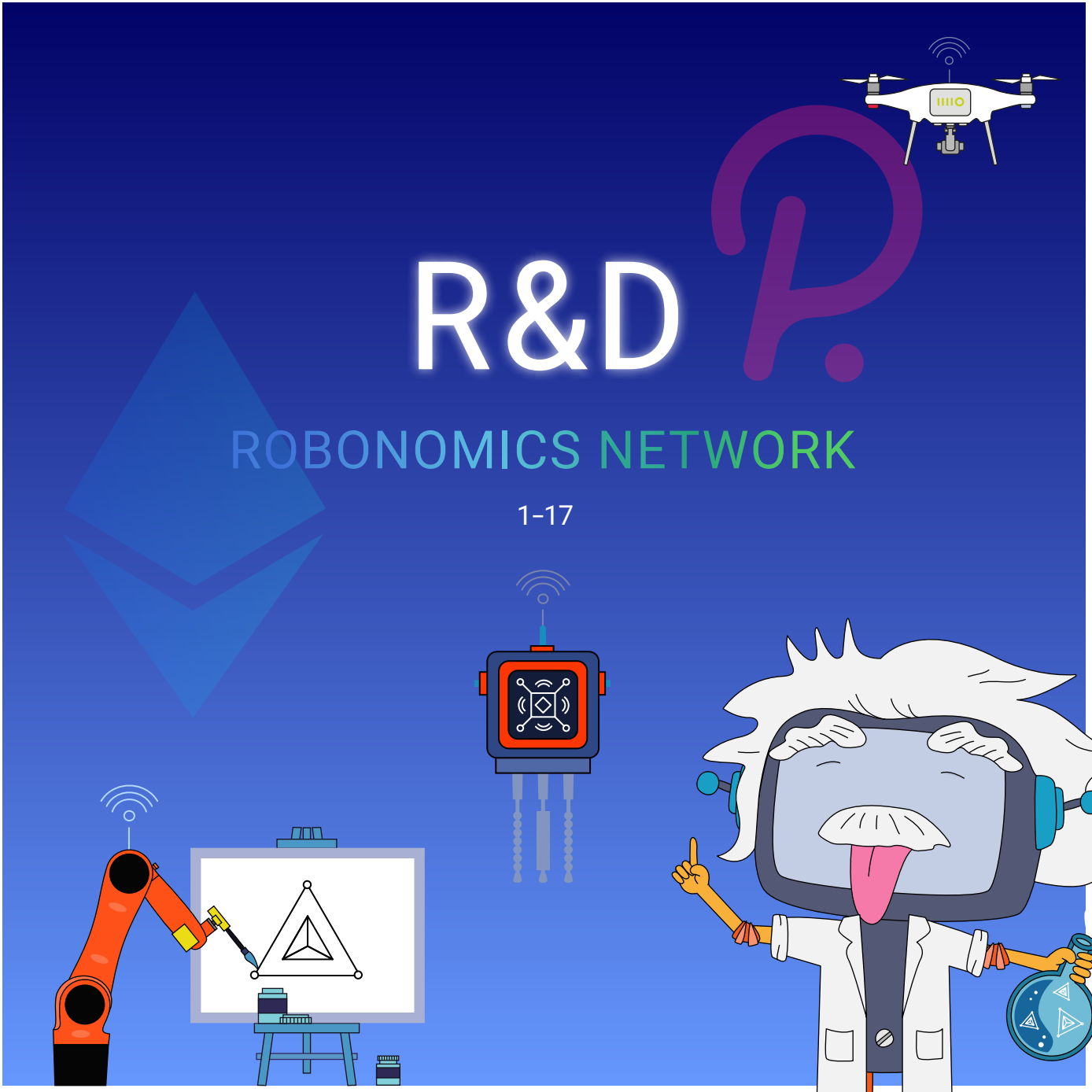
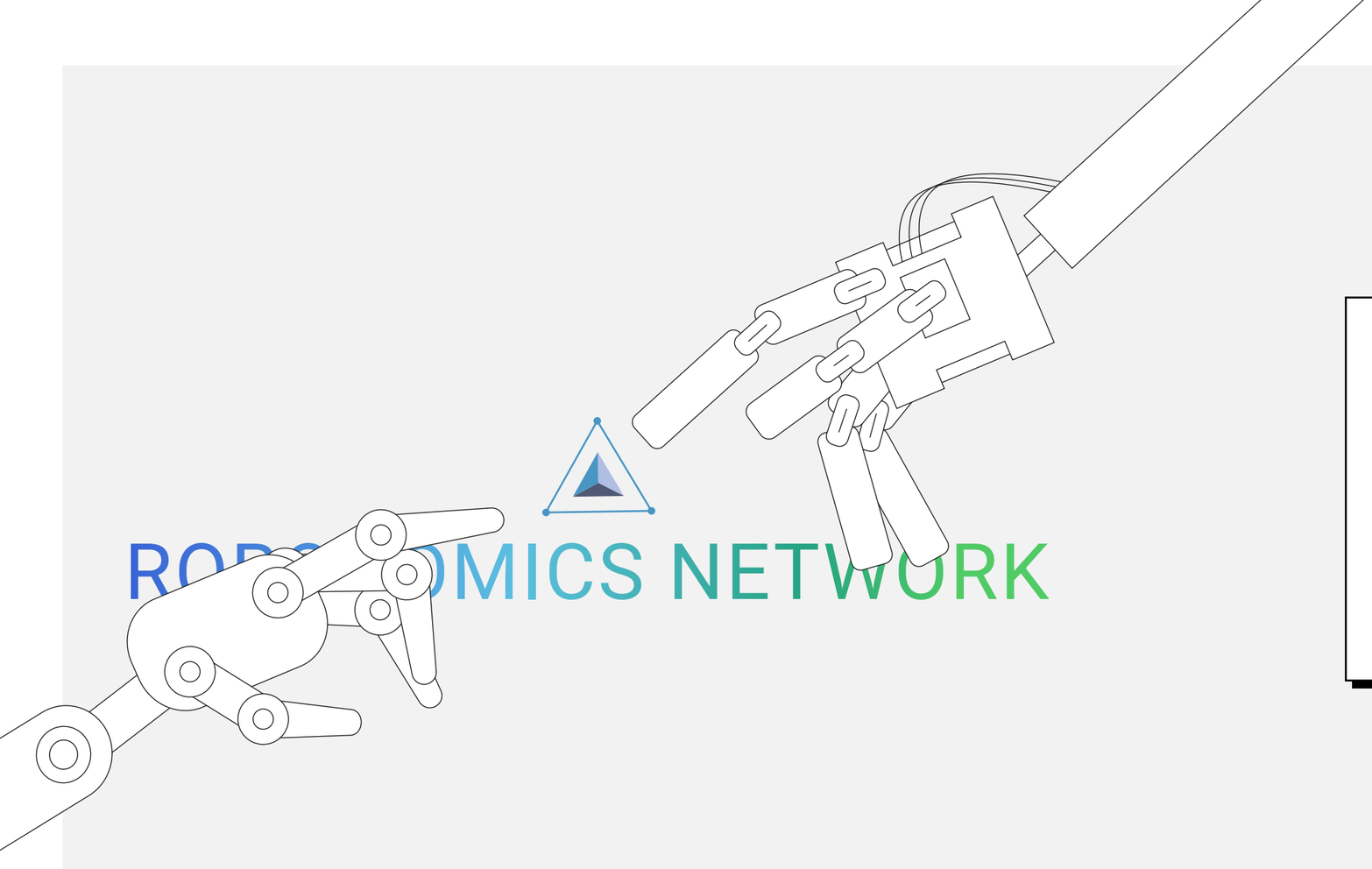


ROBONOMICS.NETWORK • BOOK №3 • 2021 • English version



ROBONOMICS NETWORK

The Robonomics team has created several MVP & PoC projects utilizing the capabilities of the Ethereum and Polkadot blockchains over the past six years.

We invite you to familiarize yourself with the following list of proven applications of modern robotics technologies.

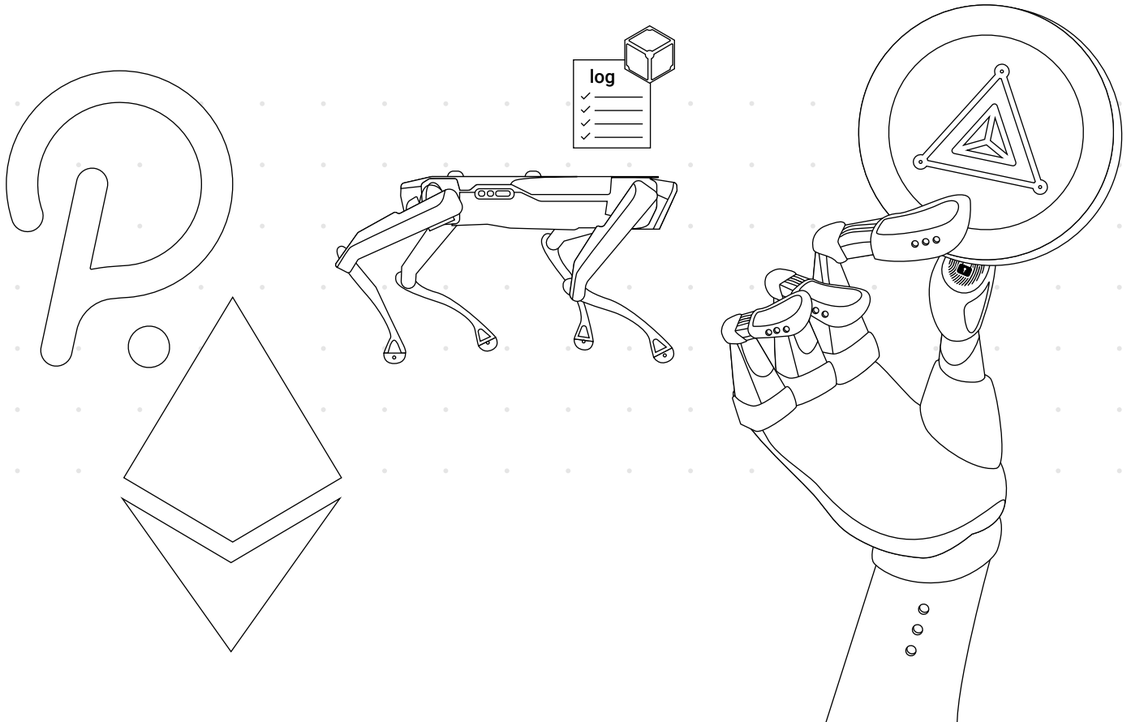
#Ethereum #Polkadot #Kusama #Parachain #IPFS #substrate #ROS #robotics #IoT #web3

ROBONOMICS CAN:

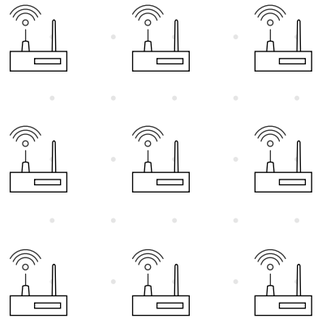
(1) Connect your robots under the control of Ethereum and Polkadot.
Yes, it sounds futuristic! But not when you need to launch a complex cyber-physical system. For example, a sensor network or a drone base, with the signal coming from a user application.

(2) Teach robots to save a log of performed operations on the blockchain.
Your robots autonomously perform their work. Do you want to keep the results of their work publicly available and immutable? Then using the blockchain is your best choice.

