charon - a privacy enabled cross-chain amm

https://github.com/themandalore/charon

Charon is a privacy enabled cross-chain automated market maker (PECCAMM). It achieves privacy by breaking the link between deposits on one chain and withdrawals on another. Charon works by having AMMs on multiple chains, with one of the assets on each AMM being charon USD(CHUSD), a free-floating dollar targeted token created by deposits on an alternate chain and then a withdrawal via a zero-knowledge proof[i]. To achieve this cross-chain functionality, charon utilizes an oracle to pass commitments (proof of deposits) between chains.

design

Charon can be broken down into three parts:

- an automated market maker (AMM) structure allowing deposits to other chains
- a bridge which passes deposit commitments to other chains
- a mixer structure that mints CHUSD on the destination chain

the charon AMM

The AMM structure used by charon is similar to uniswap[ii] or balancer[iii] in that it is a standard two token AMM with single side withdrawals / LP deposits on the CHUSD side. The tokens traded are defined as a "base" token (e.g., native chain asset) and then charon USD, a newly minted token created by privacy-enabled deposits from another chain. CHUSD is a synthetic asset that represents the deposit on the other chain. CHUSD is burned when a trade happens on the AMM for the base asset (CHUSD is burned rather than added to the pool). The only way to add CHUSD to the pool is to LP directly with CHUSD (single side LP). Since deposits are denominated in USD terms (based on the current AMM price), the newly minted CHUSD should roughly track the dollar, with spreads built in for oracle variability and time constraints due to the lock time of the bridging process.

the bridge

Charon utilizes an oracle to get information about other chains. Either a native oracle (e.g. the Polygon data bridge[iv]) or another decentralized oracle structure (e.g. tellor[v]) can be used to pass deposit information from one chain to another. The oracle mechanism is a key point in security as the oracle alone can deposit valid commitments to mint CHUSD on the destination chain.

the mixer

Charon achieves mixer functionality due to the anonymous nature of withdrawals on alternate chains. This is similar to a standard mixer (e.g. tornado cash[vi]), where a user deposits on one address but withdraws with another. The unique aspect of charon is that deposits are made on one chain (commitment generated using destination chain logic (the destination chain is part of the secret)), the commitment is passed to many chains, and then the withdrawal happens on the destination chains. Since the commitment is passed to many chains, assuming other deposits and commitments, anonymity is achieved since there is no way to prove which chain is the destination or which withdrawal on the destination chain corresponds to a given deposit.

asset pricing across chains

In order to allow deposits of multiple different currencies on multiple different chains, the AMM itself is used to price the dollar amount of the deposit (e.g. $1000 USD of ETH). This allows the withdrawal on the destination chain to simply mint $1000 CHUSD regardless of which currency the deposit came in the form of (e.g. $1000 deposit of ETH on Ethereum or $1000 deposit of MATIC will result in the same withdrawal of $1000 CHUSD on Optimism (assuming these chains are in the system)). Arbitrage across chains should force the price of CHUSD to be even on each chain, and if set up properly, should act as a stable medium of exchange across the assets in the system. Due to the long delay between deposit and withdrawal however, parties should be incentivized to keep reserves of CHUSD and/or leave open withdrawals for quick arbitrage should prices diverge. This arbitrage incentive will help further increase liquidity and anonymity of the system.

flow

There are three sets of users for the charon system: LP's, bridge/mixer users, and traders. The flow for each user is as follows:

bridge/mixer usage

- deposit on chain1 with commitment (created for withdraw on chain3)
- oracle passes commitment to chain2, chain3, chain4 (if anonymity desired)
- user waits to add anonymity then withdraws CHUSD on chain3 using a proof
- The CHUSD is then traded as a market order on the chain3 AMM

trader

- same as user, however, will likely not focus or wait for anonymity
- the arbitrage trader will likely sit in the "to withdraw stage" if incentivized but will hold CHUSD if not.

LP base asset (e.g. chain1 base asset (e.g. ETH))

- first user acquires equal amounts of base asset and CHUSD (via an exchange or cross-chain deposit)
- deposit chain1 base asset and CHUSD for pool tokens
- withdraw both assets at pair rate when finished

LP CHUSD (e.g. on chain2)

- deposit on chain1 with commitment (created for withdraw on chain2)
- oracle passes commitment to chain2, chain3, chain4 (if anonymity desired)
- user waits to add anonymity then withdraws CHUSD on chain2 using a proof
- CHUSD are deposited in single side LP on the chain2 AMM

circuit and cryptographic function constructions

The cryptographic functions for off-chain use are implemented in the circomlib[vii] library. Much of the mixer structure and solidity implantation of the Merkle Trees are taken from tornado cash, specifically Poseidon-tornado[viii], a fork with a more efficient hashing algorithm. The Solidity implementation of the Poseidon hasher is created by Iden3[ix]. The SNARK keypair and the Solidity verifier code are generated by the authors using SnarkJS, a tool also made by Iden3.

