ITMO UNIVERSITY

Smart Waste Management: An IOT and Blockchains based approach

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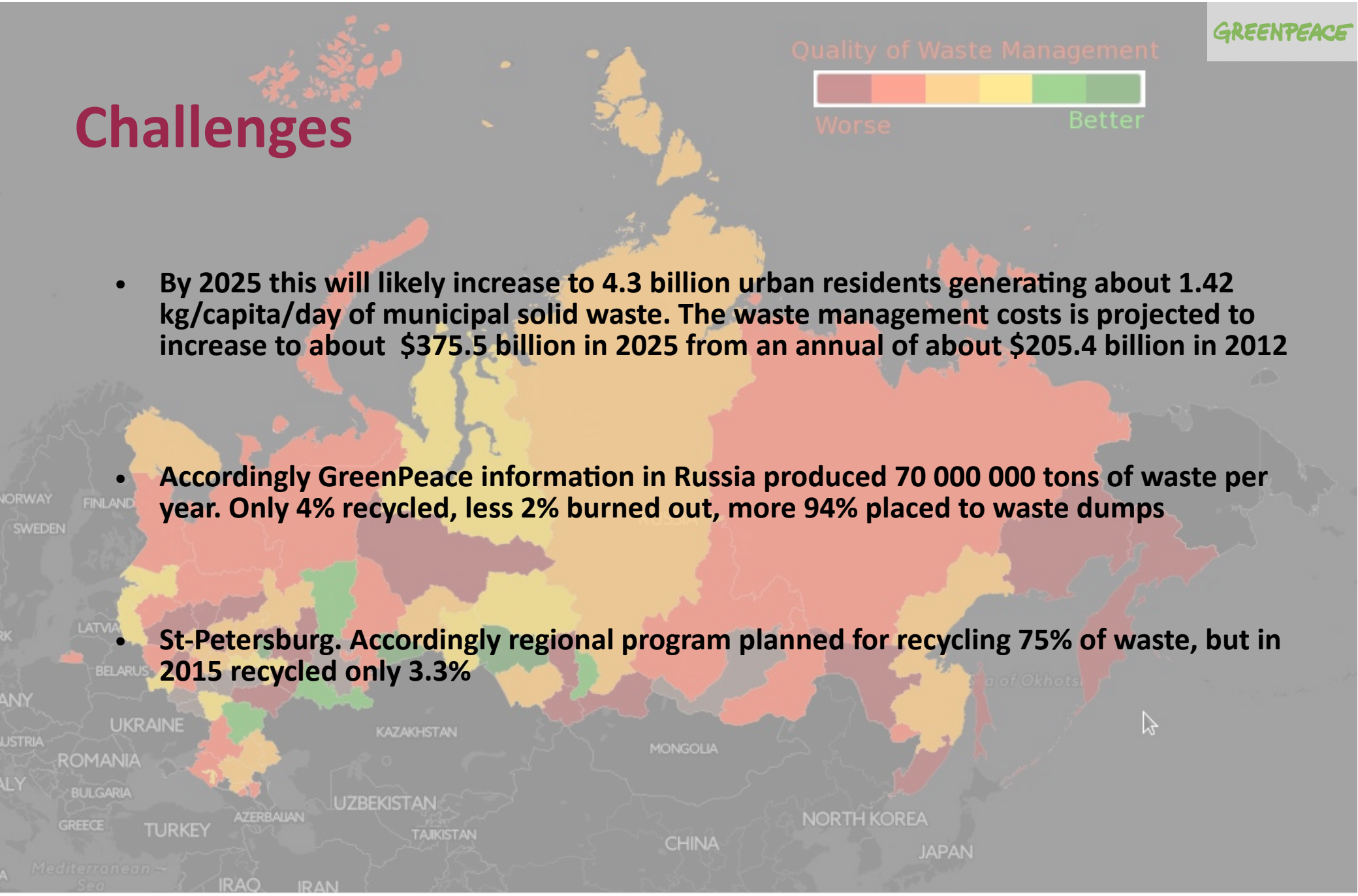
About bIoTope

- The bIoTope HORIZON 2020 project lays the foundation for creating open innovation ecosystems by providing a platform that enables companies to easily create new IoT systems and to rapidly harness available information using advanced Systems-of-Systems (SoS) capabilities for Connected Smart Objects – with minimal investment.