(3) Cryptocurrency is money for robots.
Teach your robot to accept payments from users autonomously and pay for example electricity bills, rent, toll roads, etc, all in cryptocurrency.

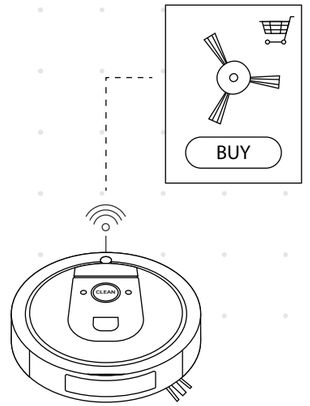


(4) Create access to autonomous robots by subscription.
This is a variation on 'Money for robots', but for those who are not ready for cryptocurrencies just yet. Create a registry of tokens to access the services provided by your robots. Let your users communicate and interact. The peer-to-peer communication through decentralized mesh networks is remarkable.



(5) Create a digital market for providing services to robots.
Robonomics will make robots and IoT systems autonomously interoperable; including for payments.

"Why does iRobot need write to me that its rollers or brushes are worn out? Let it order spare parts and pay for the service itself!", says Sergei Lonshakov, architect of Robonomics.



ROBONOMICS

is an open-source, decentralized platform for IoT applications powered by Ethereum and Polkadot.

It has similar features currently provided by centralized, cloud-based IoT platforms such as AWS IoT and Azure IoT.

In addition to standard connectivity features, Robonomics provides the functionality of creating a digital "twin" on the blockchain. Along with that a marketplace for robots and other features that embody the "Robot Economy" concept, such as machine-to-machine (M2M) smart contracts. The solutions are designed for industrial, consumer, and commercial uses.

#1
LAUNCHING A DRONE UNDER THE CONTROL OF A DECENTRALIZED COMPUTER

Six years ago, when Ethereum was still unknown and had only just launched its mainnet a few months earlier, Robonomics launched a drone on its network.

The Ethereum node codebase, as well as its documentation, was very crude back then. However, we were able to figure out an approximate way of how Robonomics could work on decentralized networks rather quickly. We set up a local Ethereum PoW network and started testing. The first tests took place in a simulation, to deduce how the drone should react to signals from the chain and how to send them. Then, it was time for field tests.

In automatic mode, the experiment went into complete chaos... The propellers were breaking down, the drone would fly off to unknown places, and so forth. It seemed like an impossible task. Everything changed when two new 3DR x8s arrived from the USA two months later. As the name suggests, these are eight-motor cruciform drones featuring an excellent autopilot by 2015 standards. We found them to operate consistently and predictably while supporting open standards.

We recorded a full-fledged video with a complete cycle of human-machine interaction through the Ethereum network on this new hardware platform during the winter, in fresh snow. Alexander Krupenkin was sending a transaction with the coordinates of the destination point for the drone. Then, the transaction was included in the block, and the drone was receiving the instructions from the local chain and automatically headed to the specified position. This was probably the first full-fledged interaction of an autonomous robot and human through a peer-to-peer (P2P) transaction enabled by a decentralized computer.

Field test
of drone control
youtube

#2
THE MANAGEMENT OF A FLEET OF DRONES ON A DECENTRALIZED NETWORK

Distributed Sky is the backbone of the global UAS Traffic Management (UTM). It uses a worldwide network of computers to process and store identity, traffic, and other sensitive information while using cryptography to make the UTM process secure and scalable.

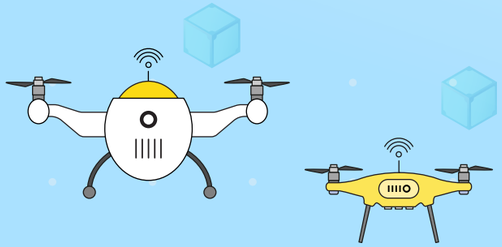
The following requirements are imposed on the UTM communication system:

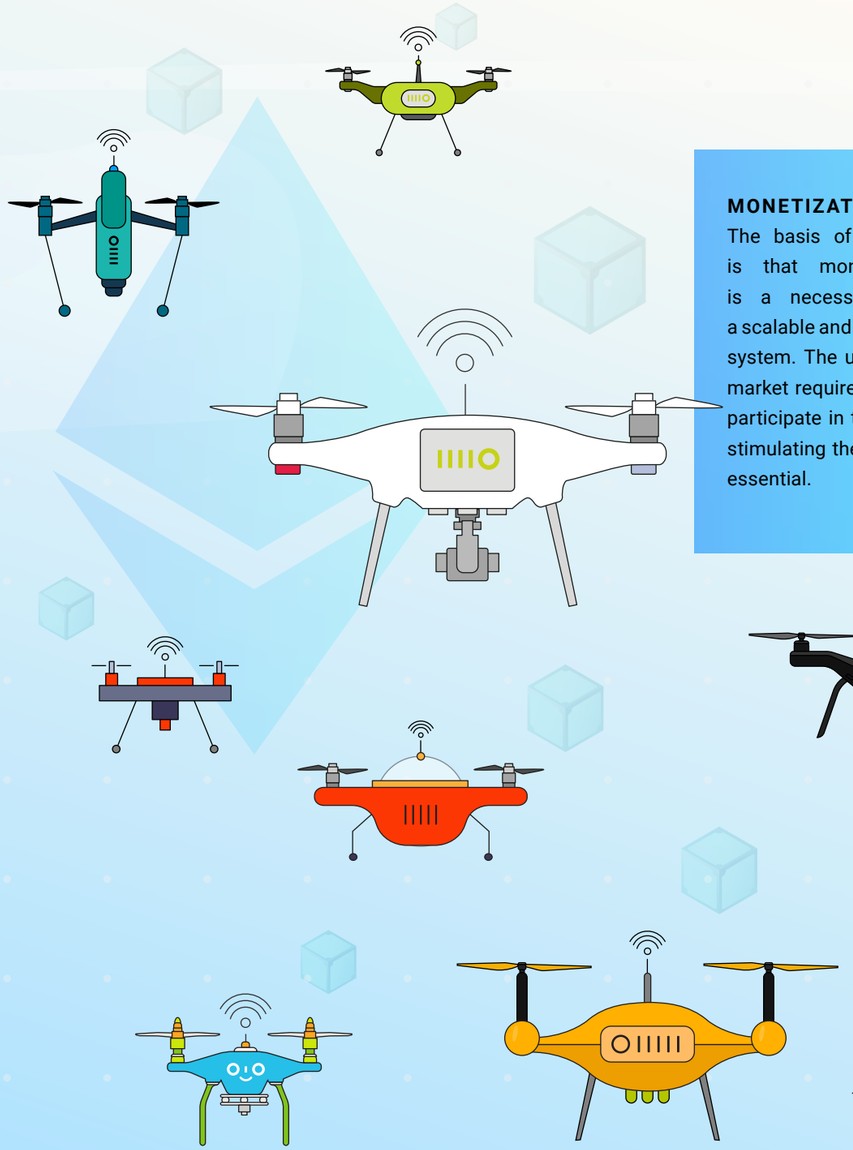
- To have the ability to handle requests under high demand.
- To be able to make decisions in real-time.
- To ensure that events do not create unwanted emergencies using a robust consensus algorithm.
- Maintain diversified equipment.

We use a combination of Ethereum and IPFS technologies. This enables all relevant parties to store critical information such as the UAS and USS license registry, airspace structure and condition, as well as restricted airspace information. The blockchain acts as an archive or digital black box for UTM interactions. It keeps track of the contracts created between participants and it keeps track of responsibility. Large files such as topographic info or media files are stored in IPFS and only a hash of each file is written to the blockchain. This approach prevents attackers from manipulating data stored outside the blockchain, since each file's hash is tracked on the blockchain. It optimizes the efficiency and thus the cost of utilizing the public blockchain.

There are three main benefits to using distributed technologies:

1. Decentralized cybersecurity has proven to work efficiently to protect against intruders.
2. Global access and simple, infinite scalability.
3. Compatibility between both legacy and fully-autonomous systems.





MONETIZATION

The basis of the Distributed Sky concept is that monetization of UTM services is a necessary component for building a scalable and efficient air traffic management system. The unmanned aerial vehicles (UAV) market requires private companies to actively participate in the UTM process, which makes stimulating the development of UTM services essential.

A description of
the Distributed Sky concept

#3
DRONE-PATROL

Forests hold some of the most valuable resources for humans. Wildfires increasingly impact Russia and many other countries around the world.

Monitoring nature is carried out using outdated methods, even in the era of unprecedented global progress and technological revolution. Everything happens on foot and mobile patrols, stationary cameras, and helicopter surveys. As a result, we often find out about fires way too late, when it is much more difficult to fight them.

Unmanned Aerial Vehicles equipped with video cameras and sensors can make regular flights of forests in automatic mode; independently detecting fire sources and other threats, allowing emergency services to respond in the early stages of a wildfire.

Blockchain technology allows any customer to control the execution of work on monitoring the territory, thanks to the immutability of the data provided.

The creation of an autonomous sensor platform for monitoring territories such as forests will enable emergency services to make use of a modern and effective tool for monitoring the territory for threats such as fire. Using drones to monitor fires will reduce the risks of wildfires to human life and property. This also reduces the costs for responsible government agencies while ensuring the efficacy of crisis response and ongoing resource management.

#4
TOKENIZATION OF DATA OF IOT DEVICES

Bitcoin and Ethereum represent the emergence of digital value without any territorial boundary. This creates a new global institution. Based on game theory, communication protocols, and the open-source implementation of software and code.

The value is protected by the consensus of a decentralized, open, and impersonal arbitration. The value of performing work accurately, supported by the economic incentives of network participants. Value that's extremely attractive to users and investors all over the world, especially once seen against the background of globalization. The primary property of Bitcoin, its algorithmic emission, is what makes every user and investor in the world interested in it.

Blockchain is sterile since the data stored on it changes based on a given algorithm. This is considered to be the reason why the exchange of commodities and other types of value can't really benefit from the use of Blockchain technology today. It requires a mechanism for the emission of new digital units which can't be changed by a human.

Machines are honest in their work and can be independent, objective parties. They supply information that is based on an algorithmic analysis of the network itself and in turn they can emit new units of value.

Value that's based on the labor of machines will be much more interesting for the new generation than any other value that has its emission built on another principle.

Science is able to develop numerous algorithms and methodologies for analyzing the information stored in the Blockchain network. All of this will enable a new generation of securities to emerge: tokenized values.

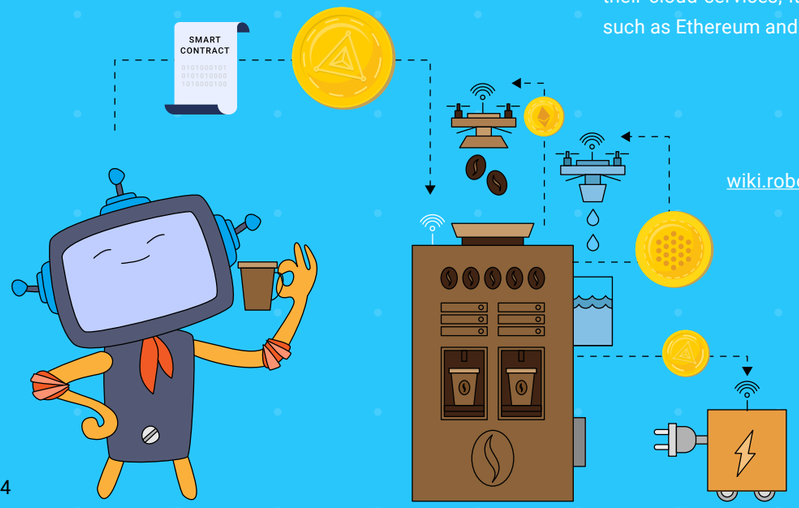
A token is a freely and globally traded unit of value. Its history is transparent and unchangeable. The creation is based on data and energy from machines and an algorithmic mechanism. All properties that hold great benefits.

