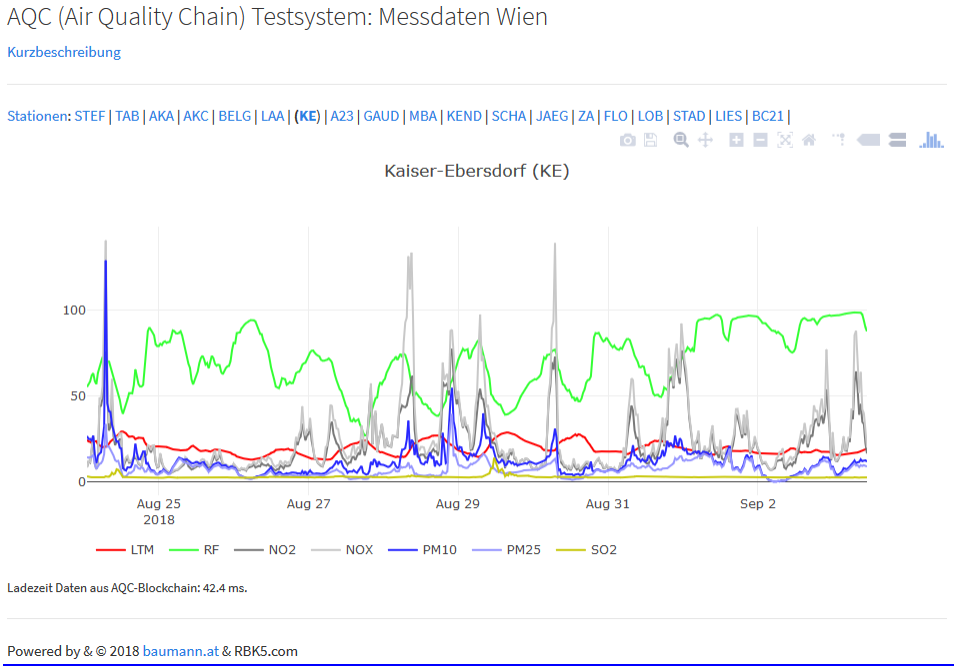

Figure 3: Example of representation in time series form

AQC (Air Quality Chain) Testsystem: Strahlenbelastung Österreich

Kurzbeschreibung

Messwerte vom 3.09.2018, 11:00

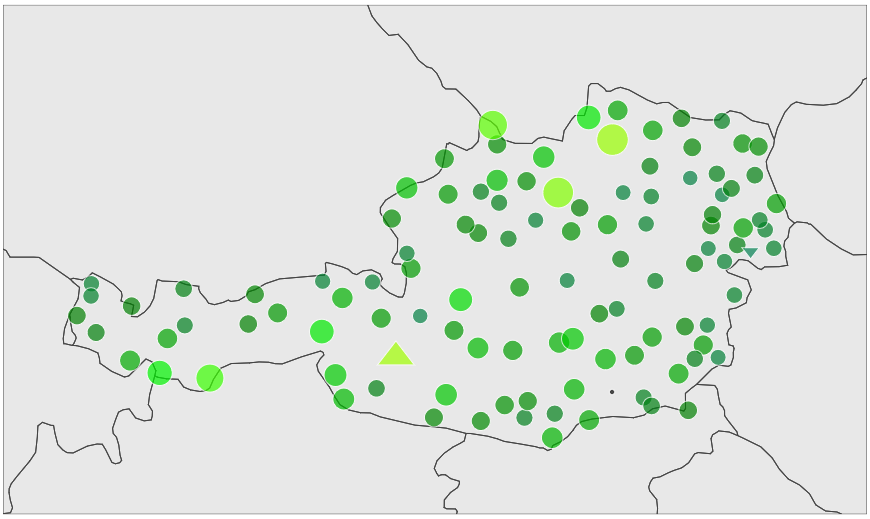

Figure 4: Example presentation on map

In addition, the current air quality data from Vienna can be retrieved via a "telegram bot", see https://www.data.gv.at/anwendungen/telegram-bot-air-quality-vienna/.