- The bIoTope project is a collaboration amongst market leading industrial organizations, innovative software tools and platform technology companies, research organizations and public authorities in major European cities that are developing and undertaking pilot evaluations of advanced technologies for products and services that exploit the Internet of Things.
- The bIoTope project is composed of 21 partners from 10 countries and includes leading universities and research institutes. A dozen smart city pilots will be deployed in three major European cities of Brussels, Lyon and Helsinki, along with a further pilot in the city of St Petersburg, Russia. Two categories of pilots will be used to validate the effectiveness of the bIoTope Systems-of-Systems platform for IoT:
  - Domain-specific pilots – ensure industrial impact through the well-established customer networks of bIoTope partners addressing electric car charging stations, self-managing buildings and equipment, smart air quality and others.
  - Cross-domain smart city pilots – provide concrete proofs-of-concept of IoT system composition and interoperability scenarios in smart city environments including smart metering, shared electric vehicles, smart lighting, hyper-local weather data, smart priority lanes for bikes and many more.

- ITMO University (International Research Laboratory in Modern Communication Technologies, and Applications in Economics and Finance) located in St. Petersburg, Russia, carry out Research dedicated to Internet of Things, Waste Management, Smart Cities, Intelligent Transportation Systems and relevant research topics. ITMO University conduct a comprehensive and thorough survey on ICT waste collection models with a focus on IoT as a key enabling technology in contemporary waste collection. ITMO University utilising the bIoTope technologies to establish a use case related to smart cities, namely “IoT – enabled waste-management” for validating the technologies and creating an ecosystem for IoT products and services within the St. Petersburg region.

Challenges



- By 2025 this will likely increase to 4.3 billion urban residents generating about 1.42 kg/capita/day of municipal solid waste. The waste management costs is projected to increase to about $375.5 billion in 2025 from an annual of about $205.4 billion in 2012

- Accordingly GreenPeace information in Russia produced 70 000 000 tons of waste per year. Only 4% recycled, less 2% burned out, more 94% placed to waste dumps

- St-Petersburg. Accordingly regional program planned for recycling 75% of waste, but in 2015 recycled only 3.3%

Current State of Development

At present, we have finished laying the foundation of the entire architecture.

- Simulating SGBs
- Hardware Implementation:
  - Garbage Bins
  - Raspberry Pis, Arduino processor boards
  - Sensors (Ultrasonic, Humidity, temperature, gas) and GPS
  - ITMO OpenStack cloud (H/w and S/w)
  - Actuators for locking the SGB
  - LoRaWAN network modules
- Web applications for Municipalities, Waste Management Ooperators, citizens and govermnent structures
- Mobile applications for track drivers and janitors
- Cryptocurrency driven collecting waste data and working with it