#5
DIGITAL MARKETS FOR ROBOTS

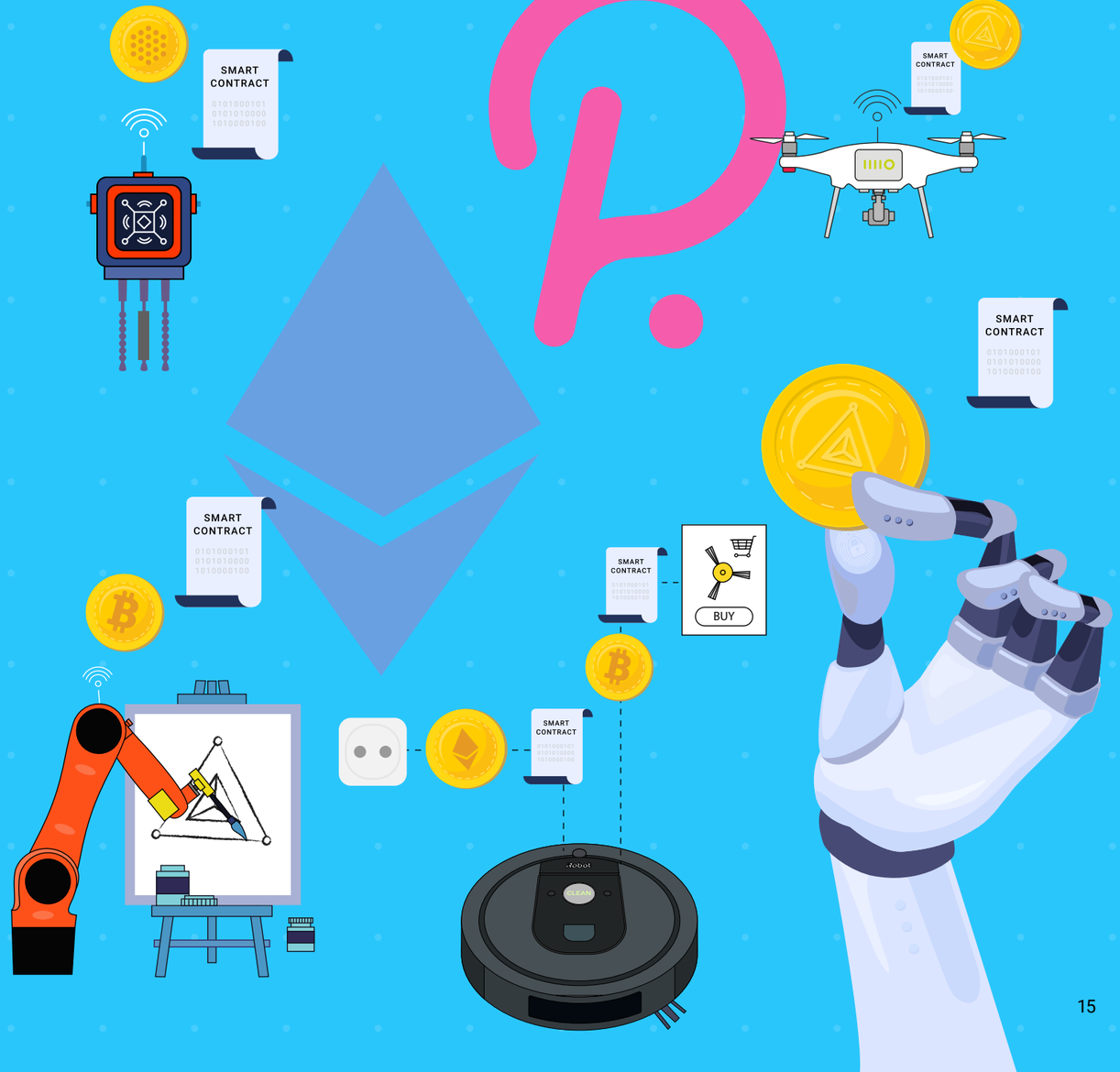
The development of robotics and automated systems in the wake of the Fourth Industrial Revolution will require sufficient capability for robots to order services for their own maintenance.

In the past, there have been similar technological transitions. For example, all the calculations related to production, logistics, and consumption have shifted from people to machines. If it were suddenly necessary to carry out all financial operations manually, the entire population of our planet would be insufficient to conduct these complex calculations.

We aim to offer hundreds of automated services to assist people with their daily routines. Yet, there are simply not enough workers to maintain all vending machines, car-sharing operations, drone deliveries, 3D printers, and other automated services. The solution is to provide robots with the ability to independently order water or coffee, self-charge and request maintenance at a base station, and call engineers without the need for contacting a call center. It's a given that we will face similar issues in the next 10 years and begin creating digital markets for robots. The question will relate only to technologies and some of them will be the fastest and the most scalable. This is needed to meet the norms of smart cities. Robonomics provides an alternative. Instead of surrendering this technology to corporations with their cloud services, it utilizes public blockchain networks such as Ethereum and Polkadot.



How do the digital markets
for robots work?
wiki.robonomics.network/irobot-self-service



AWS IoT and RWS
COMPARATIVE TABLE

DEVICE SOFTWARE	
AWS IoT Greengrass FreeRTOS	Aira Robonomics io
MANAGEMENT SERVICES	
AWS IoT Core, AWS IoT Device Management – connectivity and management services	RWS core - launch() && datalog() functions in Robonomics Parachain
TRANSACTION TYPE	
Technical	Technical and economic
SECURITY	
IT-company cloud control	Polkadot and Ethereum
SIGNAL TYPES	
pub/sub	pub/sub
PROTOCOL	
HTTPS MQTT	IPFS Robonomics
AVAILABILITY	
Global “-”	Global “+”
ECOSYSTEM	
Private	Shared
SERVICES	
Amazon Web Services	Polkadot, IPFS, and Ethereum ecosystem projects
ACCESS TO CRYPTOCURRECIES	
No	Native access to crypto currencies
ACCESS TO SMART CONTRACTS AND DEFI	
No	Yes

THE ROBONOMICS WEB SERVICES

is a decentralized service for robotics and IoT. Our goal is to enable robots to directly participate in the economy. To achieve this, it is necessary to ensure that users are sufficiently educated and trained. In other words, they are required to comprehend this new paradigm to work within it.

With this goal in mind, we created Robonomics Web Services (RWS). It offers a simple service that allows the user to build solutions with us (subscription, launch, datalog).

Subscribing to RWS solves the problem of transaction fees. The functions of device triggering and telemetry (storing the state of the digital twin) have also been added.

TRY
ROBONOMICS WEB SERVICES
RIGHT NOW!
robonomics.cloud

#6
INDUSTRIAL ZONE MANAGEMENT WITH CAPITAL

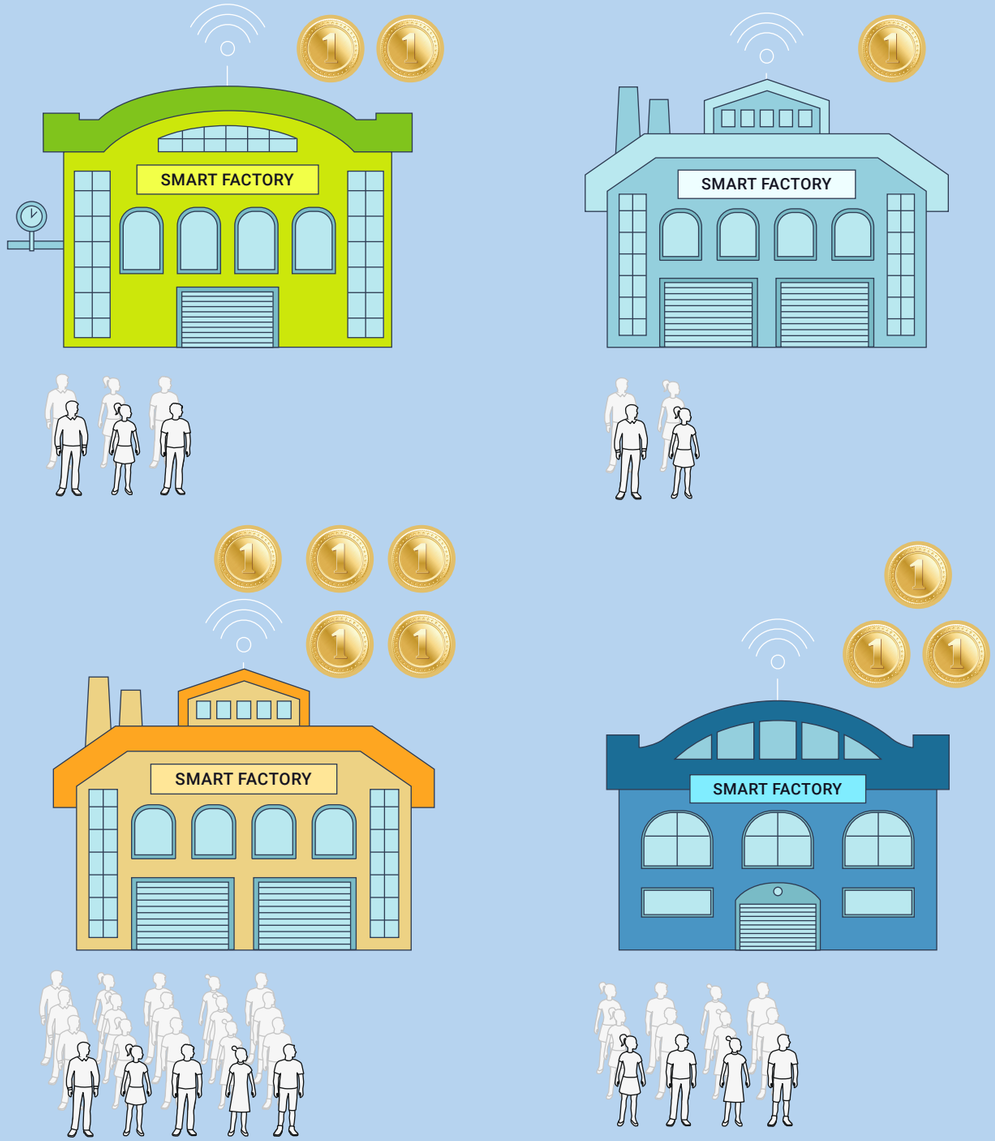
> WHY SMART FACTORIES SHOULD RESPOND TO CAPITAL CHANGES IN THE MARKETS

An investor engaging in the process of arbitrage investing may seek to compensate for the lack of supply in the market on one hand. On the other hand, it extracts his capital from the markets with an abundance of supply. If we consider this behavior from a different perspective, we can say that the supply in the market changes due to the redistribution of capital by investors. Thus, producers seek to reduce the error in allocation of their production operations across markets following capital and to lower the mismatch between the production and consumption in the system as a whole.
As a result, investors can be interpreted as “oracles” of the global economy.

