THE RESILIENCE PROTOCOL

A DISTRIBUTION MECHANISM TO CREATE RESILIENT TRANSACTION NETWORKS

Digital transaction technologies make possible new distribution schemes that allow continous flow of liquidity through all participants.

The following is a description of one of such schemes. Inspired in Johan Nygren's resilience protocol, which is based on the weakening of transactional links.

I. Transactional links

With a few diagrams, let's see how they'll work for this protocol:

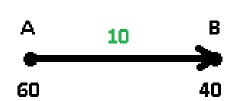
Say there are two accounts A and B with initial balances 70 and 30 respectively:

Then say there's a transaction from A to B of 30:

Thus a transactional directional link is created between A and B for the transaction's value (Green). System's balance is still 100: A: 40 + B: 60 = 100. Only now, there's a link that would allow to return to the initial state.

If A makes again a transaction to B the link is reinforced. Say A sends 20 to B again:

Then say that B makes a transaction back to A of 40, weakening the link:



And then, a transaction from B to A of 30, changing the direction of the link:

Here, the link can be cleared if A sends 20 to B:

<u>II. Value Tranfer Mechanisms</u>

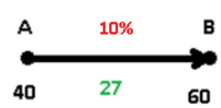
The network supports its participants by distributing voluntarily added fees. These modify the value of transactional links. First, when a transaction is made, either by over- or under-registering the deducted amount from the sender's balance. This determines the direction of value transfer within the network. And secondly when distributions are made, by weakening links as backtracking transactions that try to clear them.

Forward value transfer (FVT): deducted amount link fee underregister

First let's see how the mechanism of value transfer works within the network:

Say A sends B 30 at 10%, underregistering the deducted amount 33 as 30 in the link:

The added fee (3) at an auxiliary B's account B' will be later <u>distributed backwards</u> through the link, weakening it:



Note that if the direct backwards transaction were followed to clear the link, it wouldn't return to the inital state:

Hence, an account's balance is not the difference of incomming vs. outgoing links since there is the value of fees floating about. It's instead calculated from incoming base transactions and outgoing complete transactions, which aren't exactly represented by the links. Instead, links can be can be used to calculate what would be the account's 'value for the network' given by:

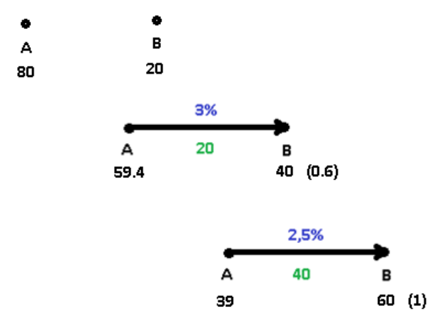
$$V = B + B' + oL - iL$$

Where B = 'account's balance' and B' ='account's auxiliary', oL = 'outgoing links', iL = 'incoming links'. Thus, V would be the balance of the account if all transactional links of the network were followed back to 0 and all auxiliaries emptied.

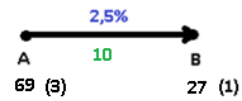
Accounts should only receive into their balances from distributions when B < V and V > 0, this would mean the network would try to support each participant up to its value to the network, in other words, the network will try to make B equal to V for each participant.

New transactions with different rates alter the sender's link rate by pondering [new rate of link = (previous link value * previous link rate + new transaction's value * new transaction's rate) / sum of previous link value and new transaction's value].

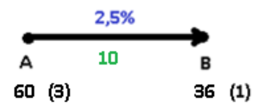
Withholding distributions for this next example, say A makes a transaction of 20 to B at 3%, and a second transaction of 20 to B at 2%:



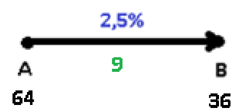
Unless it changes direction, backwards transactions don't alter the link's rate. Say B makes a transaction of 30 at 10% to A:



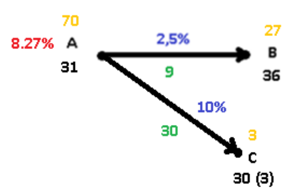
Transactions without added fee (rate 0%) <u>should not be registered in links</u>, this transfers the amount and its complete V. A transaction from A to B of 9 at 0% would be:



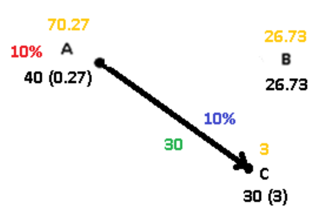
However, **distribution transactions** are registered transactions of rate 0% in links, hence these don't transfer V. Clearing the distributions in this case, dB'A (1) and dA'A (3): (A' and B' are auxiliary accounts for the fees)



Each account has a rate it makes transactions set by its user, but may also have a **public rate** (PR) calculated by pondering the rate of its links PR = Sum(link value *link rate)/Sum(link value). (note: Initial PR is the same as the rate set by user). Say A makes a transaction to C of 30 at 10%:



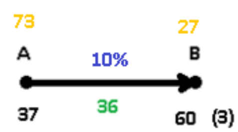
V of each account is displayed in yellow. Let's review the forward value transfer mechanism, say B sends 9 to A at 3% clearing the link. Warning: Clearing links splits the network.