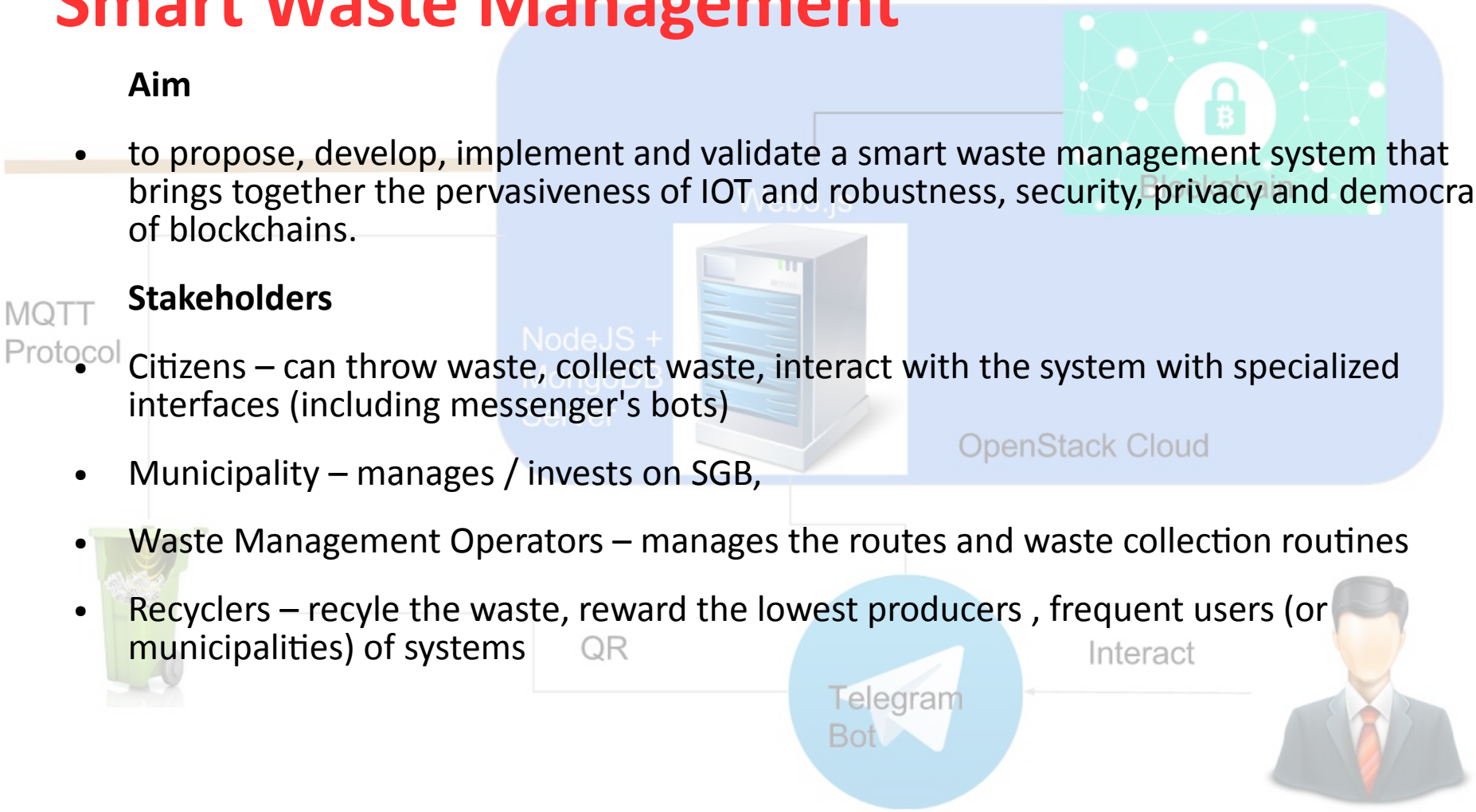
Smart Waste Management

Aim

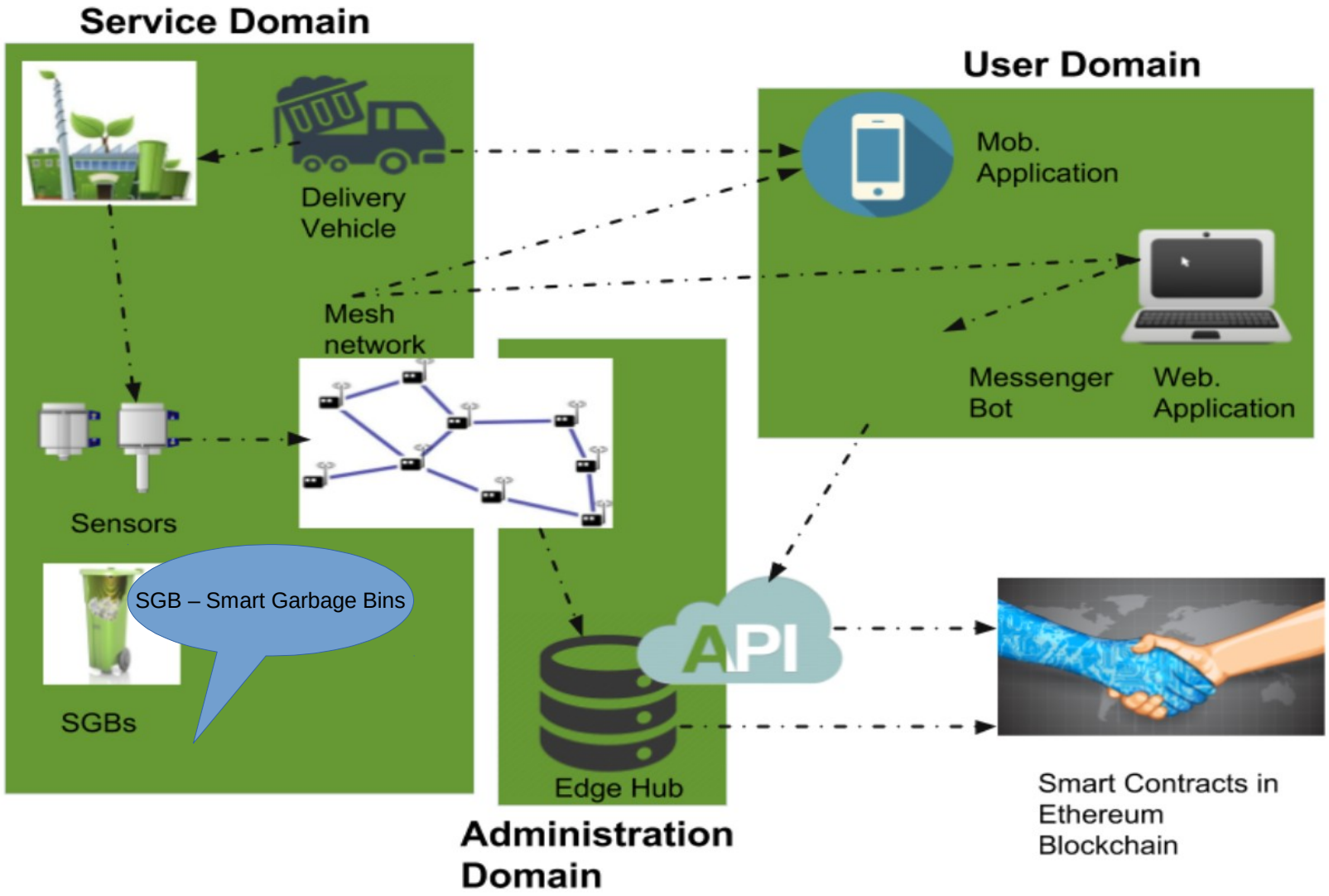
- to propose, develop, implement and validate a smart waste management system that brings together the pervasiveness of IOT and robustness, security, privacy and democracy of blockchains.

Stakeholders

- Citizens – can throw waste, collect waste, interact with the system with specialized interfaces (including messenger's bots)
- Municipality – manages / invests on SGB,
- Waste Management Operators – manages the routes and waste collection routines
- Recyclers – recyle the waste, reward the lowest producers , frequent users (or municipalities) of systems



