Payments Engineering

Lessons Learned in Writing Software for Payments

- What is payments engineering?
  - Overview
  - What's a payment (system) ?
  - Credit Cards
- Problem Solving in Payments Software
  - Reconciliation and auditing
  - Double charges
  - Testing and observability
- Q&A

What is Payments Engineering?

Building software in the problem domain of payments. Working with or building payment systems.

- Understanding real payment systems
- Complex state management
- Security and privacy
- Precision, correctness
- Auditability, reconciliation
- Fault tolerant
- Expensive mistakes

What's a Payment Anyway?

Payment: "A transfer of value between a sender and a receiver, denominated in some currency."[1]

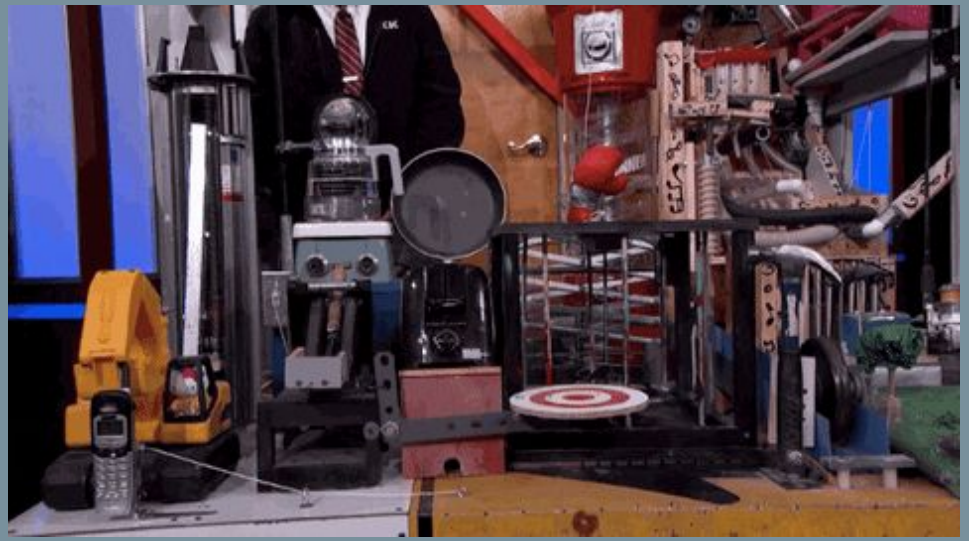
[1] C. C. Benson, S. Loftesness, and R. Jones, Payments Systems in the U.S.: A Guide for the Payments Professional. 2017.

What's a Payment (System) Anyway?

Payment System: "Connects senders and receivers, and provides framework for transfering value." [1]

Some examples:

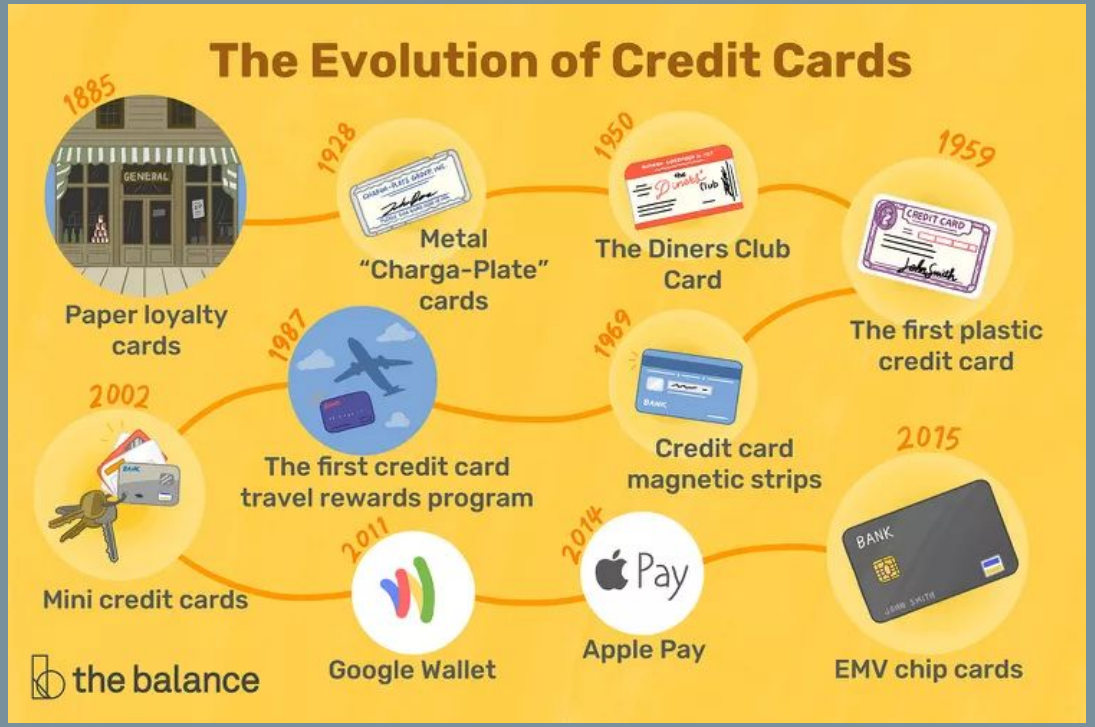
- Credit Cards: Visa, Mastercard
- Bank transfers - ACH, wires
- Cash
- Digital currencies



[1] C. C. Benson, S. Loftesness, and R. Jones, Payments Systems in the U.S.: A Guide for the Payments Professional. 2017.

Credit Cards

- Pretty old idea
- Modern cards still modeled on processes that pre-date computers



