Robot Economics Doctrine

Total robotization. It is inevitable that the role of robots will further very substantially increase. Machines are capable of performing tasks impossible for humans, they are more effective and reliable including in many types of business activities, and they are already saving peoples time every day.

The development of robotics has reached the point where the ability to separated autonomous agents (robots) to communicate among themselves and how communication can improve the utilization of robots has moved to the center of the attention. Robots have the capacity to decide which actions are appropriate even within constantly changing environments. Technologies that are now being used in the world of machines constantly expand the number of decisions that can be taken by a robot, which in turn increases its level of the robots autonomy and decreases the ongoing role of people.

The potential for communication between autonomous robots is most noticeable in such spheres as Industry 4.0 and Internet of Things. We believe that the following questions are the most relevant for the further development of robots:

1. How are the legal consequences of autonomous actions to be determined?
2. How can a fully autonomous factory understand the changing needs of customers?
3. How is the direct interaction between robots of two different corporations to be organized and how are related risks to be minimized?
4. How are autonomous activities of robots' activities to be taxed and what is considered a separate robotic unit?

Unless answers to this questions are implemented in a consistent manner, risks up until the collapse of the system in which the world currently interacts can arise - the less slavish human labor is, the smarter the organization of work has to be.

The organization suggested by the doctrine of robot economics (robonomics in some articles) is radically different from the main current manner of organising the world of machines (that is completely dependent on a large number of individual corporate decision-making centers) and allows an alternative manner of humans communicating with robots and machines communicating among themselves. Both robots and humans are agents with a large degree of autonomy in causing consequences. This approach decentralizes communication between people and robots, which is the most efficient option for integrating robots into the economy and organizing the interaction between humans and robots. For this decentralization to be successful, technical, organizational and legal innovation are to go hand in hand.. Unless the work of robots is structured well, efficiency will suffer.

The power of the "center" is dangerous. Extrapolating the manner in which the world currently is developping, the more processes are automated, the more they are controlled centrally by corporations or governments. The result can be that robotic devices in your house / city / country can restrict freedom of movement, make it impossible to obtain the goods that are important to costumers and to serve all including the basic needs of society based on the command from the "center." The dangers inherent in control by a "decision center" becomes evident in the following contexts:

1. System failure. Naturally, no system can be without fault and risk, in particular if it is used throughout decades. Even a very short failure of a larger of the vertical networks of subordinate machines can lead to serious consequences.
2. Seizure of the decision-making center. In the face of ever-changing political elites, the seizure of centers which control the machines on the function of which the society is based may be a central part of the policies of e dictators coming to power.
3. Self-awareness of the robot. We can not be sure of how the robot will behave if it reaches the self-realization of its existence, and decisions that harm mankind could be

the consequence. f a large network of subordinate machines is connected to the self-aware decision-making center.

About the free market. An alternative to centralized control of the world of machines can be a free market for purchasing the right to use robot availibility. The market, as a structure, can become a sufficient tool for coordination, stimulation, and regulation of the activities machines.

Modern open source decentralized technologies can ensure the existence of a free market for direct economic relations between a human and a robot in such a way that a global robot economy comes into existance.

The use of free markets as the basis for communications between autonomous robots can create fair competition between large corporations and small businesses that are easily accessible to the consumer. In comparison, a large corporate cyber-physical system, in particular from the perspective of the consumer, in the end consists of nothing other than a single economic agent which can only sporadically be influenced by other market participants. Accordingly, under this model assessments of single products are made solely on the basis of the quality of the product in comparison with similar options and will in addition be influenced by the internal complexity and size of the enterprise. In contrast, a free market does not create similar barriers for the consumer when the consumer is choosing products.

In order for the market to more comprehensively understand how the functions of coordination, stimulation and regulation of the activities performed by machines in the human society, micro- and macroeconomic model are useful.

Microeconomic model of robot economics. The emergence of a global free market of robot liability contracts and instruments for the creditor (robot which owes the delivery of the service) and for the beneficiary (of the service performed by creditor-robot) drives production and thereby forms the capital of the robot economy.

About the importance of valuation of robot economy. The higher the liquidity the robot economy will become, the more effectively the market can perform the functions of coordination, stimulation and regulation. Liquidity increases if the system can effectively deal with the main challenges that the industry faces now and take into account the interests of macroeconomic players that help the industry cope with potential challenges.

Macroeconomic model of robot economics. The main purpose of looking at robot economics at a macro level is the ability of such a system to drive what we see as being main related challenge, namely organizing change of in production and supply chains of fully automated enterprises.

