# Distributed Ledger To Counter Pandemic Spread

How to use Smart Contracts and Distributed Ledgers to counter the spread of a virus

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The current pandemic calls for technology driven reconstruction of infection chains. The main building blocks of these systems are:

- Critical proximity detection
- (Local) contact store
- (Global) infected persons ledger / database
- Database distribution mechanism
- (Local) potential infection resolution algorithm and user interface

Critical proximity detection describes a technology that provides the possibility to recognize a contact between individuals. Bluetooth low-energy is currently in discussion for this. This document contributes and complements the architectural of Excalibur, an open source reference by Unleash Future®. It is a "Tamagotchi-sized" durable sensor, computing, and communications device that can complement currently developed mobile phone-based contact tracing apps. In following named 'smart sensor'. It can be a vital element to close the coverage gap of young children, elderly people and people without mobile phones. This amounts to 44% of the population in the U.K. as calculated by researchers at the University of Oxford[1]. Similar ranges can be assumed for Western countries and even more in some parts of underdeveloped countries.

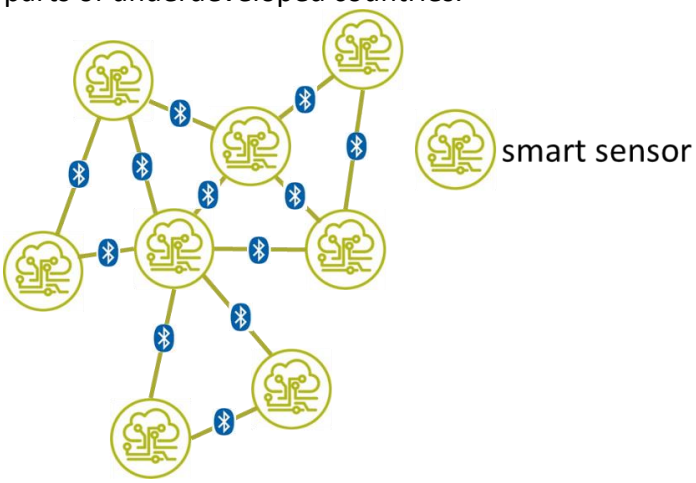



*Figure 1 - Excalibur network: Smart sensor network*

[1] See Hinch, et al. (16.04.2020): "Effective Configurations of a Digital Contact Tracing", Report to the NHSX

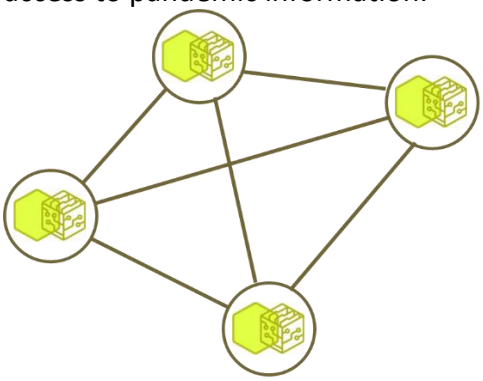
The local contact store ensures that information about critical proximity is stored in the local smart sensor of an individual. This information is stored for about 3 weeks (typically, the incubation time). The smart sensor can receive a list of infected individuals. Then the smart sensor can inform his owner about the critical proximity to an infected person once that person shows symptoms or is tested positive.

Maintaining and distributing a list of infected individuals may require distributed ledgers or/and smart contracts. The following arguments will explain why:

In general, *distributed ledgers* provide the possibility to establish trust in data and transactions where no single source of trust is available. Typically, this goes along with the price of eventually delayed consistency as well as a distributed and potentially more complicated architecture. *Smart contracts* ensure transactions on the blockchain following coded rules that can be reviewed by everyone using the blockchain.

The pandemic has shown that trust in global institution falters quickly and nations fall back to trusting only in themselves. Lockdowns, to regain control of the virus, and re-enter containment through infection chain tracking emphasize national solution thinking. Consequently, maintaining a global database under such circumstances may seem a difficult endeavor, the time to negotiate and set up databases in different countries taking precious time, while covid-19 is taking lives every day. Further, maintaining that database will require global rules. Examples include rules and restrictions about who may enter if a person is infected or configuring incubation times. We currently fail to build a global response system much needed to secure global economy.