https://www.thebalancemoney.com/history-of-credit-cards-4766953

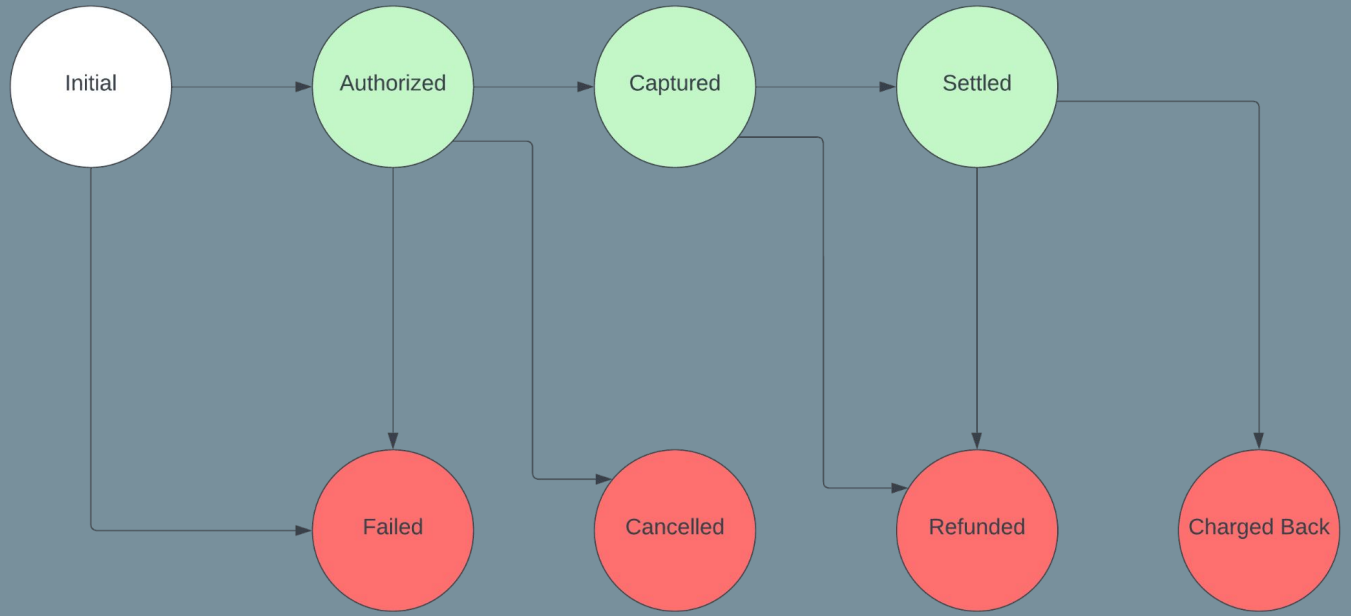
Credit Cards

https://www.bbc.com/news/business-39870485

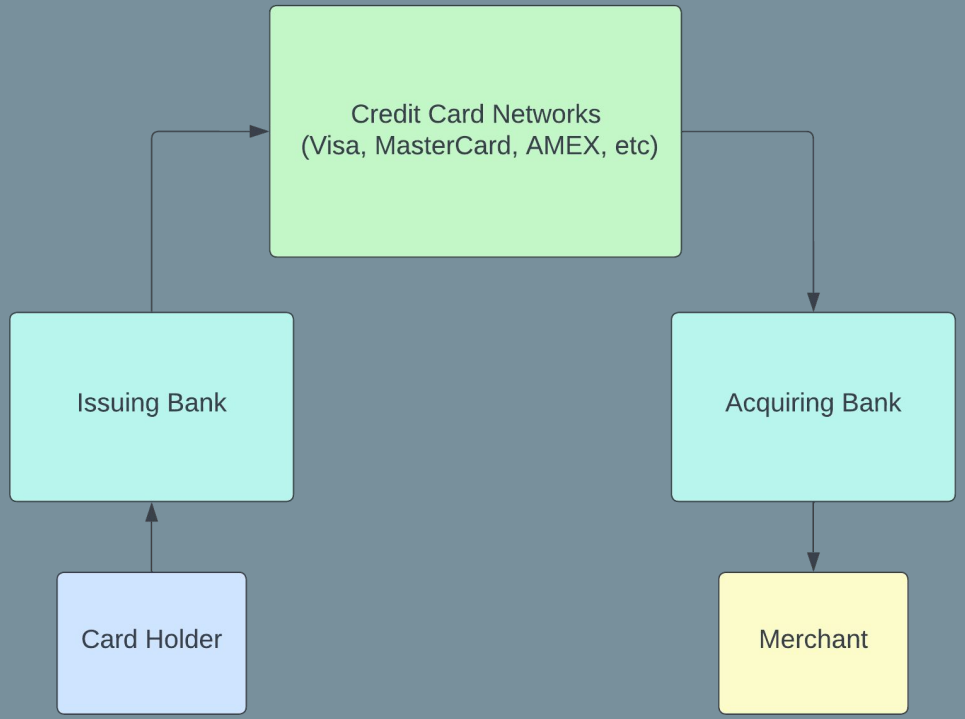
Credit Cards

https://www.nytimes.com/wirecutter/blog/your-mesopotamian-credit-card/

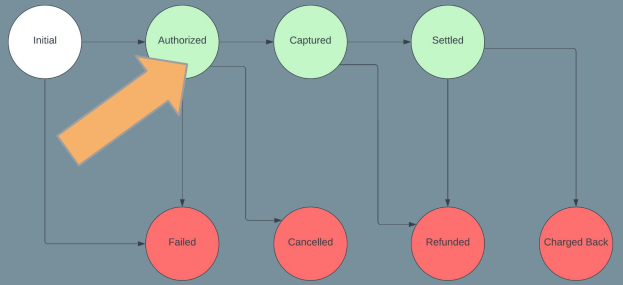
