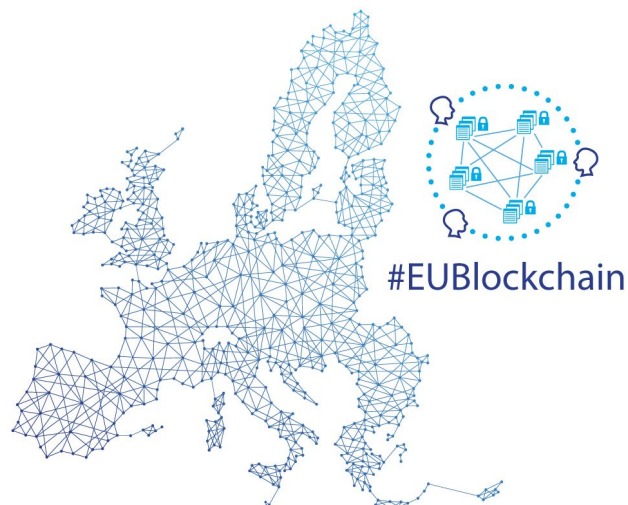# EU BLOCKCHAIN OBSERVATORY & FORUM

Workshop Report -
Convergence of blockchain, AI and IoT
Brussels, 28 March, 2019

#EUBlockchain

By the European Commission, Directorate-General of Communications Networks, Content & Technology.

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Introduction to the day

Pēteris Zilgalvis, Head of Unit, Digital Innovation and Blockchain, Digital Single Market, DG CONNECT; Co-Chair, FinTech Task Force, EC, gave the welcoming remarks.

- There are a number of important EU blockchain initiatives. These include:
  - The EU Blockchain Observatory & Forum, which is designed to raise the level of knowledge about what is happening in blockchain in Europe.
  - The European Blockchain Partnership, now 29 European countries and soon to be 30, which is working to build a European Blockchain Services Infrastructure as part of the Connecting Europe Facility. It is at the moment a Member States initiative, but is intended to eventually be a public/private cooperation. Early use cases are in RegTech, diplomas, document certification and self-sovereign identity.
  - The International Association of Trusted Blockchain Applications (INATBA), which is the newly formed association of private blockchain stakeholders. INATBA will also be helping the EC in setting up a World Blockchain Congress in the fall that will include a regulatory dialogue.
- Zigalvis also pointed out that the information gathered by the Observatory, including at workshops like this one, can help provide information that could help the new European Parliament as they make decisions on the upcoming legislative agenda.

Ludovic Courcelas, project manager of the Observatory, then set the scene and introduced the objectives of the day.

- The topic of the convergence of blockchain, AI and IoT had attracted a great many people to the workshop, and this topic has indeed been the subject of much discussion and not a little hype recently.
- It is important to look beyond the hype and see what value the three technologies bring. At a high level:
  - Blockchain is about transfer of value, decentralisation and smart contract automation.
  - Artificial intelligences is about autonomous analysis and some skills like visual and speech recognition, as well as the ability to take decisions and act upon what has been learned.
  - IoT is about collecting data about the real world and being able to take actions in this real world. It links the digital world with our real lives.
- Each of these technologies also has one main pain point:
  - Blockchain's weakness is that it is in a closed environment. To be effective you must get trusted data onto the chain.

- - ○ Artificial intelligences depends upon massive amounts of data to be effective, and so it is important to ensure that this data is valid and trustworthy.
    - ○ IoT generates the data that we need, but it is no good if this data is not trusted, both at source but also as it travels along the value chain.
  - These pain points can in many cases be solved by combining the technologies. How that can be done is in essence the topic of the day.
  - Platforms based on the convergence of these technologies can transform entire industries. Promising convergence use cases include smart cities, smart healthcare, international trade, smart agriculture, fintech.
  - The specific objectives of the day were to:
    - ○ Map the potential interactions between blockchain / AI / IoT and the most promising use cases
    - ○ Identify the industries that could benefit the most from more convergence
    - ○ Draw a vision for the future of technology solutions and challenges to be met along the way
    - ○ Prioritize measures that could foster innovation in the EU and position it at the forefront

Presentation Tim Weingärtner

Professor Tim Wingärtner from the Lucerne University of Applied Sciences and Arts gave an overview of the current state and potential in convergence of blockchain, AI and IoT.