further considerations

oracle methodology

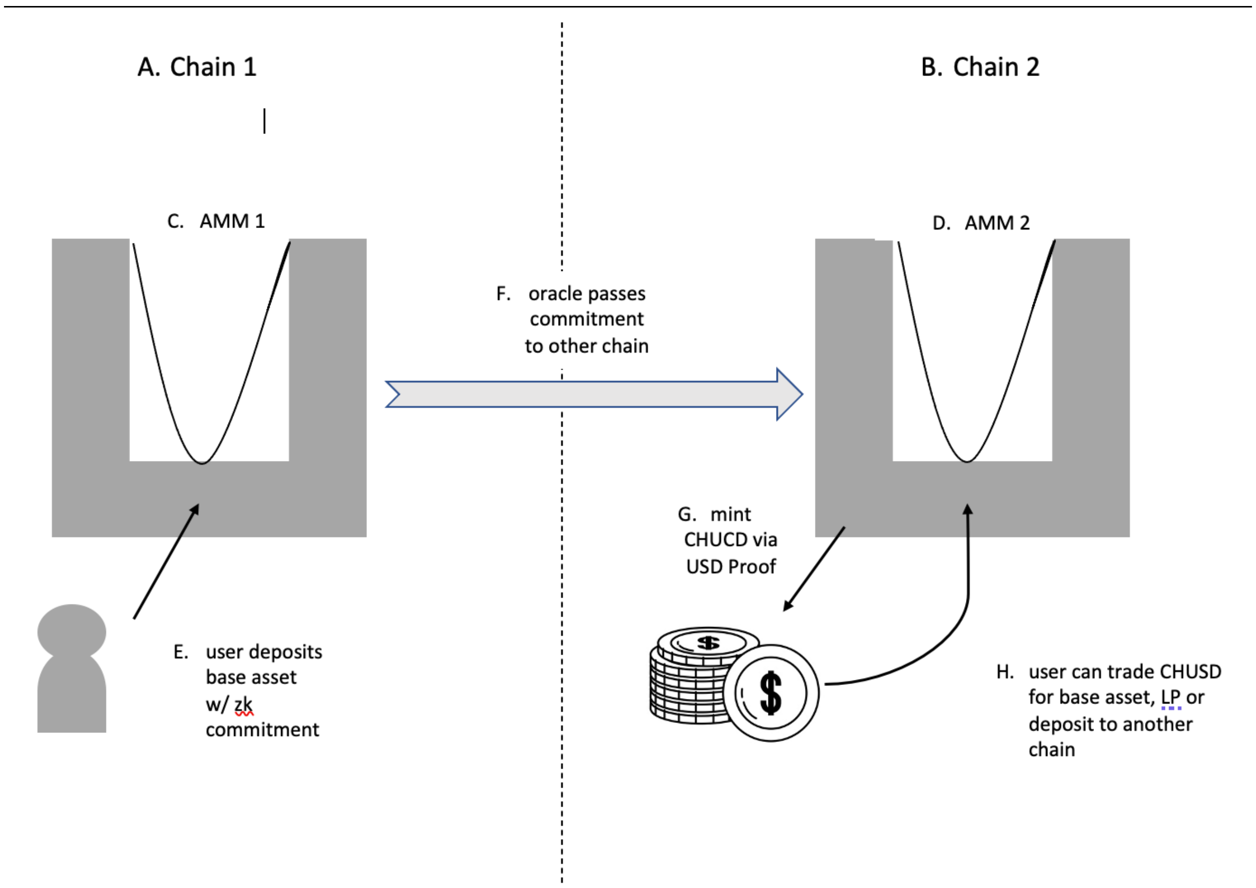
The security of the system relies completely on the oracle mechanism. If the oracle mechanism was broken, false deposits could be created, and the pool could be drained. Due to the potential regulatory issues of charon, the oracle must also be completely trustless and censorship resistant. For this reason, and other aspects, systems such as native data bridges or Tellor will be used as the trustless bridge. For the specific implementation, the use of longer delays for validation can be used to create a safer system. Another benefit of a long delay is that users could see that Tellor (or another oracle) is being attacked, and then can dispute the malicious value to protect the charon deposits. In the worst-case scenario that the oracle is completely compromised (their dispute voting mechanism is overtaken, the delay also enables users a window to withdraw all LP funds, leaving the party with nothing.

liquidity / anonymity set incentives

Many AMM and anonymity systems utilize token incentives or large investors to bootstrap liquidity and/or privacy deposits (commitments not withdrawn). Since charon has no investors, an initial token could be used to bootstrap liquidity via a yield farming[x] campaign or similar mint-to-LP and/or depositor scheme. It is optimal to have no token, however creating these incentives will be important for the successful launch of the protocol and are being considered along with other initialization mechanisms.

---

[i] zero-knowledge proof - https://en.wikipedia.org/wiki/Zero-knowledge_proof
[ii] uniswap - https://uniswap.org/
[iii] balancer - https://github.com/balancer-labs/balancer-core
[iv] polygon data bridge - https://docs.polygon.technology/docs/pos/state-sync/state-sync/
[v] tellor – www.tellor.io
[vi] tornado cash - https://github.com/tornadocash
[vii] circomlib - https://github.com/iden3/circomlib
[viii] poseidon-torndao - https://github.com/ChihChengLiang/poseidon-tornado
[ix] iden3 - https://github.com/iden3
[x] yield farming - https://blockworks.co/what-is-yield-farming-what-you-need-to-know


A. Chain 1
B. Chain 2
C. AMM 1
D. AMM 2
F. oracle passes commitment to other chain
G. mint CHUCD via USD Proof
E. user deposits base asset w/ zk commitment
H. user can trade CHUSD for base asset, LP or deposit to another chain