If the capacity of the robot economy is expressed by an internal token then, in addition to a valuation of the total of the available production capacity, we will be able to cause a completely automated plant to react to the changes in our needs by analyzing the distribution of the internal token between different markets of robot economy throughout our life.

Responsive robot economy. The ability to replicate the process of production, logistics and data supply by autonomous robots to reflect changing human needs is the most important step on the way to the advent of fully automated enterprises. The main issue to be resolved in this context is to set adequate triggers for changing the behavior of the robot or changing the function it performs.

Optimal results are possible by assessing the distribution of limited capacity in different vectors (a vector representing a market of one type of service) of the robot economy to reflect changes in human behaviour. In this context, not only current market volumes, but also the potential of future periods can be given a market value. The same is true for markets for ideas can come into existence and therefore potentially interesting proposals that do not yet exist on the market. The task of forecasting the next period of the market and the task of evaluation of the new

market has also been conceptualized as mechanism of predictive markets with the use of the futures on the market volume estimate (including a market index) as described by Vitalik Buterin in the article An Introduction to Futarchy, t. Such a mechanism can lead us to a responsive robot economy which will adapt to our constantly evolving needs.

One valuation, a set of market vectors. The classical predictions market is based on a concept of choice between the two outcomes of one event and on the fact that voting by capital by purchasing the metric in which the person believes or appreciates more is a more objective assessment than the usual poll of interested persons ("vote values, but bet beliefs . ").

If we abandon the model with two outcomes and supplement the predictions markets by using a single token, the classical problem of, by the choice of the token, also choosing between an unlimited number of market vectors and limited resources arises. At the same time, the price of the token will be useful for both estimating the next period of the current market and for assessing new markets.

Standard questions for token holders. The "one capital, many market vectors" approach requires the standardization of the considerations that are likely to lead to investements into the tokens. Each expectation reflects a new vector of the robot economy and with the correct assessment of the market potential an investor can collect earnings from the relevant futures. The standard for creating new vectors developed by Aira is based on the following assumptions:

(1) The expectation is always about volume.
(2) The expectation should always evaluate the market in the internal token of the robot economy.
(3) The expectation should always have a time interval.
(4) The expectation should always specify the size of the market commission including the commission of the market creator and investors.
(5) The specification which the robot will understand must always be attached to the relevant expectation.

Example of the basis of an expectation: “How do you evaluate the market potential for dosimeters in Europe in 2018 with a market commission of 3%?”

Robot unification in the eyes of the market. The aira (autonomous intelligent robot agent) project implements the standard of human-robot and robot-robot economic interactions with the help of liability contracts. Aira allows to connect a lot of different robots to the liability contract market existing in Ethereum for direct sale of data from robot sensors, ordering unmanned transportation services or personalized products in robot enterprises.

THE INFORMATION THAT I WOULD EXPECT IN THE FOLLOWING IS:

- WHAT IS NEW IN THE TECHNICAL FUNCTIONALITY OF "AIRA";
- WHAT TYPE OF FUNCTIONALITY OF "AIRA" DOES AREADY EXIST;
- WHAT ARE THE PLANS FOR GETTING 'AIRA' ACCEPTED BY ROBOT-OWNERS AND HOW FAR HAVE THEY PROGRESSED;
- WHAT IN SUMMARY IS THE CONTENT OF SMART CONTRACTS.