- The amount of digital data available in the world is growing exponentially, and with it we are seeing the growth of a new digital world in parallel to our real world. The digital world has different "parts".
  - ○ We have sensors of different kinds all around us that collect data and transfer them to the digital world. These include things like cameras, microphones, IoT sensors, location sensors, etc. On the other hand, the digital world provides ways to get this data out, in effect giving us in the analog world access to this digital world. With VR we can even start to step in to this digital world.
  - ○ There are parts of the digital world that think and act. We have AI to consider information and make decisions and carry out actions in the digital world.
  - ○ We have things like robots, drones and 3D printers to act in the physical world based on decisions taken in the digital one.
- The digital world has some properties that are not found in the physical world. For example, in the physical world you can only be in one place at one time. In the digital world you can be in more than one, or travel instantly between places. In the physical world we are trapped in time. In the digital world we can do things like reverse time (go back in time).
- The digital world also has properties that can cause challenges. For example, it is extremely easy to copy data. If we want to be able to identify people and objects and

transact assets in the digital world we will need to make digital objects unique. Blockchain can help do this.

- Right now blockchain can be employed in the infrastructure, data and value creation parts of the IoT stack. In future it will spread to the device level. There are companies now building integrated chips with blockchains in them that can help machines transact directly with each other with no human intervention.
- Among the most interesting use cases for blockchain and IoT right now are in supply chain management, the sharing economy, data markets, identity and network management (access control to devices), and automation.
- There are also a number of interesting use cases for blockchain and AI. Blockchain can help democratise the data used to train AI algorithms by allowing people to own their own data and so have control over and receive payment for its use. It can also be used to help trace the provenance and authenticity of data used in AI training.
- Similarly, blockchain can help with the "explainability" of AI decisions by providing audits of the decision making-process. It can also provide audits of what actions were taken as a result of AI decisions to ensure that the intended actions were indeed carried out.

IOT for trusted data on-chain: hardware oracles

Arnaud Danree, IoT Product Manager at the company Ledger, known for its hardware wallets for cryptocurrencies, gave a presentation on hardware oracles, using examples from Ledger's projects. After first explaining the importance of having trusted data on-chain, and how hardware oracles can help, he presented a number of use cases. These included:

- **Green energy.** Ledger partnered with Engie to develop the first blockchain-based hardware to secure data at the source of energy production. The goal is to be able to certify green energy by monitoring solar panels. The company's custom built sensors are attached to solar panels and provide trusted data, gathered at the source, to the blockchain regarding how much energy the panel has produced. The sensor has a secure hardware element that takes the data and creates a record using the same fields as would typically be needed for a green energy certificate under EU law. This data record is then secured via hashing and sent to the blockchain. This provides trust in the data. Once on the blockchain it can be used in an energy market exchange. This automates the certification process and greatly facilitates the exchange. The project is live, on a real blockchain.
- **Automobile odometer.** Another use case is around mileage in automobiles. Odometers in automobiles, which record how many kilometers they have been driven, are easily manipulable and therefore not trustworthy. Ledger has developed a hardware oracle that can record mileage information at source and save it on a blockchain. This trustworthy data can then be accessed by anyone needing it, for example by someone buying a used car. A car owner could also make this data available to his or her insurance company via a smart contract, to for example qualify for reduced premiums by proving

that the car has only been driven so many kilometers. This is an example of how this capability can generate new business models like a mileage insurance, or adaptive pricing of insurance.

- **Water quality.** Ledger will soon be announcing a project with a major actor in the water quality ecosystem. The project involves securing data from sensors used to check water quality, so people can daily check the quality of the water that it is being delivered to their home or during some specific event. This can also help control consumption. In California the company is involved in a project to monitor the amount of water a vegetable producer uses. As a result, if a producer doesn't use its full allocation it can sell it on. This helps facilitate a water usage market.

Panel discussion – Convergence of Blockchain AI and IOT: Use cases and existing implementations

After the talk on hardware oracles, there was a panel discussion focusing on implementations. Here we present highlights from the discussion:

Panelists were:

- *Ibby Benali (SingularityNet.io)*
- *Alessandro Biancini (Alkemy)*
- *Tom de Block (AIOTI)*
- *Christoph Jentzsch (Slock.it)*
- *Raphael Pralat (ConsenSys / Grid+)*
- *Emanuele Ragnoli (IBM research)*
- *Ken Timsit (ConsenSys)*
- *Moderator: Susan Poole*

The panel focused on four main questions.