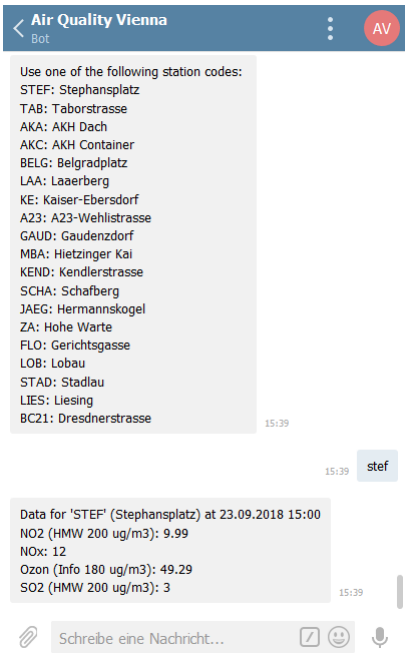

Figure 5: Screenshot of Telegram-Bot

Interested institutions (eg. schools) or persons can set up their own blockchain nodes any time and participate in the system, eg. to evaluate the existing data. Furthermore, a test system is operated in which measurement data from "private" sensors are recorded, such as prototypical IoT ("Internet of Things") systems or as part of tests for "smart city" applications.

In an upcoming phase, in addition to the data of the city of Vienna, the official data of as many Austrian federal states as possible will be integrated. Initial contacts with Germany and with an NGO from the environmental sector are also being established.

OPENSOURCE

As blockchain technology the system "multichain" is used. The Community Edition is published as an open source under the "GNU General Public License version 3", see https://github.com/MultiChain/multichain.

The open source library "EasyBitcoin-PHP" (see https://github.com/aceat64/EasyBitcoin-PHP) was used as a library to access the multichain API. In the course of the project it was adapted or extended by functions and again as open source library published under the name "MultiChain API PHP", see https://github.com/baumann-at/MultiChain-API-PHP.

ASPECTS OF BLOCKCHAIN TECHNOLOGY

The use of blockchain technology for distributed collection, unchangeable logging, and distributed storage of environmental metrics is a novelty. This has not been done in any other (known) system so far.

The use of blockchains extends Opendata's idea of decentralized distribution: the published data "self-distributes" to all participating systems (blockchain nodes). Furthermore, data storage gains the dimension of time: Usually, only the chronologically current data record is published as opendata, with AQC the data is historicized and thus extended evaluations and analyzes (eg. time series representations) are possible.

Another aspect compared to conventional database systems is the use of blockchain nodes is the "lowest common denominator". As a result, functions such as the synchronization of the decentralized data sets are performed transparently and fully automatically by the blockchain technology. Relatively simple APIs are available as an interface to the respective applications and there are program libraries in all common programming languages available as open source.

Probably the most important aspect is the ability of blockchains, to store data unchangeable, secured by cryptography. This makes it clear that the data can never be manipulated.

Planned future developments concern the topic of scaling in order to enable the processing of data from tens of thousands of measuring points (eg in an international / Europe-wide application) and the integration of further protocols from the area of Internet of Things, such as "Message Queuing Telemetry Transport" (MQTT).

SOCIAL BENEFITS AND IMPACT

Dealing with blockchain technology increases the level of knowledge in this area. This makes air quality more tangible and more practical than most other topics mentioned in connection with blockchains: tokenization, supply chain, smart contracts, etc.

The AQC project increases awareness of air quality and environmental protection. In tourism the trend is coming, to select the holiday destination based on air quality. AQC can contribute to this by increasing confidence in the recorded or published air quality data.

Finally, to proof compliance with Europe-wide limits, AQC can be used for a public, immutable documentation of the ambient air quality.

NEXT STEPS

If you are interested in this project as provider or user of environmental data or as supplier of sensor equipment etc., feel free to contact me!

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