DATABASE AND API FOR PAYMENT CARD ISSUING

PAYMENT SCHEMES AND MESSAGING

The payment card industry consists of five principal players. At the center is the Scheme such as MasterCard or Visa. The Scheme the infrastructure that connects other participants and sets the rules for the interactions between the participants. Principal participants are the Issuers and Acquirers. An Issuer, such as a bank, solicits individual Cardholders. An Acquirer, usually also a bank, solicits Merchants.

A payment card Scheme is attractive to Cardholders due to ability of spending funds electronically (with or without an a credit line provided by the Issuer) at Merchant locations; and vice versa, for merchants to receive funds electronically (with customers' whose spending power may be amplified by a credit line). The flow of funds orchestrated by a Scheme illustrates the business model of the participants. Assume a Cardholder does a purchase of 100.00 EUR at a Merchant location. The Issuer (in the case of a debit card) deducts 100.00 EUR from the customer's bank account. The Issuer, however, is only obliged to send 100.00 EUR minus "interchange" to the Scheme. With 1% interchange, the issuer sends 99.00 EUR to the Scheme, booking 1.00 EUR as profit. The Scheme will forward 99.00 EUR to the Acquirer servicing the Merchant. In order to extract revenue, the Acquirer will deduct "merchant discount" from the funds it settles to the Merchant. With 2% merchant discount, the Merchant will receive 98.00 EUR (even though the Cardholder purchased goods worth 100.00 EUR). Acquirer will book 1.00 EUR as its revenue. Separately, both the Issuer and the Acquirer will pay various fees to the Scheme.

It is crucial to note that no money as such moves in the Scheme. What the Scheme manages is messaging about money and the monetary obligations of Issuers and Acquirers towards each other as intermediated by the Scheme. Each purchase facilitated by the Scheme consists of two messages. First, an "authorisation" is executed to reserve funds, and second, a "presentment" is used to capture reserved funds. When a Cardholder uses a card at a Merchant location, the Merchant's point of sale terminal sends an authorisation message to the Acquirer who forwards it to the right Scheme (e.g. MasterCard or Visa). The Scheme routes the authorisation to the correct Issuer of the Cardholder. The Issuer will do a number of checks including availability of funds in the Cardholder's account. If the checks pass, a positive ack is sent back via the Scheme to the Acquirer who confirms to the Merchant's terminal that the payment is to proceed. The Issuer may also decline an authorisation. If the payment is approved, the Issuer will reserve funds on the Cardholder's account to cover the amount of the authorisation.

Separately to the authorisation, the Merchant needs to use a presentment message to capture the payments. Usually authorisation and presentment are done within the same day. In some scenarios the time between authorisation and presentment, however, may be a number of days. For example, a Merchant operating a car rental agency might authorise a very large amount when the car is rented, and then present when the car is returned (presentment amount may differ from, but not exceed, the authorised amount). A presentment message is sent through the Scheme to the Issuer in the same manner as an

authorisation. When the Issuer receives a presentment, funds are deducted from the Cardholder's account and the earlier reservation cancelled.

After the end of a day, the Scheme will perform a process called "clearing". Effectively, the Scheme calculates the net balances of each Issuer and Acquirer, i.e. how much (based on the presentments) Issuers need to pay the Scheme and how much the Scheme needs to pay the Acquirers. Bank transfers are used to transfer the funds in bul between the Scheme, Issuers and Acquirers, in a process called "settlement" (i.e. settling the obligations incurred between participants due to the card payments that are represented by the presentment messages). Note that if authorisation happens on day T, then presentment will only come through earliest on T+1. A number of parameters, such as exchange rates, are only indicative on authorisations, and are final with presentments. Between e.g. T and T+1 exchange rates may differ.

OPERATING AS AN ISSUER

Assume that you are a fintech company, acting as an Issuer, with Cardholders as customers. You operate payment accounts for your customers and issue debit cards that draw funds from your customers' payment accounts. You issue the debit cards as a member of an international payment card Scheme.

