# Solmate Project Solution

**Since**: Wednesday, December 15, 2021
**Version**: 2

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1. **Problem**

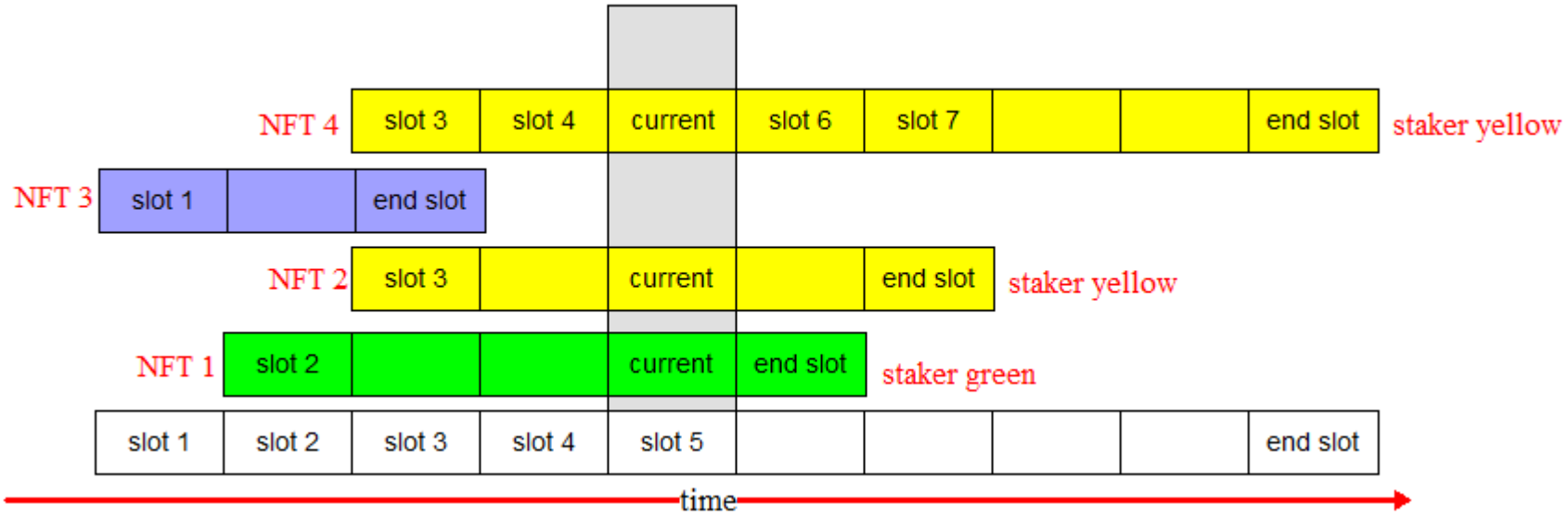
- Previously it's found that the follow algo can exaust comput unit very soon, just few stekd NFTs can exaust it.

  Loop through a slot gap

  Loop through (wallet, nfts) over BtreeMap

  Loop through nfts

2. **Model Deep Analysis**




As long as the reward calculation is based on $CIETY emission of per slot, the per slot caculation can't be avoided, is a MUST, no matter:

- Whether veNFT is used or not
- Whether a outside trigger is empoyed or not

As illustrated in the above diagram, on slot 5,

Staker Yellow contributes 2 cells
Staker Green contrubutes 1 cells
So,
Staker Yellow’s share is: 2/3
Staker Green’s share is: 1/3

Any share calculating mechanism is a variant of this.