Distributed ledger and smart contracts have been proven to overcome these challenges building global decentralized systems. Distributed ledgers provide the infrastructure and means to distribute transactions and data in a trustworthy way – without centralized data storage and control over the data. Existing networks, such as the Ethereum Network, have proven scalability to meet the requirements for a world-wide network of smart contracts supporting a decentralized distribution network (DDN) for pandemic outbreaks. Smart contracts could enforce the rules and parameters to input data into the infected persons network. New privacy functionality is being developed within current blockchain networks (e.g. ETH 2.0) that may even ensure that the privacy of individuals is maintained. Access to Ethereum network is already available globally without restrictions, therefore democratizing access to pandemic information.



decentralized distribution network

*Figure 2 - Decentralized distribution network*

In order to set up a blockchain-based solution for taking the pandemic under control, the following steps towards a working setup can be sketched:

1. Devise a smart contract to manage the rules to store and distribute information about infections using the blockchain (verify data)
2. Use smart contracts on local devices to calculate information about the risk of having been infected (verify algorithm)

The choice of the blockchain technology should be discussed for the network design, cost, as well as suitability of technology:

1. Hyperledger fabric: an open-source blockchain platform for the enterprise. It also comes with a wide support, a good set of tools and a large developer community. Hyperledger is often used to build up private blockchains in enterprises, where some control over the data on the blockchain can be centralized.
2. Ethereum: seems to be a well-established network built on smart contracts. It has a large developer community, a good set of development tools ("truffle"), and an operatively working and scalable global network. Ethereum is a public blockchain that guarantees maximal openness. On the downside, transactions within the Ethereum network have an attached cost (gas-cost) that may limit access to the network.

We may consider devices and apps both becoming co-existing and interoperabel smart sensors. Smart means: we collect and send information (e.g. IDs), but calculate individual risk probability on the device. Decentralized Distribution Network (DDN) is the network to exchange the positive lists, either self-spotted or verified by official testing. Therefore, we can look at two scenarios: each device globally participating in a somewhat ad-hoc network, or a heterogenous network of sensors communicating with a decentralized distribution network.

To create a fast response, we propose an alternative procedure: smart sensors (up to 8 billion sensors) communicating with a decentralized distribution network (about 100 thousand devices). It allows to split efforts in parallel branches, saving time and people's lives.

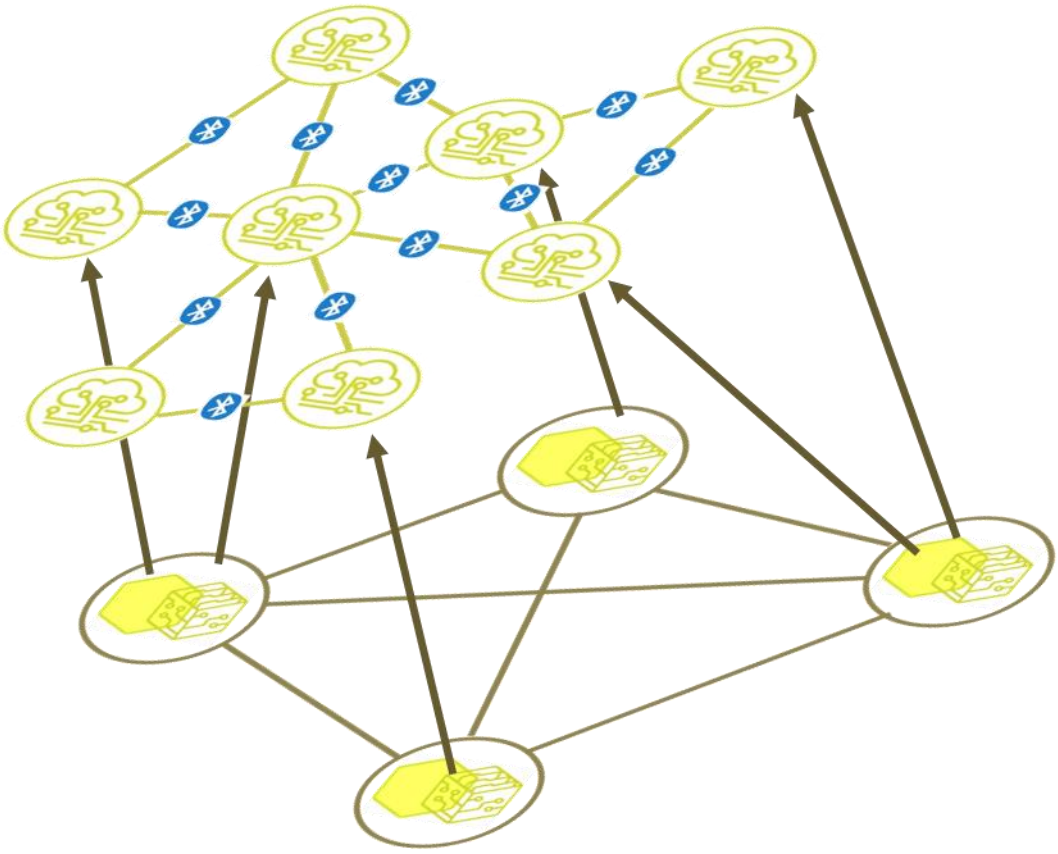


*Figure 3 - Communication between Excalibur network and DDN*

In a nutshell, blockchains can help fighting the pandemic by establishing a global trusted network to share information about critical contacts. Rules to access and control of the information can be formalized in smart contracts. The technology and infrastructure already exist and can be used on a global scale – let's do it!