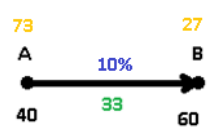
Value transfer direction and amount can be independent of the base transaction's direction and amount. Many different features can be designed around this:

Backwards value transfer (BVT): Deducted amount link fee overregister

Let's have A send 30 at 10%, this time overregistering the fee to the deducted amount from A 33:



Checking V for each account, the value transfer can be seen going backwards. Hence, this kind of transaction should be consented by the receiver, its maximum rate should be receiver's public rate, and should be made from accounts with less V than the receiver. Distributing backwards we have:



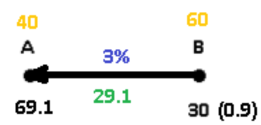
Again, notice that distributions don't transfer value, but contribute to making B = V when B < V

<u>With both FVT and BVT networks should be designed to transfer value to the party with less value in the transaction, aiming at averaging values across the network</u> (recommended).

Direct value transfer (DVT):

So far, it can be seen that value is transferred when links are registered such that backtracking won't take to the initial state. This means, creating links between sender and receiver that don't alter balances in the same proportion transfers network value. Starting from:

Is possible to make transactions that only transfer network value. Say A sends 30V to B:

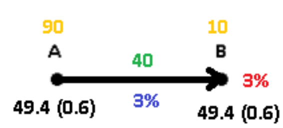


Since this kind of transaction could change receiver's public rate, the mínimum rate for these kind of transactions should be of the receiver's public rate. The appeal of this kind of transaction for the receiver would be again, that the network would try to make B = V with its endemic activity.

It's also possible to make mixed forward-direct transactions, the design of this feature is open to developer.

Swap balance-value :

Another interesting transfer that could be made between two parties is the direct exchange of balance to value or viceversa. Say A exchanges 20 from its balance for 20 of B's V:

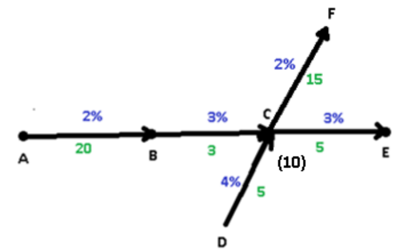


The cost of this Exchange should lie on each participant into the opposite's auxiliary and should be of the bigger rate between both PRs. Note that this operation doesn't require a 1:1 ratio on Exchange, this feature is open to developer.

A network could be designed for all accounts to only make forward value transfer transactions. There could be different kinds of participants within the network, some allowed to only make forward value transfer, or only make direct value transfer, etc.

III. Distribution Mechanism

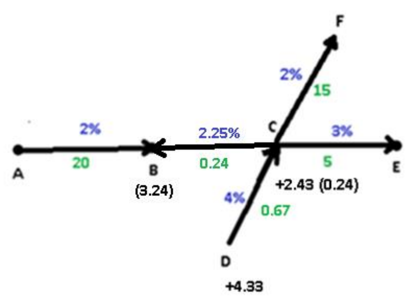
The added fees are accumulated in auxiliary accounts, and then distributions are made when the number of transactions to the auxiliary accounts are the same number of incoming links+1. These are made towards incoming links' auxiliaries and self balance by pondering links' rates and public rate of distributing account. Say this is the third transaction that C's auxiliary account receives and has accumulated up to 10:



Since C's public rate is 2.25 = (2*15+3*5)/(15+5). Distribution is made as follows:

- C receives 2.43 = 10 * (2.25/(2.25+3+4))
- B' receives 3.24 = 10 * (3/(2.25+3+4))
- D' receives 4.33 = 10 * (4/(2.25+3+4))

Note that D' meets the distribution condition so D' distributes to D. All cascading distributions have to be cleared before a new transaction is made. This distribution also weakens DC link and changes BC link's direction, inheriting C's public rate:



A feature open to developer's design would be self-distribution, taking a part of the amount to distribute directly into the balance of distribution emmiter.