## 3. Data Architecture

### 3.1. Data Model

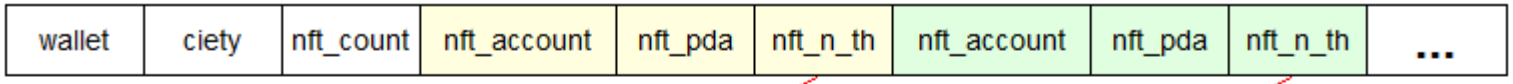



Figure 1 Per Wallet Data Model, denoted as pwdm

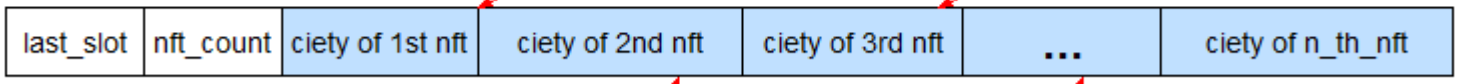



Figure 2 Global Ciety Data Model, denoted as gcdm

← fixed length, doesn't matter even 7000 NFTs all staked for 365 days assuming 10MB space limit →

| Slot # | Nft Count | Cells taken by whcih NFT | | | | |
|---|---|---|---|---|---|---|
| 0 | 3 | 1 | 2 | 3 | | |
| 1 | 4 | 8 | 9 | 11 | 15 | |
| ... | ... | | | | | |
| n | 5 | 30 | 2 | 28 | 9 | 11 |

Figure 3 Global Slots Data Model, denoted as gsdm

### 3.2. Data Size Evaluation in Worst Case

- Pwdm, wallet(32) + ciety(4) + nft_count(2) + (nft_account(32) + nft_pda(32) + nft_n_th(2)) * 7000 = 462038 bytes, each wallet has an account holding this
- Gcdm, last_slot(2) + nft_count(2) + ciety_of_nth_nft(4) * 7000 = 28004 bytes, globally only one account holding this
- Gsdm, 365 * (slot(2) + nft_count(2) + nft_nth(2) * 7000) = 5111460 bytes = 4992 kb, meaning all NFTs staked for 365 days, globally only one account holding this

## 4. Idea

We used to use to use hilgh capsulated data structure, like Vec and BtreeMap, actually it's not absolutely necessary given a fixed data volume.

DATA STRUCTURE WITH FIXED STRUCTURE AND SIZES ARE EXTREMELY EFFICIENT, we drop any high level collection struct, like Vec and BtreeMap, instead WE DO EVERYTHING ON RAW BYTES ARRAY DIRECTLY.

## 5. Algo Per Use Case

### 5.1. Stake

Input = a wallet + multiple NFTs

Given one time of staking, for each staked NFT:

- nft_nth = gcdm.get('nft_count') + 1, O(1)
- gcdm.set ('nft_count', nft_nth), O(1)
- pwdm.add( (nft_account, nft_pda, nft_nth) ), O(3)
- loop all slots taken by given NFT, O( number of slots * 2), 365*2 at most, assuming only one NFT can be staked at one time.
  - gsdm.get(slot).set('nft_count'), O(1)
  - gsdm.get(slot).appendOnSlot(nft_nth), O(1)

for example, if right after initialization there is an NFT staked which has a time length 30 days, then all data model will look like this:

| wallet | ciety | nft_count | nft_account | nft_pda | nft_n_th | nft_account | nft_pda | nft_n_th | ... |
|---|---|---|---|---|---|---|---|---|---|
| wallet 1 | 0 | 1 | addr | addr | 1 | | | | |

| last_slot | nft_count | ciety of 1st nft | ciety of 2nd nft | ciety of 3rd nft | ... | ciety of n_th_nft |
|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 0 | 0 | | 0 |

| Slot # | Nft Count | Cells taken by whcih NFT | | | | |
|---|---|---|---|---|---|---|
| 0 | 1 | 1 | | | | |
| 1 | 1 | 1 | | | | |
| ... | ... | | | | | |
| 29 | 1 | 1 | | | | |

If this staker staked another NFT for 60 days after 10 days, the data models will look like this:

| wallet | ciety | nft_count | nft_account | nft_pda | nft_n_th | nft_account | nft_pda | nft_n_th | ... |
|---|---|---|---|---|---|---|---|---|---|
| wallet 1 | 0 | 2 | addr | addr | 1 | addr | addr | 2 | |

| last_slot | nft_count | ciety of 1st nft | ciety of 2nd nft | ciety of 3rd nft | ... | ciety of n_th_nft |
|---|---|---|---|---|---|---|
| 0 | 2 | 0 | 0 | 0 | | 0 |

| Slot # | Nft Count | Cells taken by whcih NFT | | | | |
|---|---|---|---|---|---|---|
| 0 | 1 | 1 | | | | |
| 1 | 1 | 1 | | | | |
| ... | ... | | | | | |
| 9 | 2 | 1 | 2 | | | |
| 10 | 1 | 2 | | | | |
| 11 | 1 | 2 | | | | |
| ... | | | | | | |
| 69 | 1 | 2 | | | | |
| | | | | | | |