Credit Cards: a Beautiful State Machine



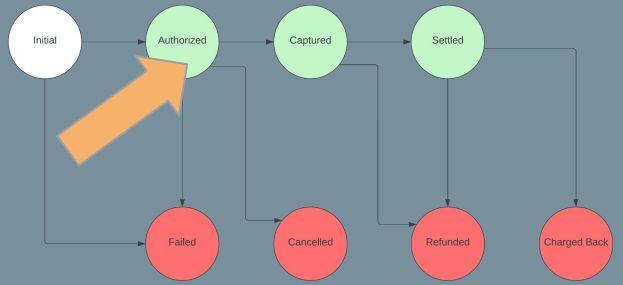
Credit Cards: Parties Involved



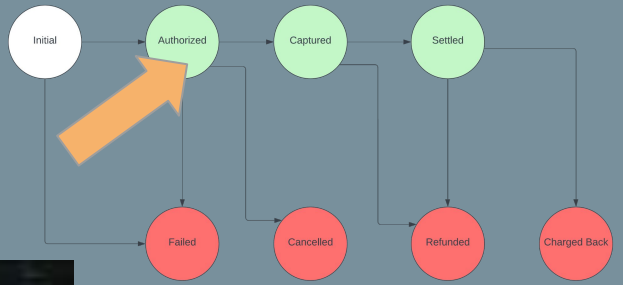
Credit Cards: Authorize



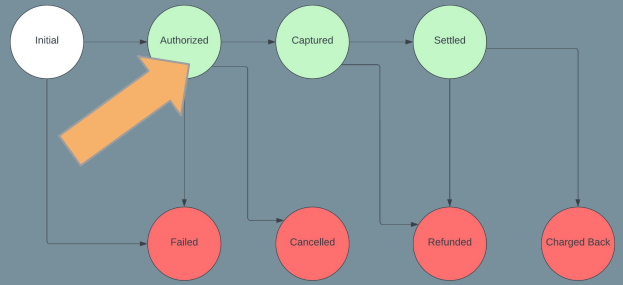
Credit Cards: Authorize



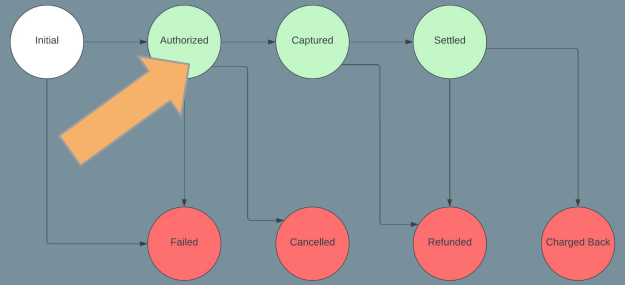
Credit Cards: Authorize