The Scheme operates a modern infrastructure. Whenever your Cardholders use their cards at a Merchant, the Scheme sends you a webhook with JSON data. Appendix A contains examples for "authorisation" and "presentment" webhooks. An authorisation requires a 200 (OK) response if you, as the Issuer, approve of the payment. Declining a payment should result in a 403 (Forbidden) response.

As a fintech company, you hold all your customer's money at a partner bank. As you're just starting out, you have two customers. Each has 500.00 EUR on their payment accounts (your liabilities, i.e. what you owe to your customers), and you hold 1000.00 EUR at the partner bank (your assets, i.e. the cash that matches what you owe to the customers).

When your Cardholders use their cards, the following happens:

1. On day T, authorisations messages come in to a HTTP API endpoint as JSON data.
2. For each authorisation, you'll verify that the Cardholder has enough funds on their account.
3. If enough funds exist, you'll reserve an amount indicated in the authorisation, and send a positive ack. If there's not sufficient funds, negative ack is returned.
4. On T+1, presentment messages come in over the same API.
5. For each presentment, you'll deduct the funds from the Cardholder's account. You'll account the deducted funds as your debt to the Scheme.
6. At the end of T+1, you run a batch process to settle presented payments to the Scheme. The bulk payment is sent from money you hold at the partner bank. You'll account this as a deduction of money at the partner bank. Note that the debt to the Scheme is also reduced.

7. Any interchange revenue indicated by the difference of billable amount and settlement amount, you'll account as your revenue, i.e. the money is not sent to the Scheme.

In addition to the API for receiving calls from the Scheme, you have two internal APIs: one for transactions of a Cardholder and another for balances of Cardholder accounts. The API for transactions allows querying transactions for a Cardholder for a specific timeframe. Note that only transactions that have been presented are returned, authorised transactions are not. The balances API allows querying the balance of a Cardholder's account at a specific point in time. Note that there's two balances available. A "ledger balance" contains all presented transactions, an "available balance" includes also authorisations that have not yet been presented. All authorisations are verified against the available balances.

For your implementation, you have a base database schema for accounting, consisting of Accounts (holds monetary value in some currency), Transfers (representing a debit or credit on an account) and Transactions (bundles a number of transfers to represent movement of value between accounts). You may have maximum two extra database tables, but this is optional.

Your stack consists of Django REST Framework for the APIs and simple Django management command for the batch process that does settlement and accounting interchange revenue. Money can be loaded to a customer's account with a "load_money <cardholder> <amount> <currency>" management command.

The accounting equation must always hold, i.e. for each Transaction, the total debits equal the total credits of Transfers.

APPENDIX A

The Cardholder has been issued a card in EUR. On a trip to Los Angeles, the Cardholder, on day T, purchases a pair of Air Jordan sneakers. The sneakers cost 100.00 USD and on T, the USD:EUR exchange rate is 0.90. On T, the Issuer receives an authorisation. On T+1, a presentment comes through to the Issuer. Meanwhile, USD has appreciated relative to EUR such that the exchange rate is 0.91. The settlement by the Issuer to the Scheme is as per the presentment (T+1) exchange rate. Interchange is set at 0.50%.

```
{
  "type": "authorisation",
  "card_id": "4321LOBO",
  "transaction_id": "1234ZORRO",
  "merchant_name": "SNEAKERS R US",
  "merchant_country": "US",
  "merchant_mcc": "5139",
  "billing_amount": "90.00",
  "billing_currency": "EUR",
  "transaction_amount": "100.00",
  "transaction_currency": "USD"
}
{
  "type": "presentment",
  "card_id": "4321LOBO",
  "transaction_id": "4321ZORRO",
  "merchant_name": "SNEAKERS R US",
  "merchant_city": "LOS ANGELES",
  "merchant_country": "US",
  "merchant_mcc": "5139",
  "billing_amount": "91.00",
  "billing_currency": "EUR",
  "transaction_amount": "100.00",
  "transaction_currency": "USD",
  "settlement_amount": "90.50",
  "settlement_currency: "EUR"
}
```

(Note the quotes in the above JSON!)