### 5.2. View Reward

Input = a wallet

- Curr_slot = clac_curr_slot(now), O(1)
- Last_slot = gcdm.get('last_slot')

- For slot in [curr_slot, last_slot], worst case O((last_slot – curr_slot)*7000)
    For nft_nth in [0, gsdm.nft_count)
        Shere = 1/gsdm.nft_count
        Accumulate gcdm.ciety on nft_th
- Update gcdm.last_slot
- Calculate total rewards of a staker, for i in [0, pwdm.nft_count), O(pwdm.nft_count * 2)
    - total_ciety = total_ciety + gcdm.getCiety(nft_th)
    - pwdm.set('ciety', total_ciety)

## 6. Tests

### 6.1. Case I

- Right after initialization, a staker can stake 21 NFTs for 365 days.
- Only update gsdm, not include any other operations, like escrowing etc
- Remaining compute units are 3501

There MUST be a limit to how many NFTs a staker can stake at one time.

This updates 365 * (2 + 2 + 21*2) = 16790 bytes in 2 levels of nested loops, the time complexity is O(16790).
This big improvement conviced me it may be feasible with the idea of DO EVERYTHING ON RAW BYTES ARRAY DIRECTLY.

### 6.2. Case II

With gsdm, imagine a trigger call the calculation of reward everyday, the worst case is that the slot of calculating day has 7000 NFTs.
This will update 2 + 2 + 7000*2 = 14004 bytes, O(14004) < O(16790), so it's reasonable that there is no worries of exausting the limited compute units given we have this trigger even in the worst case.
But this doesn't include updating gcdm.ciety 7000 times and update N wallets' ciety.

But if we don’t employ a trigger, then there is a balance between slots_gap and num_nfts:
slots_gap * (2 + 2 + num_nfts*2) <=16790

Test I is a simulation of staking though, in case of viewing rewards, algorithmically it’s similar, just writing byets becomes reading bytes, so it’s reasonable in this way to estimate the situation of the case of viewing rewarding.

**In the following estimating resutls based on the above inequality:**

- **slots_gap means how often rewards are viewed by stakers.**
- **num_nfts means an average number of NFTs staked on the slots of a gap**
- **All possible balanced combination are (NOTE: within a gap, on each its slot, it all has num_nfts NFTs):**

slots_gap= 1 num_nfts= 7000
slots_gap= 2 num_nfts= 4196
slots_gap= 3 num_nfts= 2797
slots_gap= 4 num_nfts= 2097
slots_gap= 5 num_nfts= 1678
slots_gap= 6 num_nfts= 1398
slots_gap= 7 num_nfts= 1198
slots_gap= 8 num_nfts= 1048
slots_gap= 9 num_nfts= 931
slots_gap= 10 num_nfts= 838
slots_gap= 11 num_nfts= 762
slots_gap= 12 num_nfts= 698
slots_gap= 13 num_nfts= 644
slots_gap= 14 num_nfts= 598
slots_gap= 15 num_nfts= 558
slots_gap= 16 num_nfts= 523

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## 7. Analysis & Conclusion

- Basically it's safe to have trigger, But this doesn't include updating gcdm.ciety 7000 times and update N wallets' ciety.
- Don't call other functions, due to taking stake frame is not free.
- If we have a trigger, we have to let host_wallet own accounts of all stakers about staking info, host_wallet is the only payer for calcualiting rewards.
- Once a compute unit overflow occurs, no one can see his rewards and unstakes.
- Solution B: modify contracts and wirte a special client to calculate rewards by stages from last slot down to current slot.