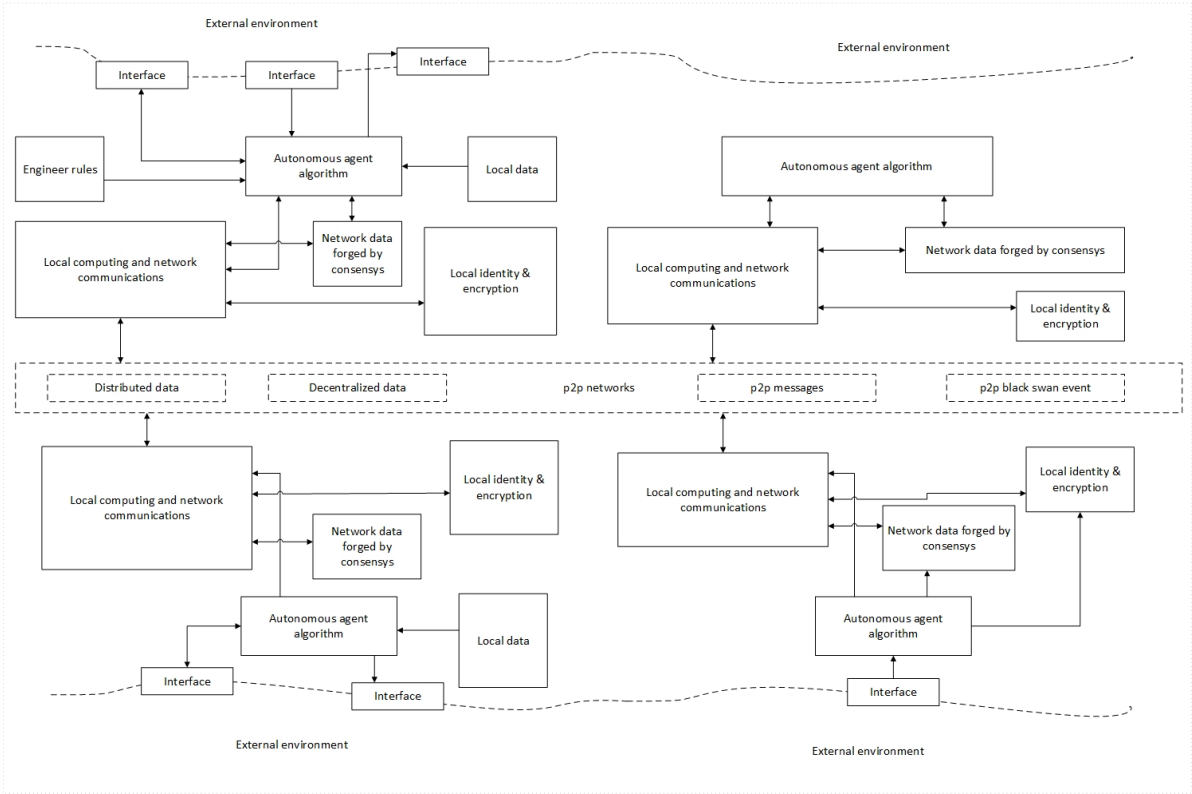


Figure 1: work scheme of a set of robots in p2p networks using the Aira image.

It is important to note the following:

- The interaction of autonomous agents occurs exclusively through the p2p network;
- An autonomous agent is not required to have interfaces to the outside world or engineer intervention mechanisms in its work;
- An autonomous agent participates in the processes of decentralized;
- An autonomous organization may not have local data, but network data is mandatory for it;

Internal market token of the robot economics (robonomics in some articles). Autonomous intelligent robot token or Air token allows creating a free global market of the robots' liabilities. Air tokens are units of the liability market, the market for connection of all robots with Aira image installed.

Air tokens are required every time when the user makes a contract with the robot.

Aira project will use the smart contract TokenEmission to implement the internal token of the robots economy market. http://airalab.github.io/core/docs/docs/TokenEmission/

The TokenEmission contract is a token contract that is fully compatible with the ERC20 interface, supplemented by the function of additional token issuance by calling a special method "*emission*".

Liability contract market for robots. It allows to the owner of robot to replicate the unified contract of the robot's liability and offer services, which can be ordered directly from the robot.

https://github.com/airalab/core/blob/develop/contracts/market/LiabilityMarket.sol

Liabilities market provides a free trade area with contract searching and dealing with the agents of the market.

The unified contract of the robot's liability. A smart contract providing the basic interaction of ROS-compatible robot, creditor, and beneficiary in a way that:

1. the lender complies with the terms of the contract;
2. the robot receives a notification about payment for the service and publishes the result of the work (in the form of a hash);
3. Air tokens are sent to the beneficiary only after publication of the work results (in the form of a hash).

https://github.com/airalab/aira-IoT/blob/master/contracts/RobotLiability.sol

The *RobotLiability* contract is an interface for interaction and message processing from a ROS-based robotic system. The liability includes the format and the order of interaction of the parties that have concluded the contract.

The theorem about safe robot economics.

Axiom 1: Economic interaction between a person and a robot is carried out on the basis of a contractual liability and capital existing in a digital form.

Axiom 2: There is not enough internal capital and contractual liabilities for the existence of a self-sufficient economy.

Robots have internal capital and contractual liabilities without ownership rights, creating a human-dependent robot economy.