We present the architecture of a communication protocol for modern and future industrial processes and business. An architecture based on cyber-physical systems for Industry 4.0. It demonstrates how to organize economic interaction between agents using a P2P network based on decentralized blockchain technology utilizing smart contracts. We describe the protocol in the form of universal software for different agents, implemented on the Robot Operating System (ROS), the Ethereum Blockchain, and soon Polkadot (DOT).

> Aside from capital shortage and oversaturation of the markets, an additional important criteria is the size of transaction costs that the user is prepared to accept. The higher the cost, the higher the interest from an investor towards the market, as it is possible to convert their share into the company’s revenue.

Blockchain based
protocol for economical
communication
in Industry 4.0
ieeexplore.ieee.org



#7

DRONES, SENSORS, AND USING BLOCKCHAIN FOR MONITORING THE QUALITY OF THE WATER OF THE VOLGA

The Clean Water Program was officially launched in 2006. This program is based on three main principles. One, changing legislation to strengthen the protection of water resources. Two, promoting the consumption of quality drinking water in Russia. And three, continuous scientific research in the field of water purification.

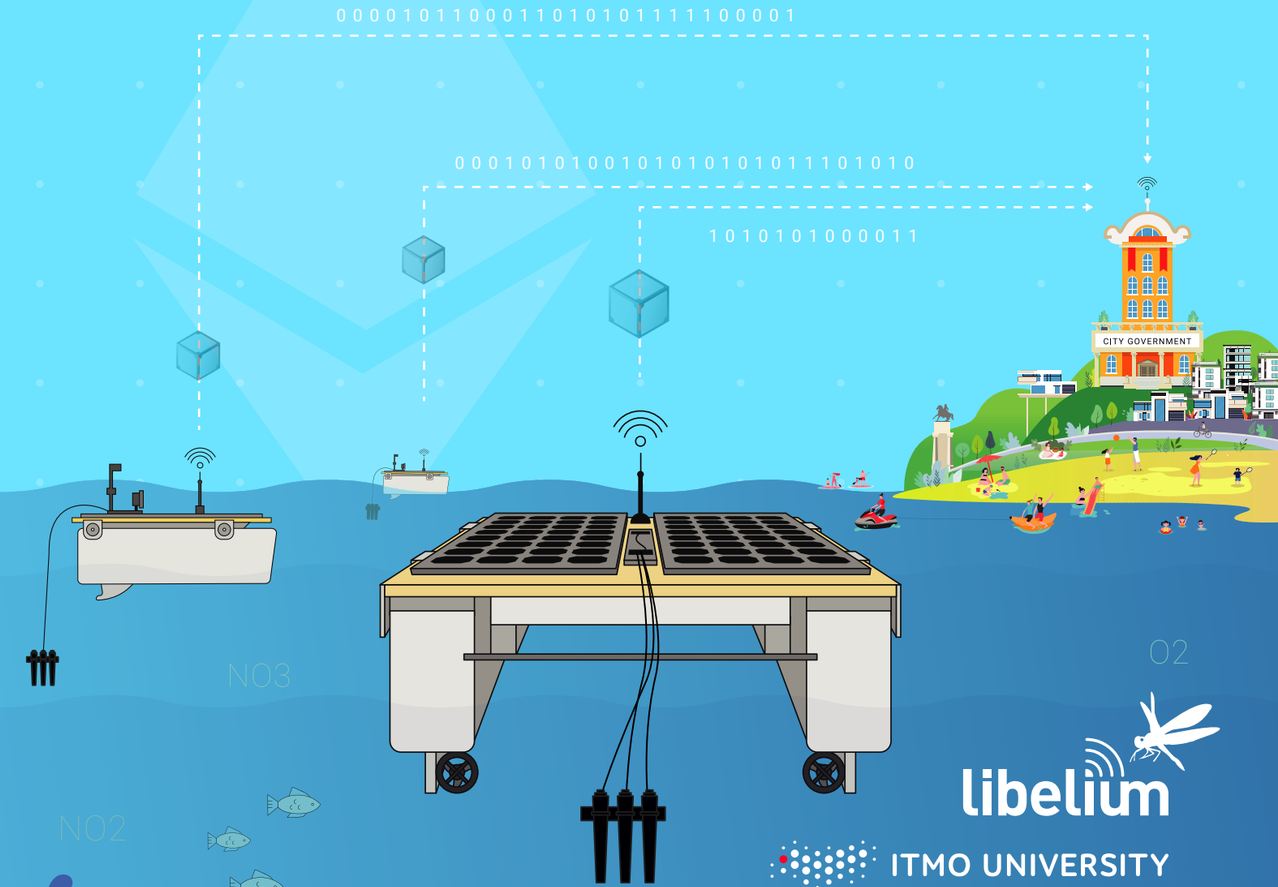
Being part of this project, a drone can offer its services through a web application that allows any user to request it. Typically, a mission requires specific parameters. Such as drone position, travel speed, water quality measurements, as well as numerous other requirements.

Communication with the robot is conducted via the Robonomics network. In this way, the robot can offer its services, and anyone from government officials to citizens can order them by making a payment in cryptocurrency through a dedicated website. The network is built on the Ethereum public blockchain and the IPFS protocol that records the hash of sensor measurements in the public blockchain, protecting historical data from possible manipulation.

This project combines modern robotics, blockchain, and the Internet of Things. We demonstrate the approach of controlling and monitoring the environment without the need for any human intervention. This method can ultimately become the basis for creating a system to permanently monitor water pollution. A matrix of data from many of these drones can be used in artificial intelligence systems that easily and rapidly detect the source of pollution.

Clean Water Program article
www.libelium.com

Video with the latest experiments
youtube



libelium

ITMO UNIVERSITY

Аиралаб Рус

#8
URBAN SENSOR NETWORK

Ecological issues are often seen in large and industrial cities. But besides that, residents don't have sufficient tools to monitor the air equality beyond their sense of smell.

Current professional air monitoring stations in cities are small in number. On average, they measure around three times a day, which misses the detection of one-time bursts in the period between these measurements.

Preventing the development of asthma attacks by using Libelium sensors under Robonomics' control
www.libelium.com

Robonomics' urban sensors network map
sensors.robonomics.network

Airalab, with the support of Smart Distribution (Libelium's distributor in Russia), installed an air quality metering network at ten different points of a residential area in the city of Tolyatti (Russia), in August 2018. The solution kit contained a particulate matter (PM1 / PM2.5 / PM10) sensor, dust sensor, as well as air quality sensors for detecting SO2 and NO. The obtained data allowed Airalab to create the first-ever assessment of the air quality in the city by using the example of one playground. All data was transmitted over the 4G network.

The urban sensor network is designed to create the basis for the implementation of integrated air quality monitoring in highly vulnerable areas (schools, playgrounds, nursing homes, hospitals, etc.). This provides local authorities with information to take measures for protecting the population.

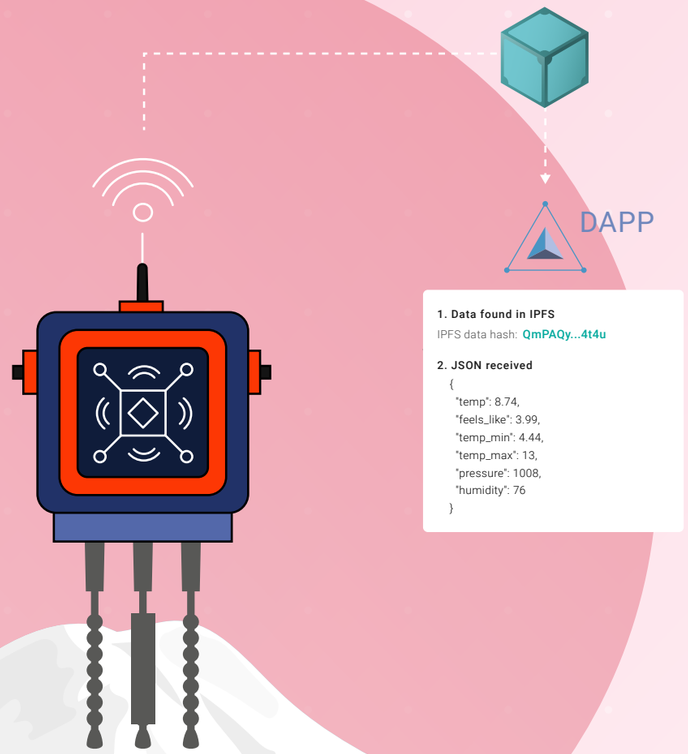
The Drone Employee team worked with IPCI to test a drone that was specifically equipped for air quality analysis. The flights took place in the area of St. Petersburg. According to the project, drones carry out dynamic monitoring of air pollution using onboard sensors. These sensors measure the concentration of greenhouse gases and pollutants. The drone-based devices can provide a higher density of measurement points in comparison to conventional weather stations and air quality sensors.

Using blockchain technology to store information on a decentralized network instills trust between the state and its citizens. Such an approach also opens up the opportunity for entrepreneurs to sell air quality information directly to the interested organizations. Furthermore, it will be possible to accelerate the process by avoiding bureaucratic procedures and recoup the costs of installing sensors.

#DEMO
«GET THE WEATHER OF FUJI MOUNTAIN»

Send a request message and get the result from the autonomous agent. The resulting file is saved to IPFS and the resultant message requires a signature with a private key.

>> HOW DOES IT WORK?
wiki.robonomics.network



#DEMO
MARS COLONIZATION, IMPOSSIBLE WITHOUT KUSAMA

During the Hackusama — Hack on Polkadot's Wild Cousin, our team has studied the UN Agreement Governing the Activities of States on the Moon and Other Celestial Bodies from 1979. Based on the studied material, it was proposed to consider the interplanetary architecture of the Kusama network and create software modules that implement article 6 "On freedom of scientific investigation", article 7 "On preventing disruption of the existing balance of its environment" and article 9 "On the establishment of manned and unmanned stations".

During the experiment, the rover traverses the route within the boundaries of the new habitable station. Then he publishes odometry and photos to the Kusama network. This information may be enough for SpaceY to start designing and selling living spaces on Mars using the adjacent slot for its parachain.

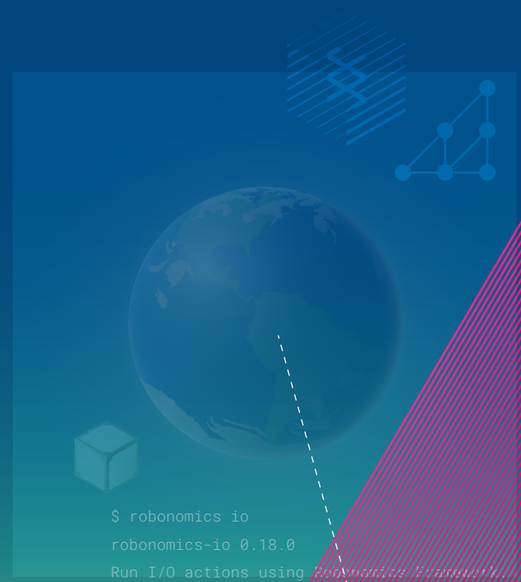
The blockchain for data storage was created by the UN Agreement Governing the Activities of States on the Moon and Other Celestial Bodies from 1979.