How can blockchain, AI and IoT combine together to leverage blockchain as a trust layer or a timestamp for AI, and what are the main use cases?

- AI, Blockchain and IoT are a match made in heaven. When you add blockchain to AI you change the infrastructure of how data is delivered to and from AI. For example, what if you are an AI developer and can sell your work to anyone in an easier way? Blockchain can help you reach a mass of people directly. Since data is gold in the AI world, when you change the underlying data infrastructure you change the power structures as well.
- When you add IoT you can access different devices, so for example a smart fridge that connects to some AI system that advises its owners how to be healthier that week.

- Blockchain can facilitate trading of data on a large scale, like a huge public API. There can be great network effects.
- Blockchain helps with micropayments, and that opens the door for new possibilities, like micropricing for energy. It can also incentivise people to enter ecosystems by making it easier to split revenues in a way that is transparent and secure. That will in turn incentivise people to try new things. For example, there may be no incentive today for a TelCo operator to build a data market. But if the company could reap a percentage of the profits of that market, it might be very interesting.
- Supply chain is probably the most important use case right now, followed by energy, smart cities and the financial sector. Large ports are also starting to use blockchain as they already rely heavily on IoT and have a lot of IoT data.
- There is also interest from the legal industry to use these technologies to make law more modular and eventually legal services more accessible.
- Healthcare is another important use case, though it has major difficulties, especially with regards to data privacy. But health is getting more and more connected to devices which monitor us, and this generates more data that needs to be managed. Blockchain, AI and IoT are also increasingly important in life sciences, for example for tracking the manufacturing of pharmaceuticals.
- The real vision is about ecosystems of machines transacting with each other. We will probably see the most interesting applications in smart cities, but not overnight.

Are there existing integrations of these technologies? What is the state of these projects?

- There is the robot Sofia, which is using some services from Singulartiy.net to function. She is still in very early development, not ready for commercial deployment, but interesting.
- KYC is a good early and simple use case, for example at a cryptocurrency exchange. There is usually some optical recognition that happens (photo of a passport and/or a selfie) and then some business logic behind that. Blockchain can help secure and manage the data from this process.
- Blockchain is not a magic sauce, but it can facilitate the sharing of all sorts of things. It removes barriers to sharing knowledge.

When will these technologies have sufficient maturity to allow bridges between their uses? What is the time horizon for large-scale uses?

- One panelist thought it would take 5-10 years for real and deep integrations. One barrier to solve in this respect is the challenge of transfer of value. Autonomous machines will be able to take full advantage of blockchain when they can transact with each other, but that means stable coins that are accepted by all. These will come from companies first then central banks. But it is a prerequisite.

- Another panelist put the time horizon at a few years. In 2020 we will see some "big things".
- The period of the proof of concept is over. We will see production projects this year, but still on a small scale with small user bases. Likely 10 years or so before we see mass adoption.
- AI and IoT are in the production phase, said one panelist, while blockchain is more in the research phase. So waiting for blockchain will take another 3-4 years.

What are the hurdles to overcome to get to that utopia of convergence?

- GDPR is a problem. Articles 11 and 13 of Europe's new copyright directive are not helpful either. You also need an interface to government services, for example to pay taxes. Some sort of deregulation and opening up of government to these technologies would be helpful.
- One panelist had re-thought GDPR. First saw it as a major problem, but it did force the tech giants to come to the table to talk about personal data and data protection. The combination of blockchain, AI and IoT is very powerful, so you need to set rules for how to do convergence in a responsible way.
- Infrastructure is an issue. If you connect everyone using Protocol A and then a better Protocol B comes along and people want to change, this can be difficult.
- Connectivity is also an issue.
- Europe is behind Silicon Valley and China in terms of funding for AI, IoT and blockchain.
- Awareness is also an issue. People need to be made aware of what is going on. Outside "our bubble" this is not the case.

What can be done to support initiatives at the EU level?

- Continue to fund research on these subjects, as with Horizon Europe
- H2020 is a great tool, but getting grants is very competitive. The innovation programs for startups are even more competitive. Maybe we could spread the funds over more projects, and perhaps be more experimental too.
- It could also help to make financial self-sustainability a requirement as well.
- Can be useful to work on projects that can be iterated on, so projects that have synergies or can build upon each other instead of separate projects that stop after a while.
- Be more experimental: maybe give smaller amounts of money to more groups to see what comes out of it.
- Also encourage cooperation outside the EU.