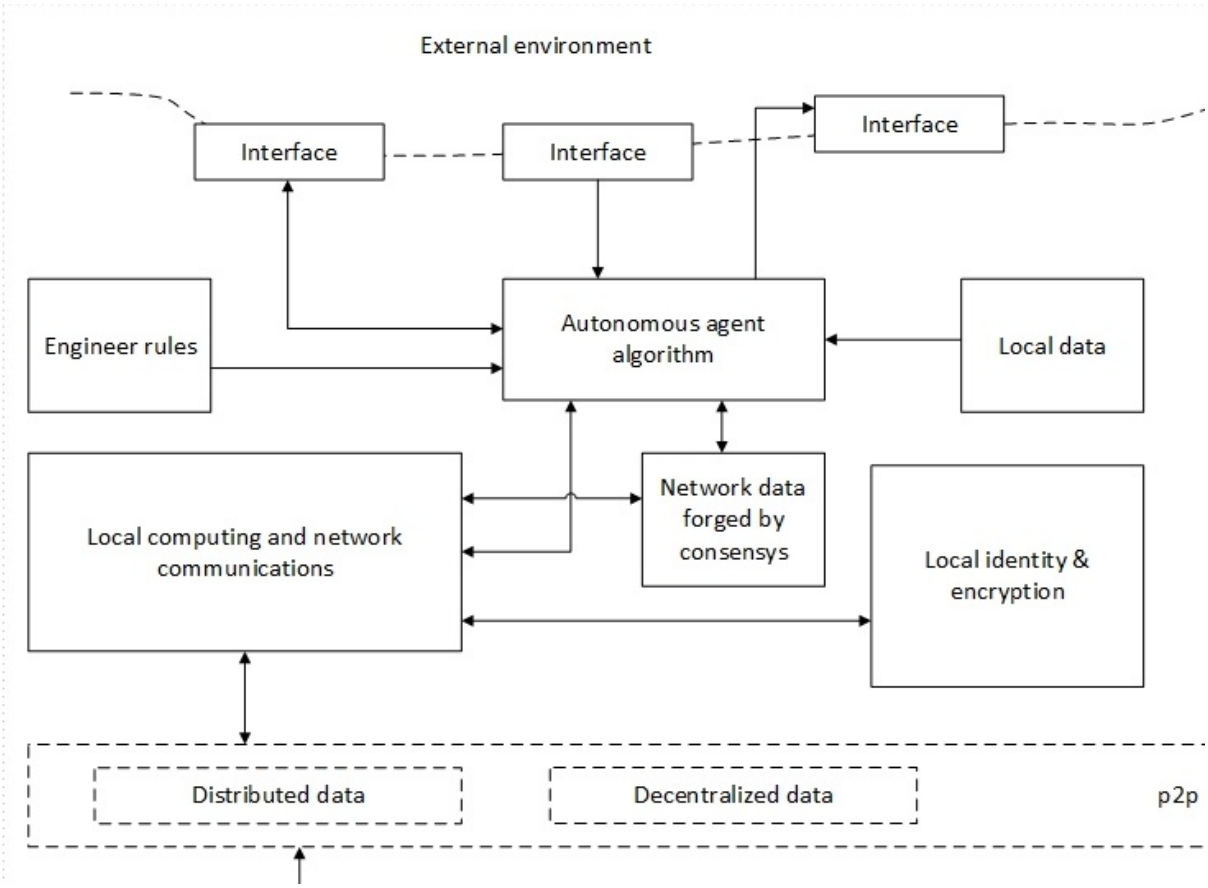
There is no liability without ownership. Any robot in the process of performing a service still needs to rent space for work.

Robot economics rules. Three basic rules for making a safe and human-dependent robots economy:

- **A robot cannot have liability rights.** While the robot works on the basis of contractual liability, people are able to control the economy of robots.
- **The economy of robots must have internal capital.** The internal capital is able to support the market and reflect the value of the participation of robots in human life.
- **The economy of robots can only exist within the digital economy** with internal capital and fulfillment of contractual liabilities.

Appendix 1. The structure of the autonomous agent

The basis of the autonomous agent is the behavioral algorithm. The robot interacts with the environment through the interface and communicates with the network through standardized network protocols.



It is important that the structure of the agent implies two types of data:

- Local data of the autonomous agent;
- Network data forged by consensus.

It is worth noting some features of the interaction of processes within the agent:

- the network communication protocol communicates with network data directly and with local data through an autonomous agent;
- the network identification of the autonomous agent is realized by the protocol but not by the algorithm of the autonomous agent;
- the control of robot during the task is engineering problem;
- the interface of the autonomous agent is close to the external environment.

Appendix 2. AIRA Internet of Things

https://github.com/airalab/Aira-IoT

Internet of Things inside robot economics is associated with blockchain based financial networks. Aira IoT project determines communication standard for robots and liability smart contracts, ref. *RobotLiability*. An example of the standard implementation is *AIRA ROS Bridge* project.

AIRA ROS Bridge

https://github.com/airalab/aira_ros_bridge

It is a package for Robot Operating System nodes and Ethereum smart-contracts communication, as a part of the Ethereum network.

AIRA ROS Bridge consists of:

- *ROSBridge* smart-contract as an Ethereum network access point for robots;

- The robotic system node is *aira_ros_bridge* application for low-level interaction with a smart contract.