The IoT infrastructure of the base camp "Mars-1" was assembled, and satellite equipment was used for transmitting data to the Kusama on Mars Parachain.

The hardware and software parts for the rover "Mars-2" were developed and the rover was connected to the Kusama on Mars Parachain.

Article about
the KUSAMA architecture
blog.aira.life

A fun video about the use
of KUSAMA on Mars
youtube



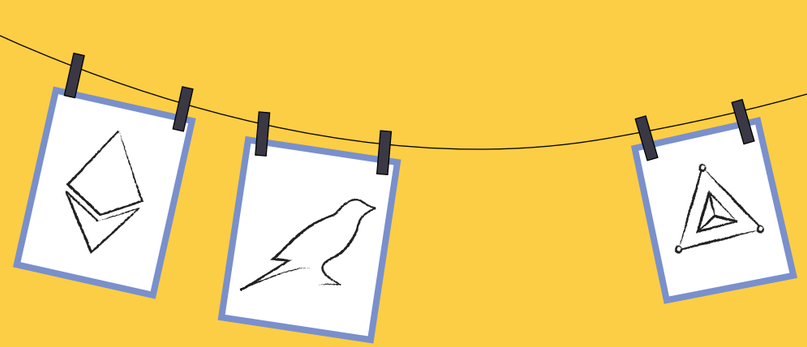
KUSAMA
on Mars

#9
ROBOT-ARTIST GAKA-CHU

Modern technologies make human life more comfortable and pleasant, freeing up time for self-reflection and experiments. Thoughts on the static nature of the industry pushed the development team to conduct an experiment focusing on the autonomous transformation of production for a specific type of product.

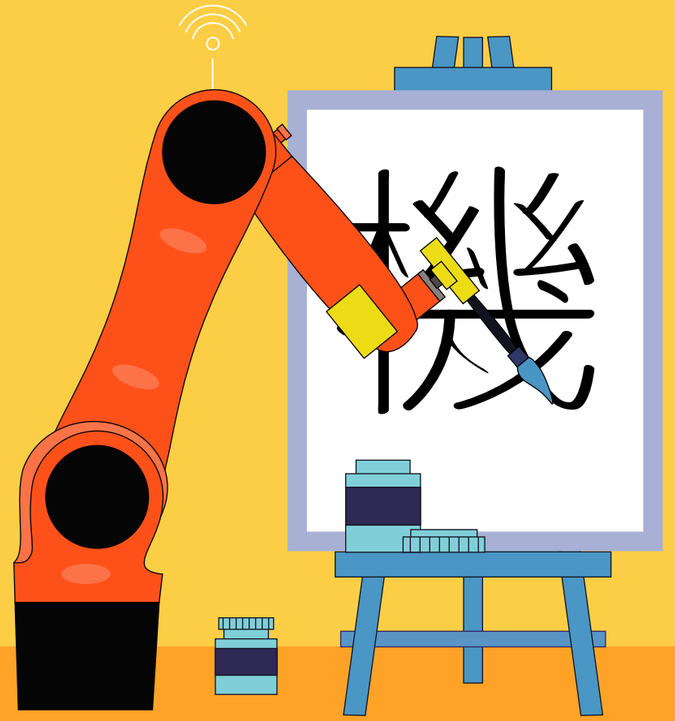
A robot artist was amongst these experiments, namely a small, clumsy KUKA manipulator living in a large world of functional industrial robots. Its name, Gaka-Chu. Why? – It's the love for drawing, because "gaka" means "artist" in Japanese, and "chu" was added because of an inexplicable affection for Pokémon.

XRT tokens were the only earnings of the artist. It could buy paint, brushes and pay for his lunch, that is, for electricity with these funds.



Though humorous, the robot artist is an example of an adaptive industrial unit that independently performs economic interactions within the Robonomics protocol.

Currently, Gaka-Chu paints exclusively for commercial purposes but strives to find inspiration with both an RGB camera and depth camera. Cognitive services will help him to understand and make use of the latest trends when creating a picture.



Video of Gaka-Chu's work
youtube

#10
ISSUANCE OF GREEN CERTIFICATES BASED ON DATA FROM RENEWABLE ENERGY SOURCES

Almost every service or product carries a trace of greenhouse gas emissions.

> WE HAVE DEVELOPED A DECENTRALIZED BLOCKCHAIN ECOSYSTEM ALLOWING USERS TO WORK WITH CARBON MARKET TOOLS, AS WELL AS ENVIRONMENTAL ASSETS AND COMMITMENTS.

The goal of DAO IPCI is to provide a common space, environment, and tools for financing climate projects and reducing social costs. The DAO IPCI ecosystem allows any stakeholder to register quantitative impacts and commitments, invest in mitigation projects, offset carbon outputs, acquire and trade mitigation results, join existing programs, or launch new ones.

Blockchain technology protects the DAO IPCI digital environment from the risks of centralized manipulation and allows minimizing transaction costs. All transactions are carried out through smart contracts, which ensures their transparency. The implementation of the DAO IPCI API on your website enables your users to offset their carbon footprint in one click.

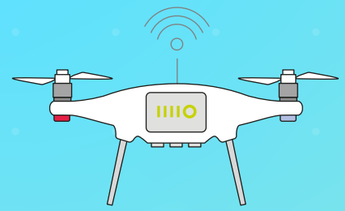
Dedicated to the memory of Anton Galenovich
— the author of research and works on the problems of carbon markets, co-founder of DAO IPCI.

DAO IPCI

POTENTIAL USES OF TECHNOLOGY FOR CLIMATE

DAO IPCI is a first-of-its-kind open-source public blockchain protocol enabling the purchase of carbon credits, green certificates, and other green financial instruments using smart contracts through a decentralized application. The protocol opens up access to the green market for CO2 emitters. This includes small office centers and residential buildings with autonomous heating, registrars, stock exchanges, auction sites, and non-profit organizations in addition to large enterprises. Any group of participants can create their own Decentralized Organization (DAO) by developing the environmental program.

Consumers who care whether their chosen brand is using green technologies and airline passengers interested in knowing the carbon footprint of their flight also benefit from the technology. A specialized IPCI calculator performs this task. In order to determine and compensate for the damage caused to nature by CO2 emissions, the user only needs an Ethereum wallet and a special browser, or an extension to Chrome, Firefox, or Opera to connect to the Ethereum blockchain. CO2 emissions are expressed in a MITO (Mitigation Token), a key element of the IPCI ecosystem needed to support smart contracts for the exchange of carbon units.



Concepts of
DAO IPCI projects
ipci.io

In 2019, DAO IPCI implemented several pilot projects with the integration of IoT devices and satellites. The implementation of renewable energy certificates in Chile was based on a solar power plant in a remote rural area, monitoring the amount of green electricity generated. The integration of satellite imagery and data from IoT devices in New Zealand has made it possible to assess the ecological footprint of several farms and issue their digital passports. The Nazarbayev University of Kazakhstan used DAO IPCI as a basis for the launch of a business game that simulated the carbon market. University campuses competed on energy consumption while recording information in the blockchain, as they could also offset their emissions using carbon units.

DAO IPCI

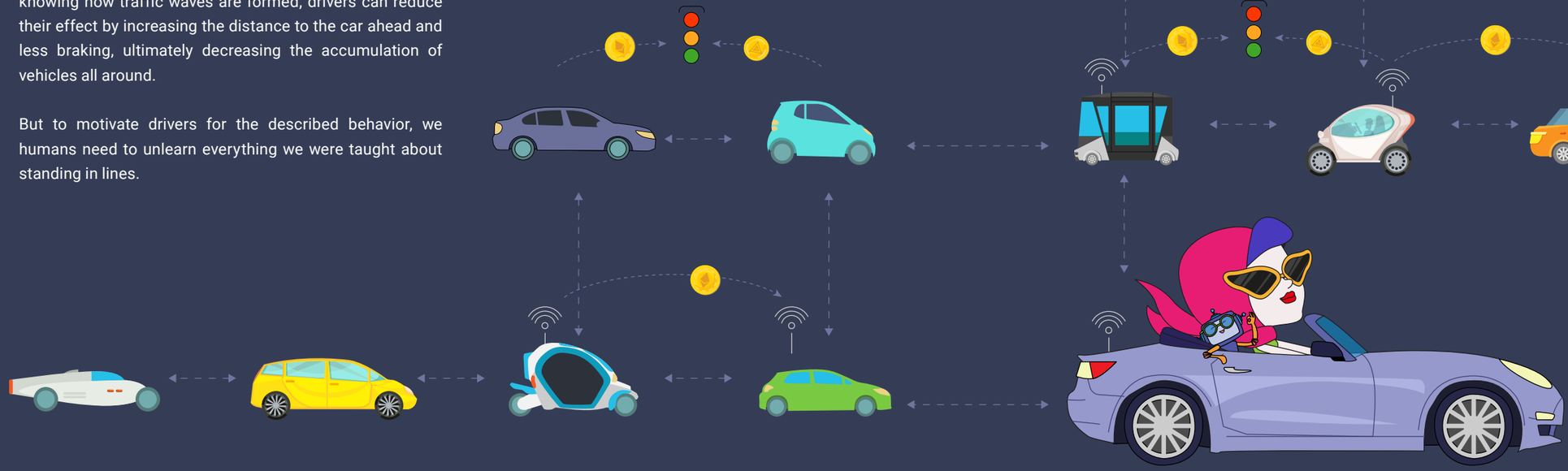
#11
A DECENTRALIZED SYSTEM FOR NEGOTIATING ROAD SPACE

> **OUR GOAL WAS TO DEVELOP A DECENTRALIZED SYSTEM FOR NEGOTIATING ROAD SPACE WHERE AUTONOMOUS VEHICLES CAN PAY FOR ROUTES AND PERMISSIONS.**

In 2008, Seattle based engineer and science hobbyist William Beaty established a so-called Traffic Waves Theory by a series of experiments. The thesis of the theory is that by knowing how traffic waves are formed, drivers can reduce their effect by increasing the distance to the car ahead and less braking, ultimately decreasing the accumulation of vehicles all around.

But to motivate drivers for the described behavior, we humans need to unlearn everything we were taught about standing in lines.

The system we introduce gives a financial incentive to both humans and autonomous vehicles. Maintaining good behavior gets paid for. This includes yielding to other cars and using the road space properly.



Project presentation during the MOBI GRAND CHALLENGE

Hopefully this system will evolve to become a part of our daily traffic infrastructure. We want to give special thanks to Jetbrains Team's Mobile Robot Algorithms Laboratory for giving us access to Duckietown.

#12
BLOCKCHAIN AS QUALITY CONTROL SYSTEM FOR CHEMISTRY

Originally, the following task was set: developing a quality control system for the production of a certain chemical product.

Why is monitoring the quality so important here? The main active substance of this chemical product is chlorine dioxide. It is hazardous to health in high concentrations. And if the concentration is below normal then this chemical product is useless.

What does Blockchain have to do with it? Blockchain helps to build trust for the manufacturing company. The consumer knows that no one can change the information in the Blockchain. That means that the manufacturing company can not forge the results of the audit.

An autonomous Cyber-Physical System (CPS) that checks the concentration of a random packet from each batch was developed in order to solve this problem. And a spectrograph is used for verification. The audit was carried out manually during tests, but, with the emergence of the production line, it can be automated using a manipulator.