Combining AI and blockchain

Jean-Charles Cabelguen, PhD, Chief Innovation and Adoption at iExec, presented on how to combine AI and blockchain.

- There are two kinds of AI: Soft AI and Hard AI. Soft AI is trained on datasets. Hard AI learns from the environment without initial input. Soft AI is in production now. Hard AI still in RnD phase.
- In the AI world, data is gold.
- There is a new focus in the industry on edge computing, meaning putting some intelligence on the machine so as to be able to do some data processing on the device itself and not to have to send data to a data center first before it can be used.
- AI and blockchain are transversal technologies to be used for industrial purposes. They do not exist in vacuums. We are already seeing a convergence of AI and blockchain teams within big companies. This is an important indication of the ultimate convergence and integration of these technologies.
- Blockchain gives AI a way of scaling the aggregation of data. Before companies only had access to data sets created by themselves. WIth blockchain companies can more easily use data sets from others. Blockchain can also help in managing the sharing of computer resources. This in turn can help AI startups access more computing power. It is also useful for reinforcement of AI model training. Blockchain can also help manage access to the AI models that have already been trained, allowing developers or companies to monetise already trained models.
- By being able to track data providers we can create a more transparent data economy, increasing trust in that data. Blockchain can also help us use reputation as a trust mechanism. We will also start to see decentralised oracles, where blockchain could help with the creation of consensus among different oracles, or identifying faulty oracles.
- Mixing AI and healthcare is promising. There are lots of opportunities to add trust in the management, ownership, sharing and processing of data, as well as in regulatory compliance.
- iExec is working on a project to train AIs on brainscan data. With the help of blockchain, we can for example imagine a situation where instead of sending patient data to an AI model to train it, the AI model is sent to the hospital, which then trains it on their data set. When it is done the model is sent back to the AI company. So at no time does the data leave the hospital. This is known as renting data and it is a very promising area.
- In future there will be thousands of manufacturers selling devices to smart cities, so how do you coordinate the information, especially with autonomous agents? Take for example the case of a robot that gets lost. The device announces it is lost, and the smart city sends a map to it so that it can find its way bock. Blockchain is used to verify that this is the right robot. Then it is used to measure the services that are exchanged and

then to manage the payment process for this service. This ability to trustfully measure output and payments is also very important.
- Forecasts:
  - For soft AI we need trusted data for input, so we will see a new economy of companies providing trusted data or reputation rankings of data providers.
  - Hard AI will need trusted behavior records, this will be critical. Blockchain can be used for trusted behavior tracking. It can be useful also in reputation ranking for how well a hard AI works.
  - Smart cities are not really smart at the moment, it's more about connecting devices in a seamless way. But it would be good if they did become smart. In future devices will connect to create networks of intelligent entities that in turn create intelligent ecosystems.

Working session: Implementing Blockchain, AI and IOT in Smart cities

The remainder of the workshop concentrated on the smart cities use case. There were two parts: a presentation of a smart cities use case, and then a group discussion with all participants on a set of theoretical smart cities use cases.

Presentation - A Strategic Mission for Blockchain: Smart Cities Abu Dhabi case study

Nabil Manzoor and Kieran Brown from the Berkeley Research Group, as well as Tom Grogan from Mishcon de Reya, presented their work advising Abu Dhabi on smart cities.

- Government bodies are grappling with certain fundamental questions. These include:
  - How will disruptive technologies impact government, citizens and private firms?
  - How do they address systemic issues like job creation, economic growth, healthcare, aging society and national security in the immediate term, while developing advanced technologies to secure their medium term future?
  - Do emerging technologies pose a threat or an opportunity to economic growth?
  - How can governments create permissive legal, regulatory and policy environments which enable and encourage innovation without exposing their populace to harm?
- Cities are where the action will be in society going forward, and where advanced technologies will take shape and move the quickest. The golden thread in smart cities is data. Blockchain can help with getting better data and also make it easier to share data.
- The smart city program in Abu Dhabi has been an excellent venue for people working with different technologies and different policy makers to come together on a subject.

- While the private sector is important, the real driver is smart government with clear policy, supporting digital infrastructure, and e-government services.
- The key technologies are blockchain, machine learning/AI, ioT, 5G and robotics.