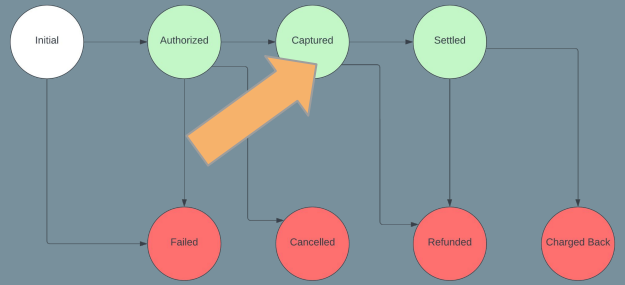
Credit Cards: Authorize



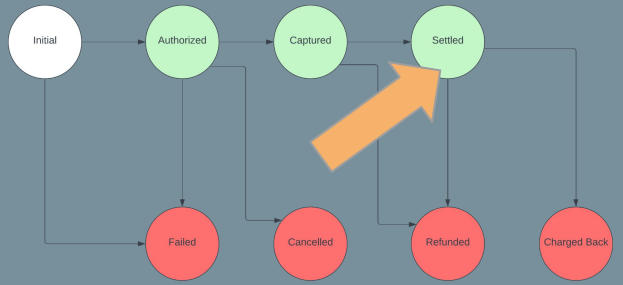
Credit Cards: Authorize



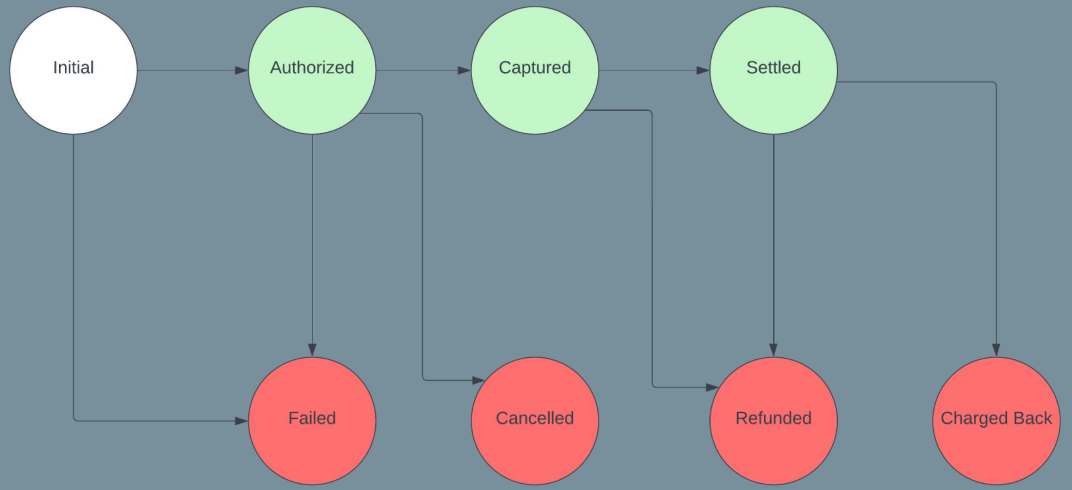
Credit Cards: Capture



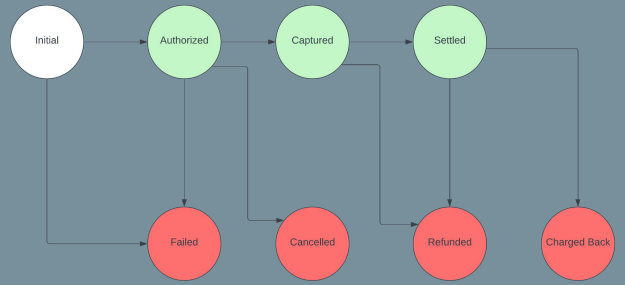
Credit Cards: Settlement



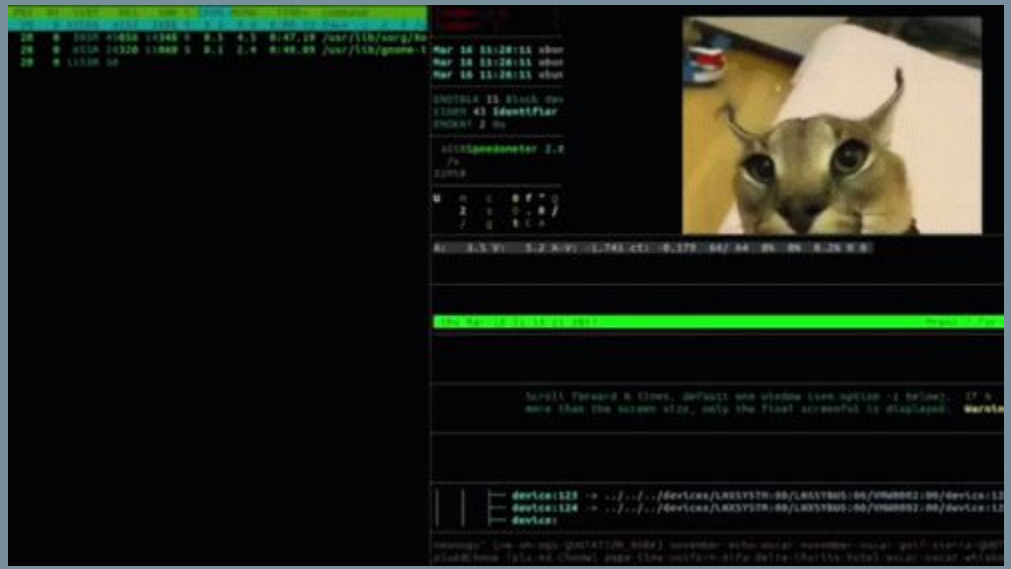
Credit Cards: Unhappy path(s)