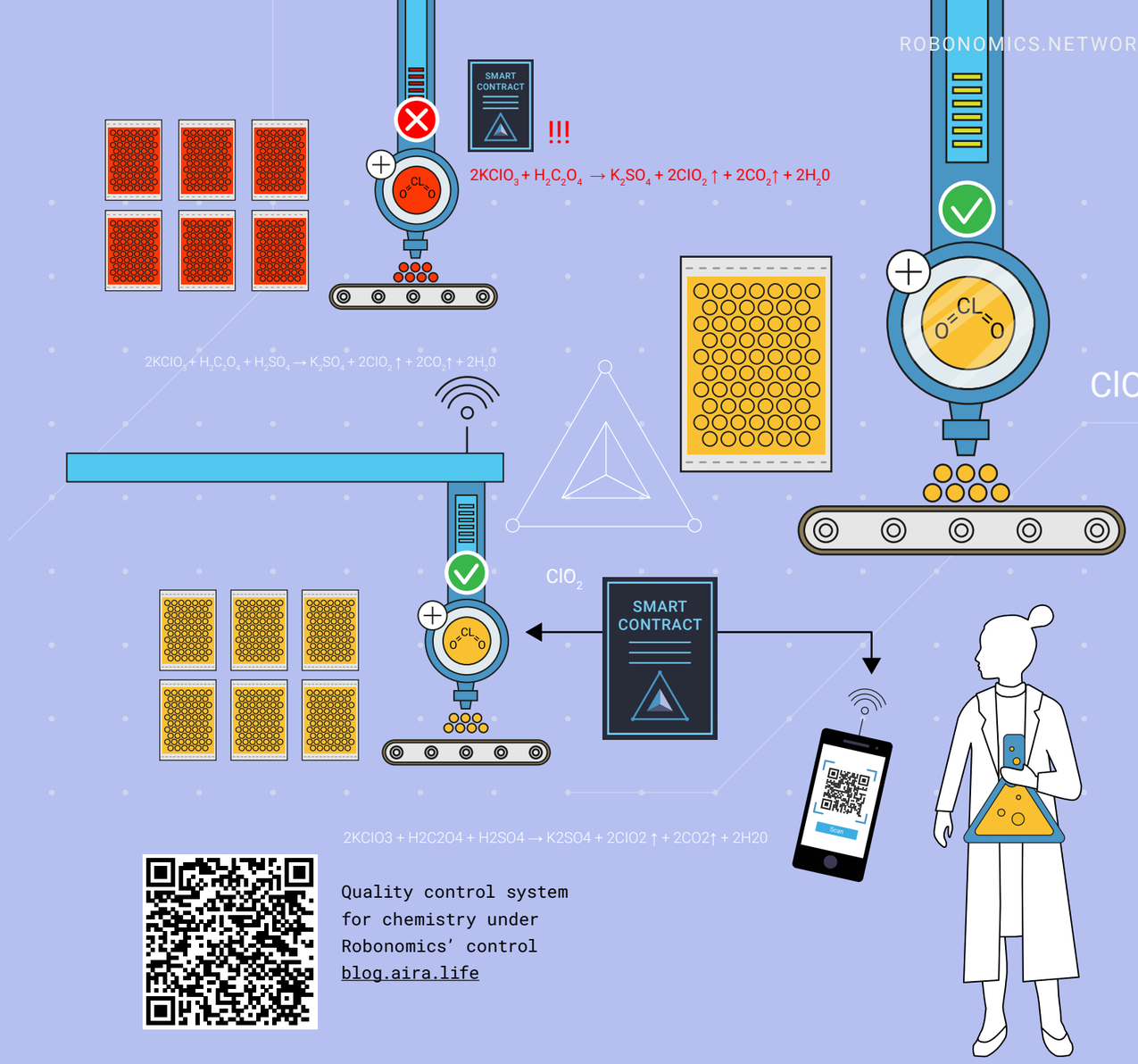
It's interesting how a CPS is building into the network of Robonomics. The quality control system is an autonomous economic agent that lists one single service on the market — quality control.

We considered the following scenario of CPS work:

1. Demand is created on the site
2. The system creates a corresponding supply offer
3. AIRA creates a liability contract
4. The system receives the task and starts implementing it
5. Finalization of the liability
6. Customer gets a QR code with the link to results of the audit

The main work starts happening after receiving the message 'task'. In our case, the lab technician sees that a liability contract was created. He then takes the next packet, checks the concentration of chlorine dioxide, and sends the file to the system. When the file is received, it's published in the IPFS network. The hash of the file and the address of the liability contract are stored in the local database, for quick access to information.

Finally, the last message about the finalization of the liability is sent and tokens are transferred to the beneficiary. If the lab technician is removed from the script, the system becomes incorruptible. The quality control system for the chemical product was designed and launched as part of this project. For the record, the architecture of the project turned out to be universal. All it takes to change the algorithm of work after receiving the message 'task' is to implement the exact system at another production.



Quality control system for chemistry under Robonomics' control
blog.aira.life

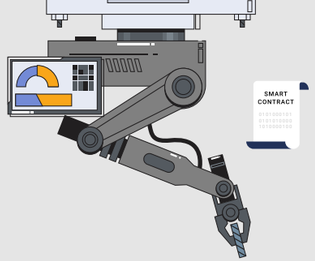
#13
CONTROL OF INDUSTRIAL EQUIPMENT AND MAINTENANCE VIA IOT

Is routine maintenance work well performed? To what extent and in what timeframe? Can one trust contractors' reports? The answers to these questions determine how many accidents and unplanned process shutdowns will arise from equipment malfunctions.

Robonomics allows reducing losses from equipment malfunctions, serving as the basis for its control system for operation and maintenance. The operation takes place utilizing an Ethereum smart contract. It records the operating conditions, maintenance plan, and technical passport of the equipment. These details are stored on the blockchain as hash links on the IPFS network. As a result, these files cannot be modified retroactively; it is only possible to add new entries in new files if necessary. Additionally, all records in the blockchain contain the exact time when the record was created and the electronic signatures of its creators. During its operation, IoT equipment collects a log, which is also impossible to download or replace retrospectively. It becomes immutable as soon as it leaves the equipment and the hash link to it is added to the blockchain.

For maintenance, the report also needs to be uploaded on time: any delay will be seen, as the system does not allow retroactive recordings. At the same time, it will be impossible to obfuscate the fact that there is no record, because it is impossible to restrict access to metadata about its creation in the public Ethereum blockchain. However, the content of records can be hidden using the IPFS network and not published to ensure the privacy of sensitive data. Each maintenance report also contains an electronic signature of the responsible person, making it easy to restore the entire history of the equipment and those who worked with it. The immutability and availability of data on the blockchain help to create both a transparent and traceable system.

Robonomics offers a generator of template smart contracts in Ethereum, and a system for connecting IoT devices to it. This system can upload data to the IPFS network using the AIRA system.



#14
ROBOT-AS-A-SERVICE

The demand for robotics will grow as more companies automate processes to stay competitive and run sustainable businesses. And as technology advances, even more industries will be able to find applications for robots. But you need to understand that this process requires big financial expenses and is associated with a high level of uncertainty.

Fortunately, **Everything-as-a-Service** is now everywhere, from applications to aircraft engines. This model gives users more flexible payment terms and guarantees monthly, stable revenue for suppliers. Our technologies are ideally suited to launch this model in the robotics market and are in line with the Industry 4.0 trend.

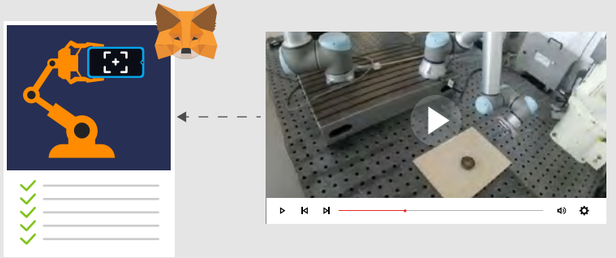
The **Robot-as-a-Service** model is a way to install robots in an enterprise without capital expenses based on an agreement with a supplier to pay for the robot's working hours. The MerkleBot decentralized application uses Robonomics to connect the robot and its operations to the logic recorded in the smart contract. It also launches a robot through the Robonomics network. By linking payment terms to the actual robot launch, we eliminate friction between equipment leasing participants as all data is stored on a verifiable public blockchain.

An example is a scenario for connecting a production process to cloud AI. As part of this project, we created a process for scanning industrial parts using a robotic arm for subsequent analysis and creating a digital passport of industrial products. In this case, the user pays only for the scans made by the robot.

This model helps businesses become more automated by transferring control of the robot to a decentralized computer. MerkleBot creates infrastructure software that helps businesses fund, deploy and manage robotics more easily!

Description of
the Robot-as-a-Service
concept
wiki.robonomics.network

MerkleBot



#15

BUILDING PRODUCT CONFIDENCE IN SMART CITIES AND SMART FACTORIES

There exists a significant trust issue between the consumer and a factory when it comes to the quality of the products produced. Products in the store can be very similar but have very different origins. The Robonomics solution allows users to record the technological process by storing it in a decentralized network. The hash from the CFS operations log is saved to the blockchain, endowing the entire product history with the invaluable property of immutability.

As a result, the consumer can be confident in the product as its history can always be verified and cannot be changed in the future.

Public blockchain stamp as a service, provided by Robonomics airalab.org

Аиралаб Рус

#16

CAMERAS FOR TRANSPARENT PRODUCTION UNDER ROBONOMICS PARACHAIN CONTROL

We have developed a concept of a system that allows you to save the history of a product in a distributed ledger.

We have now installed a test sample in a nearby coffee shop. The system includes an IP camera, a single board computer, and the network equipment that allows you to access the Internet.