Working Session: Use cases study and technical hurdles

To catalyse the discussion in the working sessions, the Observatory presented sample smart cities use cases (invented for the workshop) and then posed questions based on it.

The first was a mobility use case using AI, IoT and blockchain to rejig the public transportation system with the goal of being able to a) adjust the number of trains and buses in real time to adjust to demand and traffic, b) propose alternative roads to those who are driving, and c) adjust traffic lights to make traffic flow optimally. The question was what are the problems today keeping us from such a scenario.

- One problem is data. Data is in silos today. How do you incentivise the sharing of data?
- Another issue is who is going to govern the system, for example decide how to adjust traffic lights? Then who will pay for this? These are the two key problems with blockchain projects: to decide how to decide, to decide how to pay for it.
- In this case it could be the municipality that decides and pays. Blockchain could be useful in such a case as even within the municipal government you might have trust issues. There could also be trust issues between the citizenry and the municipality.
- Another important aspect to making anything like this work is education, for example of government agencies when dealing with IT vendors.
- Incentivisation can come in the form of money, or of convenience: getting from A to B in a faster, easier way. Blockchain could be useful for introducing micropayments, whether in paying for things or getting paid for allowing your data to be used to feed the system. If self-sovereign identity is necessary for this, then blockchain could also be useful.
- Another issue is that not all citizens are equally comfortable with new technologies, for example older people. We have to be careful not to disadvantage them.
- The question was raised if you could use some sort of token or smart contract standard to help facilitate the data and payment transactions in the smart city.
- It was also asked if citizens/end users could be over-incentivised. Would they rather just have the system work without having to participate/think about it?

The Observatory team then presented a future smart energy grid use case and asked what the technical challenges might be for such a use case, in particular: how to manage scalability, what privacy layers should be added, how to ensure data interoperability, how can a digital identity module be leveraged in a decentralised marketplace.

- To handle scalability you can use pre-processing on the edge, computation at the sensor and then submitting the result to the system/data centers. You can also store as little data as possible or even no data at all on the blockchain, and just use it for notarising and timestamping data.
- Scalability is not always an issue with IoT because these sensors often are constrained to send very small amounts of data at infrequent intervals anyway.
- In terms of privacy you also don't want to store personal data on the chain.
- Blockchains can also aid in interoperability between machines by allowing them to share and verify data.

The last part of the discussion turned on safeguards.

- There is the problem of the so-called "privacy tax": if you are rich you don't need the extra income you could make by sharing data, so you can "afford" privacy; and if you are poor you might need that income, so you sell your data even though you don't really want to.
- Europe would benefit from some focused research topics: one is to study existing convergence use cases to see what real benefits they have brought; another would be to look at sector-specific studies to what worked in specific sectors.
- Generally there was agreement not to regulate too early, but to keep basic safety in mind throughout.

Appendix

Workshop slides

- [Full day presentation](#)
- [Presentation - HSLU](#)
- [Presentation - Ledger](#)
- [Presentations - Panel](#)
- [Presentation - iExec](#)

Workshop videos

- Videos from this and all other workshops can be found on the [EU Observatory website under reports](#).
- Videos specific to this workshop:
  - [Part 1 Introductions](#)
  - [Part 2 Presentation Tokenisation](#)
  - [Part 3 Presentation IOT](#)
  - [Part 4 Panel discussion](#)
  - [Part 5 Presentation iExec](#)
  - [Part 6 Afternoon session](#)

Official agenda

9:15	*Welcome Coffee*
9:50	Introduction of the day - Peteris Zilgalvis; Agenda and objectives of the day
10:10	Presentation - Tokenization of physical assets and the impact of AI and IoT - Dr. Tim Weingärtner (HSLU)
10:50	Presentation - IOT for trusted data on-chain: hardware oracles - Arnaud Danree (Ledger)
11:30	Panel discussion - Convergence of Blockchain AI and IOT: Use cases and existing implementations.
12:40	*Lunch break*
13:40	Presentation - Combining AI & blockchain - iExec

14h10	Working session: Implementing Blockchain, AI and IOT in Smart cities Presentation - A Strategic Mission for Blockchain: Smart Cities Abu Dhabi case study (Nabil Manzoor)
15h00	Working Session: Use cases study and technical hurdles
16:00	Conclusion