

B08

## 能動的デブリ除去のための、デジタル通貨を利用した 経済プラットフォームの提案

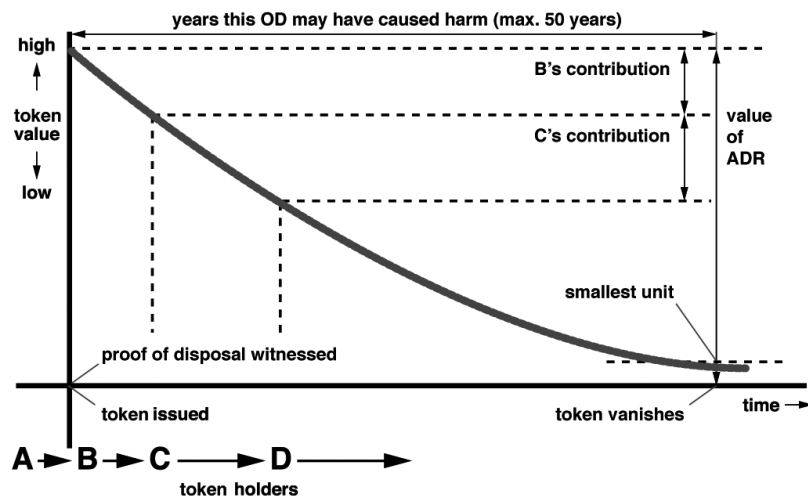
Proposal of an Economic Platform with a Digital Currency for Active Debris Removal

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本研究では、時間の経過に伴って減価するデジタル通貨トークンを流通させることにより、能動的デブリ除去のコストを賄うことを提案する。このトークンは、能動的デブリ除去の証拠に基づいて、宇宙開発による利害に関係する組織群の連携から成るグローバルな共同体(コンソーシアム)により除去業者に向けて発行される。トークンはこのコンソーシアムの負債を表すが、デブリ除去の利益を享受する主体が受け取って使うまでの間の減価分が寄付として負債と相殺されることにより、トークンの流通を通してデブリ除去のコストが賄われる。この方法では、コンソーシアムは事実上何のコストも負わない。このコンセプトは PoD (Proof of Disposal; 除去証拠) 方式として一般化でき、株式になぞらえられる ICO (Initial Coin Offering) に代わり、社会課題をデジタル通貨設計によって解決に導くために広く適用できると考える。

We propose that the cost of ADR (Active Debris Removal) can be paid by circulating digital currency tokens whose values decrease over time. Such tokens are issued by global cooperation (a consortium) of parties interested in space development to parties who actually performed ADR, in exchange with proofs of removals. The tokens represent debts of the consortium, which is repaid through contributions by the token holders (as values of tokens decrease while holding them), who are likely to be benefited by removal of debris. This scheme imposes virtually no cost to the consortium. We have generalized this concept as PoD (Proof of Disposal), which, we believe, provides a more accountable foundation for solving social problems with digital currency than many ICO (Initial Coin Offering) in practice today.





# Proposal of an Economic Platform with a Digital Currency for Active Debris Removal

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Proposal of an Economic Platform with a Digital Currency for Active Debris Removal — 2018-12-04 — p.1/9



## Abstract

- We propose that the cost of ADR (Active Debris Removal) can be paid by circulating digital currency tokens whose values decrease over time
- Such tokens are issued by global cooperation (a consortium) of parties interested in space development to parties who actually performed ADR
  - In exchange with proofs of removals
  - The tokens represent debts of the consortium, which is repaid through contributions by the token holders
    - Because values of tokens decrease while holding them
  - This scheme imposes virtually no cost to the consortium
- We have generalized this concept as PoD (Proof of Disposal)
  - We believe it provides more accountable foundation for solving social problems than ICO (Initial Coin Offering) or crowdfunding

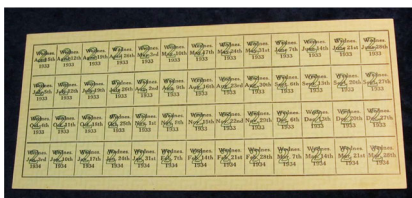
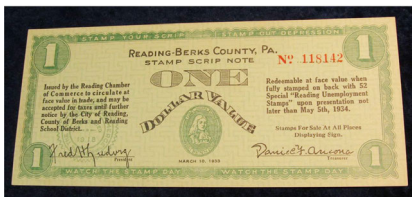
Proposal of an Economic Platform with a Digital Currency for Active Debris Removal — 2018-12-04 — p.2/9

## Problem and a Possible Solution

- For further development of space, it is mandatory for us to conduct ADR
- But building a sustainable economic model for ADR remains to be a difficult problem
  - Situation is analogous to “Tragedy of the Commons”
  - Where beneficiaries receive benefits, but the cost (or risk) is thinly diffused among everyone
- We see that a possible solution may be to design an economic medium, learning from history