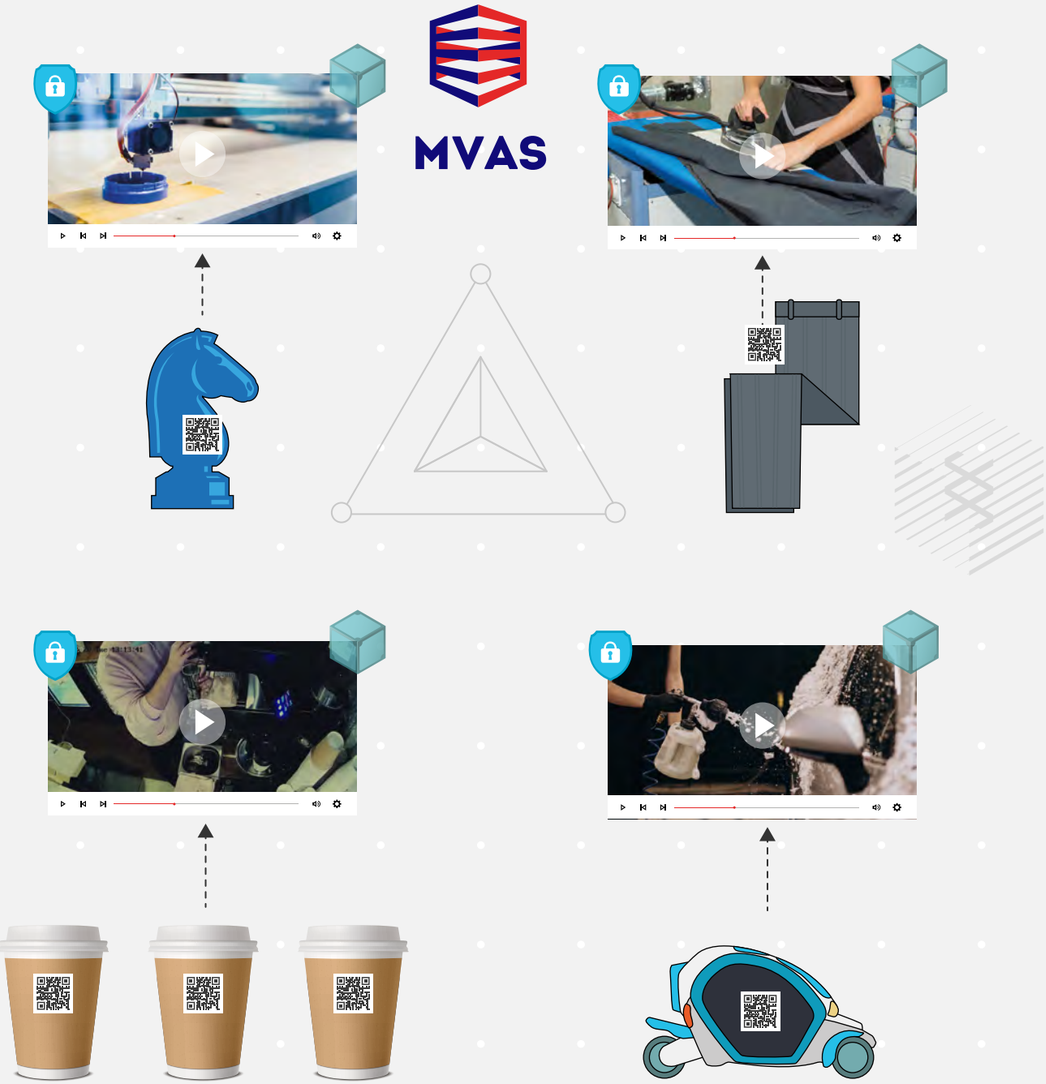
When the barista accepts the order, it sends a transaction that triggers a camera to record all the events that occur during coffee preparation. Then, upon completion, it clicks on the button again and the transaction is sent and the system issues a QR-code with a link to this video specifically for this coffee.

This link is also saved in the distributed ledger to prove its immutability and sent to the IPFS distributed storage for easy access.

We all know that during the production of any product, history goes with it. But at the moment, this history cannot be delivered to the end client. Such a system makes it quite simple to deliver everything that happened behind the scene to the user in the form of a small video.

With minor modifications, this system can be installed in pastry shops, on the production lines of any goods, be it shoes, clothes, etc.

A concept description of cameras for transparent production under Robonomics' control
blog.aira.life



#17
BOSTON DYNAMICS SPOT EXPERIMENTS

Boston Dynamics is one of the most famous robotics manufacturers. However, engineers still haven't shared access to their robots. We decided to enable this opportunity and are launching a laboratory for training to work with Spot.

It is now possible to rent a robot for an hour to test your theories or software. This also allows users to assess how Spot can be useful for your business.

After any experiment, you will receive a blockchain certificate as well as invaluable experience with the most advanced robotics in the world!

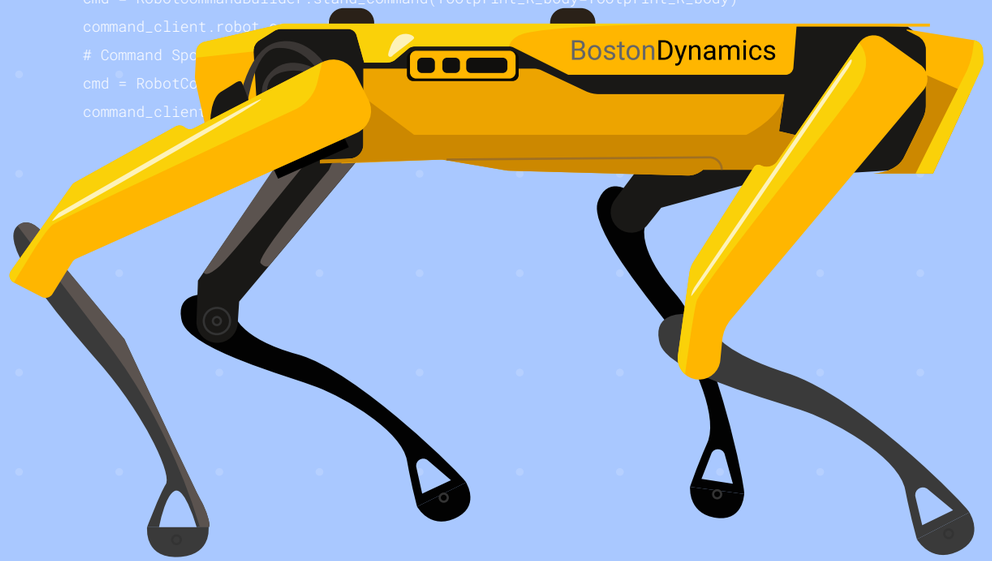
More about the program
github.com

BECOME ONE OF THE FIRST
TO BE CERTIFIED TO WORK WITH SPOT!

MerkleBot

```
# get robot's ID
$python3 -m bosdyn.client 192.168.80.3 id
beta-BD-90490007     02-19904-9903    beta29     spot (V3)
Software: 2.3.3 (b11205d698e 2020-12-11 11:53:12)
Installed: 2020-12-11 15:06:57
```

```
# Command Spot to rotate about the Z axis.
from bosdyn.geometry import EulerZXY
footprint_R_body = EulerZXY(yaw=0.4, roll=0.0, pitch=0.0)
from bosdyn.client.robot_command import RobotCommandBuilder
cmd = RobotCommandBuilder.stand_command(footprint_R_body=footprint_R_body)
command_client.robot
# Command Spo
cmd = RobotCo
command_clien
```



LABORATORY OF MULTI AGENT SYSTEMS IN SMART CITIES AND INDUSTRY 4.0

Given that the influence of robotics keeps growing, a logical step would be the same evolution in digitalization of cyber-physical systems and devices themselves. For example, a large-scale network integration to interact with human infrastructure and with each other. This will allow devices to use the collected data to self-manage and provide the most effective services to a person. Researchers have called this approach Robot-as-a-Service (RaaS) and see it as a potential economic model for the future.

However, the multitude of autonomous devices that are connected and capable of physically affecting the world raise great security concerns. Exacerbated by the negative experience of large centralized projects. Such network CPSs require studying the issues of communication protocols and managing multi-agent systems of heterogeneous devices, without taking into account the fact that managing a single device can also be a nontrivial task. The final goal of creating a networked CPS is its integration into the digital economy, and this imposes additional restrictions related to legal and economic aspects and information protection.

Laboratories that study aspects of the organization of networked cyber-physical systems in autonomous conditions using decentralized technologies.

The priorities are:

- making experiments in the field of machine-to-machine and economically significant communication;
- forming a knowledge base and publications in the field of robot economics and Industry 4.0.

Additional information about laboratories and robotics
multi-agent.io

ROBONOMICS GRANTS PROGRAM

The grant support from Robonomics Network is the first open grant program for projects in the field of networked Cyber-Physical Systems. In addition to promoting the core values of Robonomics, our goal is to help researchers and developers in their cutting-edge challenges for robotic and IoT devices that operate and communicate over the distributed network environment.

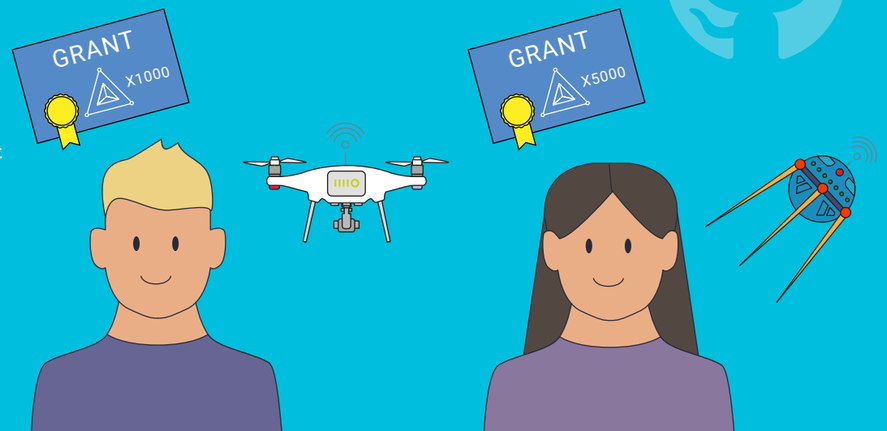
From our experience of academic practice, we understand how important it is to quickly complete a proof-of-concept or experiment, however, in a robotic sphere expensive equipment and the need to configure it are a bottleneck. Gaining university support for a potential breakthrough or rebellious technical project can take a long time due to administrative barriers, which easily negates all research enthusiasm.

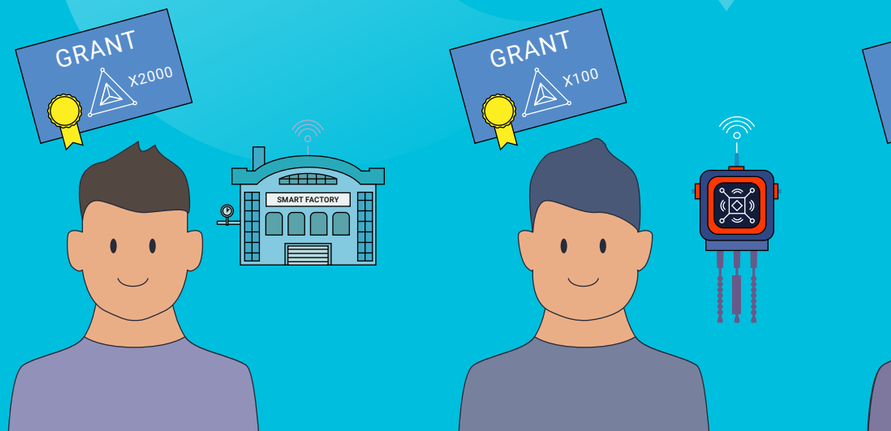
For these reasons, the program exists on the condition that it be as simple and quick as possible. With a minimum of bureaucracy involved, so that recipients can devote more time to their projects. Finally, we want to keep our relationship with recipients transparent during proposal submission and funding, so we use the capabilities of GitHub and Aragon DAO.

The maximum funding amount: 50 000 USD in cryptocurrency (XRT or DAI).

Approved program participants will receive support from the Robonomics team and our partners, including various professionals. The first three successful applicants will have the opportunity to participate in acceleration from the Web3 Foundation.

More information about the grant program
github.com





The Robonomics platform was created to solve social and economic problems that come with the robotization of mass production, urban life, and logistics.