Credit Cards: Unhappy path(s)

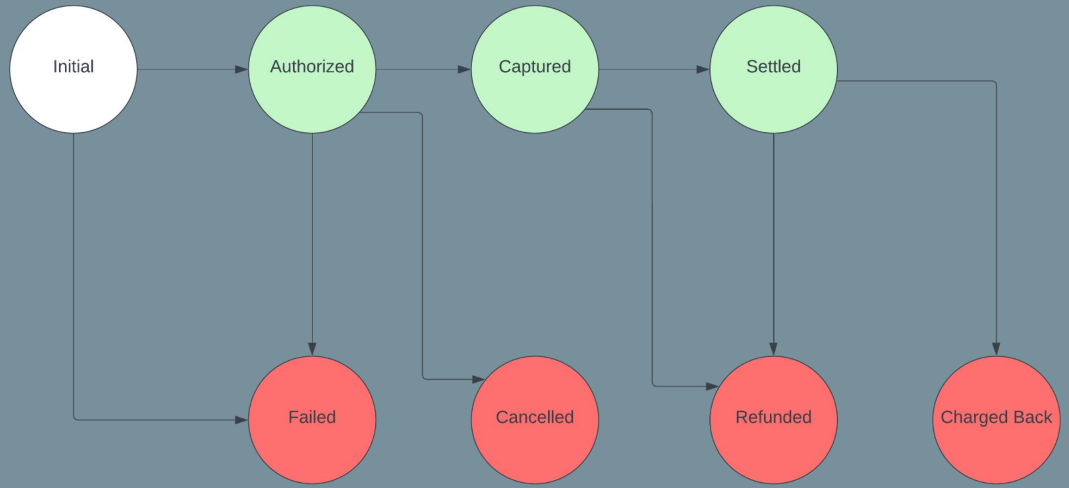


Problem Solving in Payment Software



Modeling Payments

- Long, complex life cycles
- Things happen at a point in time



Problem: Reconciliation and auditing

- How much money did we make in February?

id	date	amount	status
1001	2024-02-01	$100.00	settled
1002	2024-02-03	$20.00	settled
1003	2024-02-04	$300.00	settled
1004	2024-02-05	$150.00	settled
1005	2024-02-07	$10.00	settled

Problem: Reconciliation and auditing

- How much money did we make in February?

id	date	amount	status
1001	2024-02-01	$100.00	settled
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1003	2024-02-04	$300.00	settled
1004	2024-02-05	-$150.00	refunded
1005	2024-02-07	-$10.00	charged back

Problem: Reconciliation and auditing

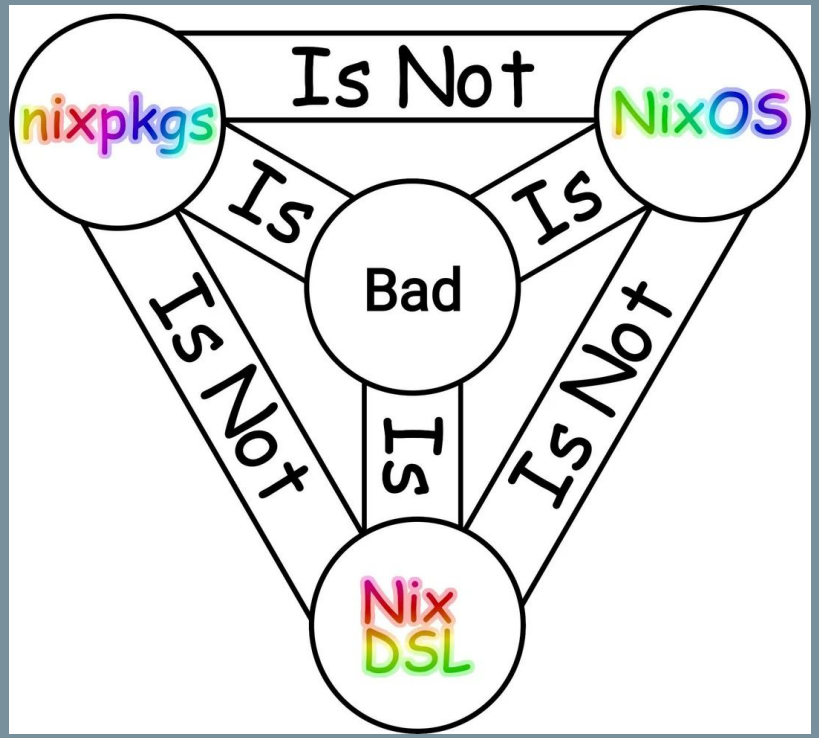
- Things happen at a point in time. Record facts.