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## How We Learn from History



- “Stamp Scrip” trials in 1930s in Wörgl, Austria, etc.
  - Great Depression era
- “Labor certificate” issued by local governments
  - Paid for public works
- Valid as long as stamped every week (or month) on back with “unemployment stamps” sold by the government
  - This is effectively **depreciating money**
  - Debt of the government is repaid by scrips themselves
- Contributed in recovering economy as they circulated rapidly
- Stopped after losing lawsuit by central bank (in case of Austria)
- Digitally feasible today

• <http://www.icollector.com/>

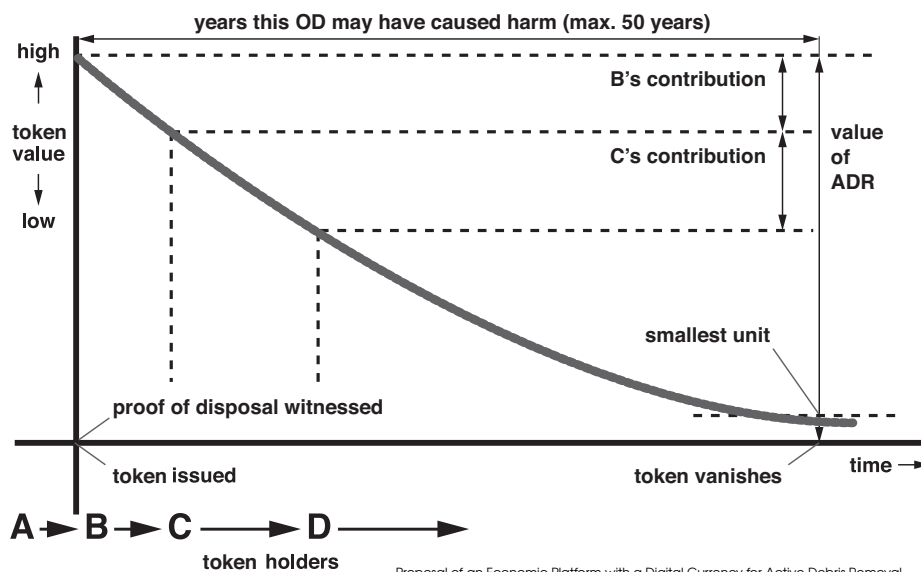
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## ADR Currency – Initial Token Value

- 1) For each OD, the consortium periodically publishes the probability of collisions and the estimated token value with its depreciation schedule
  - Token value represents the value of ADR
  - Estimation expires after a certain duration of time
  
- 2) A remover conducts an ADR, to which the consortium issues a token
  - The token is divisible and used as means for payment
  - Tokens represent debts of the consortium
  - (For the time being, a complete removal is assumed for the sake of discussion)
  
- 3) For each OD, the consortium recalculates the probability of collisions

Proposal of an Economic Platform with a Digital Currency for Active Debris Removal — 2018-12-04 – p.5/9

## ADR Currency – Depreciation



Proposal of an Economic Platform with a Digital Currency for Active Debris Removal — 2018-12-04 – p.6/9



## *Incentive Compatibility*

- For a given OD, the higher its probability of collisions is, the higher the initial token value would be when the ADR is performed
- The longer the duration of time the OD would cause harm, the more slowly the corresponding token would depreciate
- As a result, a remover would want to aim for removing an OD with higher probability of collisions that would stay for a longer time
- The incentive provided by the currency design is compatible with our intention to make future space development safer and easier

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## *For Further Information*

- Kenji Saito, Shinji Hatta and Toshiya Hanada, “Digital Currency Design for Sustainable Active Debris Removal in Space”
  - <https://arxiv.org/abs/1710.05141>
- Shows simulated prices of ADRs for intact objects in LEO
- Shows that dynamic estimation of the economic values of each ADR and automated pricing of tokens that represent the OD to be removed are possible
- Shows that monotonous decrease of highest initial token values as ADRs go on can be designed
  - Preferred for incentive reasons

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## Conclusions

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- Cost of removal of debris can be paid by circulating digital currency tokens
- This scheme (Proof of Disposal) is an accountable foundation for solving social problems with digital currencies
  - Could also be applicable to landmines, marine debris, CO<sub>2</sub>, etc.
- Simulation shows that applying this scheme to ADR is possible
  - Although further evaluation is needed
  
- An additional idea to think about :
  - For PMD (Post Mission Disposal), the same scheme can be used with deposits from launching parties
    - In exchange with the same amount of ADR currency tokens
    - Deposited amount is returned after a successful PMD