The application of the platform is primarily centered on creating trust in the services and products of smart cities and factories. Providing direct user access to autonomous cyber-physical systems, as well as managing multi-agent systems using capital.
Robonomics will expand the capabilities of Polkadot and Ethereum network infrastructures in the context of Industry 4.0, IoT, and smart cities.

for SOCIETY >>

The Robonomics network increases the transparency of goods and services produced by machines, and allows the tracking of the entire production process. Control over the fulfillment of cyber-physical obligations is separated from commercial IT companies, which can be partners of manufacturers. With Robonomics, machine compliance checks can be performed by Polkadot and Ethereum network validators.

for BUSINESS >>

There is no need to look for an intermediary who will be trusted by the participants in the entire chain and who can provide reliable information exchange and storage. The information appended to the chain and built using the Robonomics network will add significant value for consumers by enabling radical transparency of production processes.

for SCIENCE >>

We stand at the start of a new science that describes the possibility of managing complex human-machine systems using economic theory. This science is called economic cybernetics. Our work is built on the ideas of Norbert Wiener, Ronald Coase, and Victor Glushkov. We supplement the work of these remarkable scientists with our advancements to build direct economic relations between people and machines. Thus, through theory and experiments, we have begun to develop a standard for high-level human-machine communication.

for DEVELOPERS >>

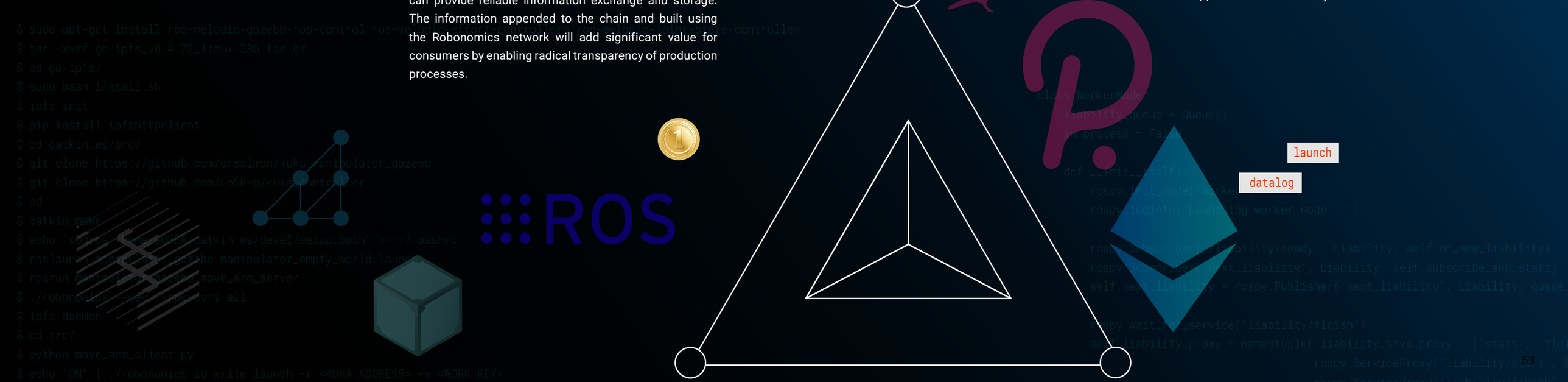
Create added value by increasing the transparency of manufacturing processes in the production of goods in smart factories.

Build behavior models for smart factories and cities based on economically significant transactions that are stored on the Polkadot and Ethereum public blockchains.

Design models of verification and fulfillment of contractual obligations by autonomous factories to and between people.

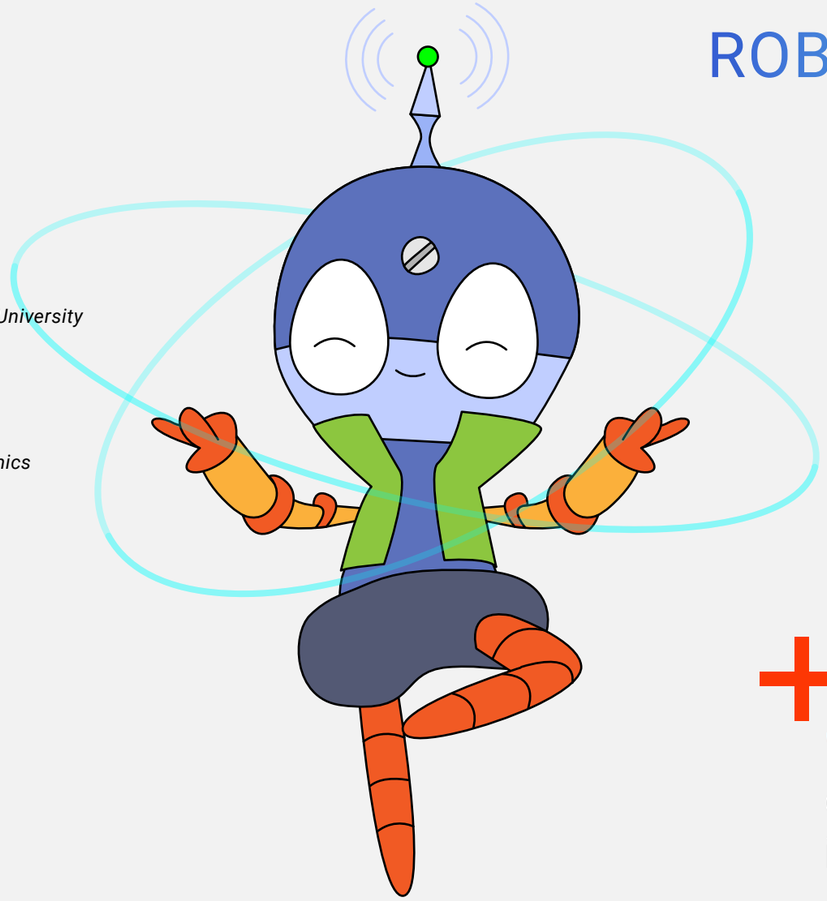
Create autonomous systems for managing the economic relations of smart factories.

Join the grant program and help us discover new opportunities for Industry 4.0 and smart cities.

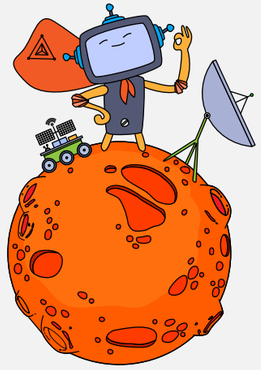


CREDITS TO WHO WORKED ON THE BOOK

- **Sergei Lonshakov,** *software architect of Robonomics*
- **Aleksandr Krupenkin,** *core developer of Robonomics*
- **Eugene Radchenko,** *Robotics and IoT engineer of Robonomics*
- **Aleksandr Kapitonov,** *Robonomics' progressor, dean of ICT faculty ITMO University*
- **Vadim Manaenko,** *Robotics and IoT engineer of Robonomics*
- **Pavel Sheremetev,** *devops engineer of Robonomics*
- **Aleksandr Starostin,** *frontend engineer / javascript developer of Robonomics*
- **Vitaly Bulatov,** *CEO Merklebot*
- **Ivan Petrov,** *CEO of NPO Airalab Rus*
- **Alisher Khasanov,** *experienced robotics software designer and developer*
- **Ivan Berman,** *scientific administrator of Robonomics*
- **Ivan Filyanin,** *IP network engineer*
- **Diana King,** *public relations lead of Robonomics*
- **Sieger Joostens,** *proofreading*
- **Anna Wimmer-Savinova,** *creative designer, illustrator*
- **Anastasiia Bakai,** *frontend Web developer / UI designer*
- **Aleksei Voloshenko,** *photographer / video production*

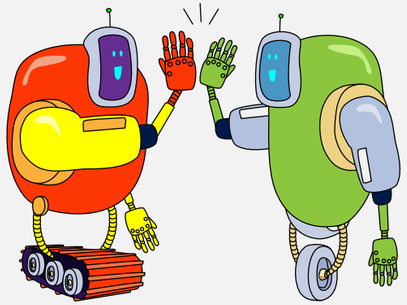


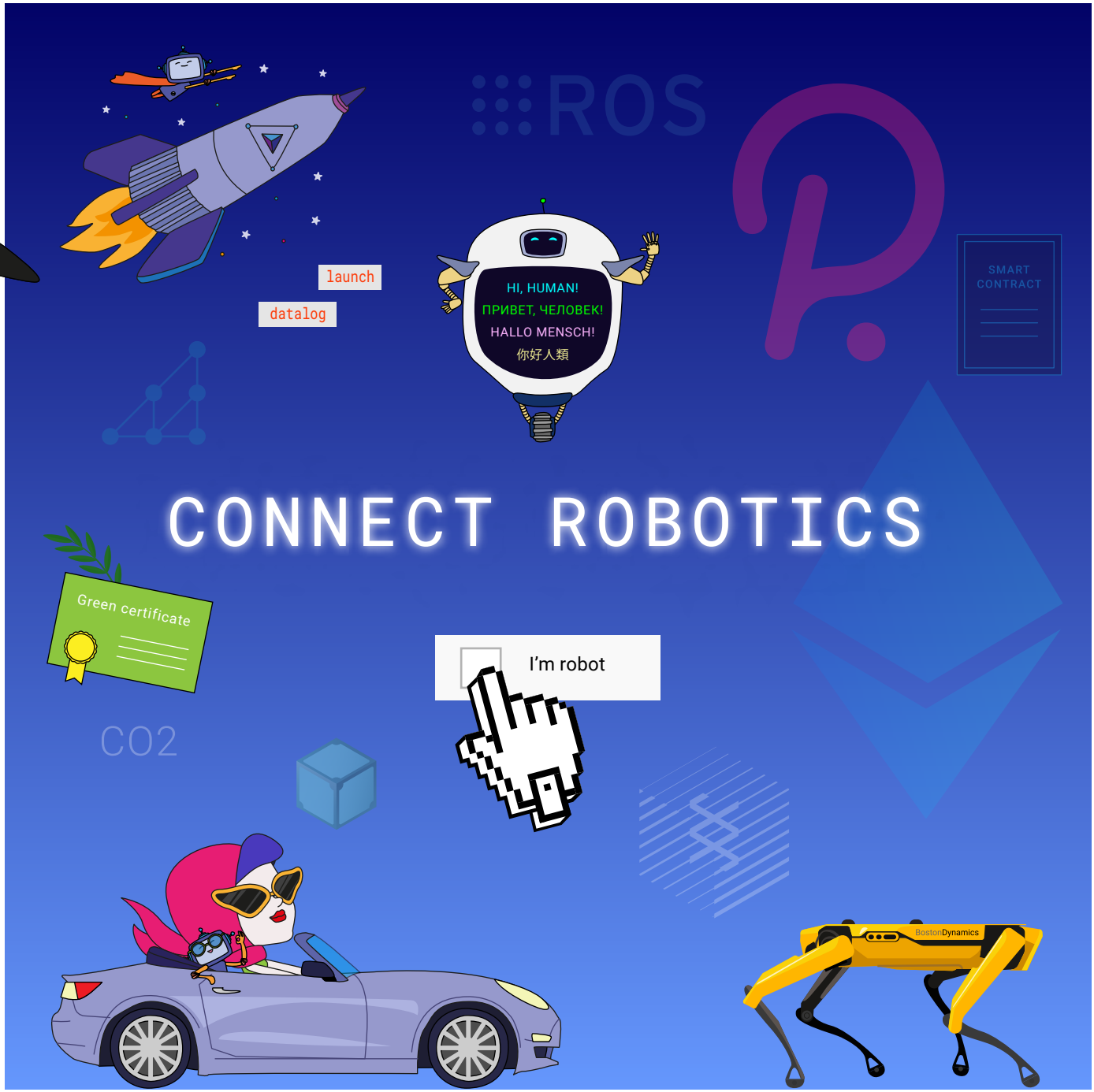
ROBONOMICS.NETWORK



+JOIN

our journey
into the future





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