



Titolo del Progetto

DeLiCE: Decentralized Ledgers in Circular Economy

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Abstract:

Circular Economy (CE) aims to transform the linear model of production, by promoting reuse and recycling of materials by means of suitable incentives to stakeholders. Typical CE projects are small-scale and rely on mutual trust among stakeholders. This assumption is unrealistic in large communities. One solution could be to introduce a central authority which controls the communication infrastructure used to track the resource flows, and which anyone is assumed to trust. This authority would have complete control of the information, compromising transparency and being susceptible to attacks, frauds and bribery. In this project we propose Decentralized CE (DeCE), which aims to guarantee reliability, security, and transparency of CE without relying on central authorities. DeCE requires complex protocols to track resources, incentivize reuse, and prevent malicious users from exploiting incentives for their own gain, rather than for the common good. This calls for theoretical foundations enabling their formal specification and analysis. The emerging field of DeFi (Decentralized Finance) faces similar challenges, albeit in a different context. In particular, lending protocols allow users to lend their crypto-assets to borrowers upon payment of a collateral. Complex mechanisms are used to incentivize borrowers to repay their loans and lenders to keep the system liquid. Lending protocols are very successful, as shown by their



proliferation on different blockchains, and by a total value today exceeding \$10B. If we replace crypto-assets with physical products, we see that the incentive mechanisms underpinning lending protocols can be the basis for DeCE. Furthermore, blockchain platforms executing DeFi protocols are the ideal solution to the traceability problem, thanks to their decentralization, persistence and auditability. However, DeFi mechanisms are not directly adaptable to CE. For instance, while the assets traded in DeFi are on-chain (i.e., they can be completely managed through blockchain transactions) and fungible (i.e., different units of the same asset are indistinguishable), in CE one needs to manage physical products, which are non-fungible. The different nature of the assets affects the actions they support and hence requires a complete rethinking of the incentive mechanisms. DeLiCE combines techniques from DeFi and Formal Methods to develop provably correct protocols for DeCE. Our first objective is a formal, executable model of DeCE protocols, and a theoretical study of their properties. Based on this model, we develop a toolkit to detect potential flaws in DeCE protocols (e.g., exploits of the incentives) before deployment. We validate our theory and analysis toolkit through a real-world CE use case. DeLiCE tackles a fundamental and timely problem - devising a theory to formalize DeCE protocols and verify their correctness and security - which, to the best of our knowledge, is overlooked in existing CE and DeFi literature.