Technical Description



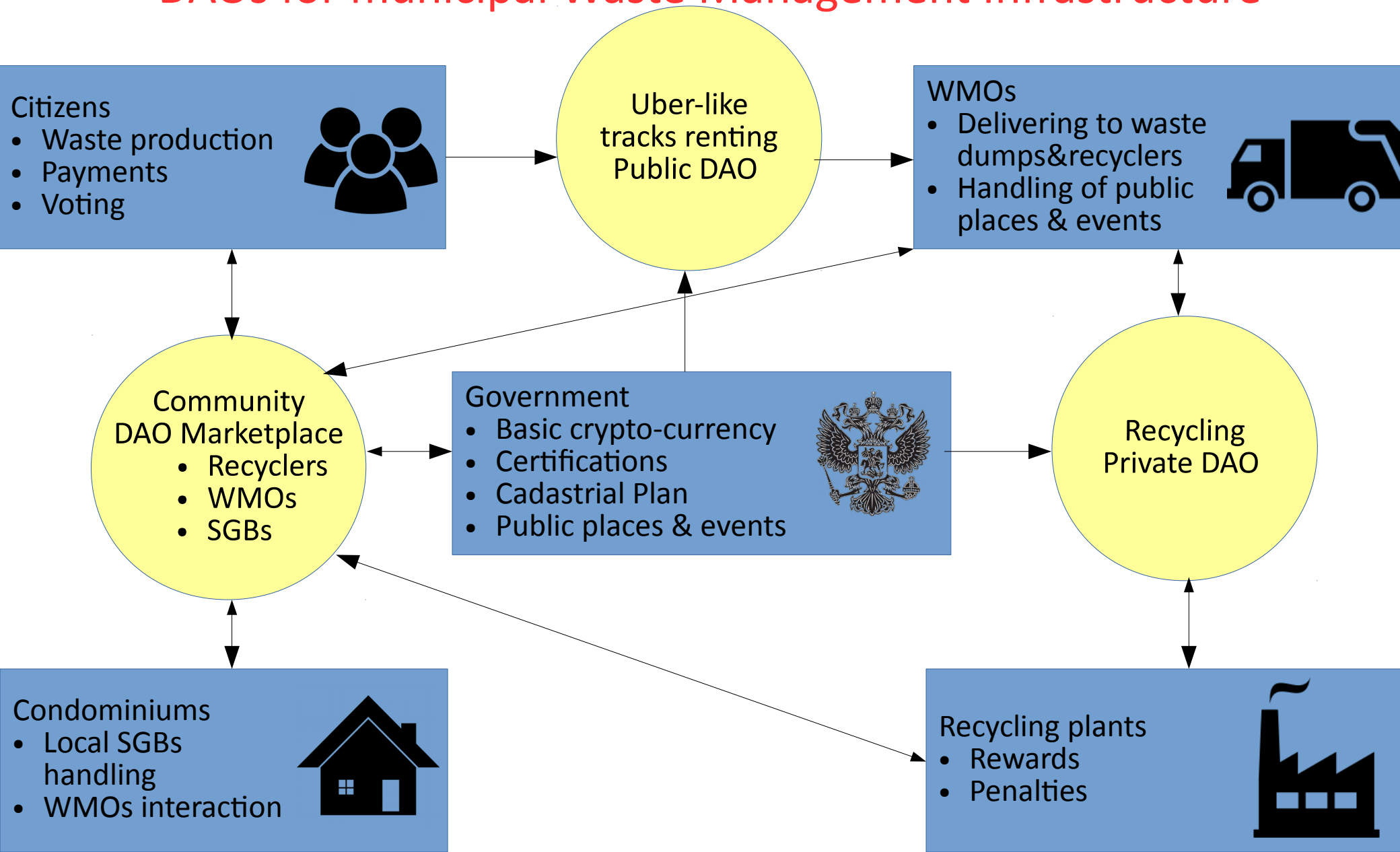
Blockchains and DAO

- **Blockchains are distributed ledger where multiple number of nodes maintain a state of the network by reaching to a consensus by collaborating with each other. Algorithms like Proof of Work and Proof of Stake (under development) are used to have a consensus among the nodes.**
- **Bitcoin (2008) was the first implementation of this technology. At present, Ethereum is working on an implementation where Smart Contracts and DAO can be created.**
- **Smart Contracts are codes written in Blockchain oriented languages (Solidity, Serpent and LLL) that are written to a carry out a specific when certain event occurs. They have an infinite lifetime and remain on the blockchains network as long as the network lives. May be used for different types on interaction between humans, IoT devices and services with higher security and lower requirements for firmware updating.**
- **DAO is a special kind of special contract. It models the real world organization in blockchains with characteristics like voting, proposals, releasing shares and so on. The crucial difference, however, is the fact that this kind of organization is decentralized as there is no central authority governing the policies or dictating terms. It is all done by collaboration of all stake sholders that possess the DAO token.**

  From the perspective of this research, we will be developing private DAO's for Recyclers and Waste Management Operators, a community driven public DAO for uber-like waste managent where, interested common users can view which SGBs are full and carry the waste to the Recycle Plants to claim the reward. A private minter / bank will be issueing crytocurrency that will run this entire economy on blockchain.

Image credits: Coindesk

Possible usage of BlockChain and Smart Contracts enabled DAOs for municipal Waste Management Infrastructure



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