id	date	amount	status
1001	2024-02-01	$100.00	settled
1002	2024-02-03	$20.00	settled
1003	2024-02-04	-$300.00	refunded
1004	2024-02-05	-$150.00	charged back
1005	2024-02-07	$10.00	settled

Solution: Immutable architecture

- Git
- Ledgers
- Kafka

Solution: Immutable architecture



ty https://xeiaso.net

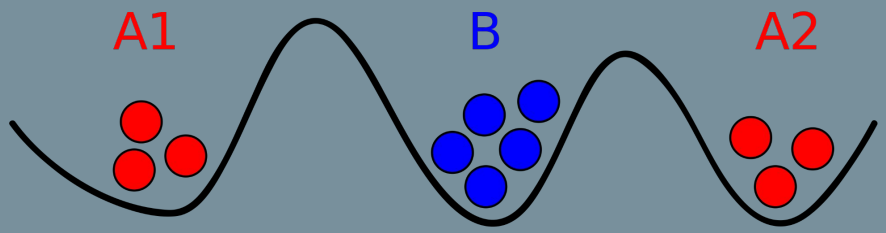
https://www.reddit.com/r/linuxmemes/comments/17n0nzb/the_holy_trinity

Problem: Avoiding double charges

- “Don’t click twice”
- “Something went wrong”

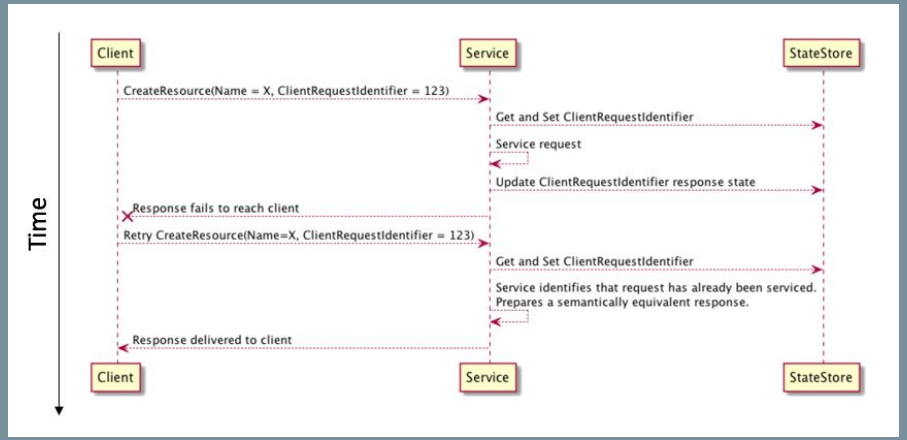
The Network is Unreliable

- Problems w/ distributed systems
  - “Fallacies of Distributed Computing (L Peter Deutsch, James Gosling ~ 1996)
- 99% - 99.9% success rate?



Solution: Idempotency

- POST Once Exactly (POE) IETF 2005
- Idempotency Keys (Stripe, AWS, etc)



https://aws.amazon.com/builders-library/making-retries-safe-with-idempotent-APIs/

Idempotency Keys

hash(user_id, order_id, amount) ->

fade33ef5120fdd0da8c44cc7cfd0bb21a5974272112d2aff410ceaf0445187a

OR

uuid4() -> ab1eaf28-e0f1-11ee-93cd-2f34b72080a7

Idempotency Keys

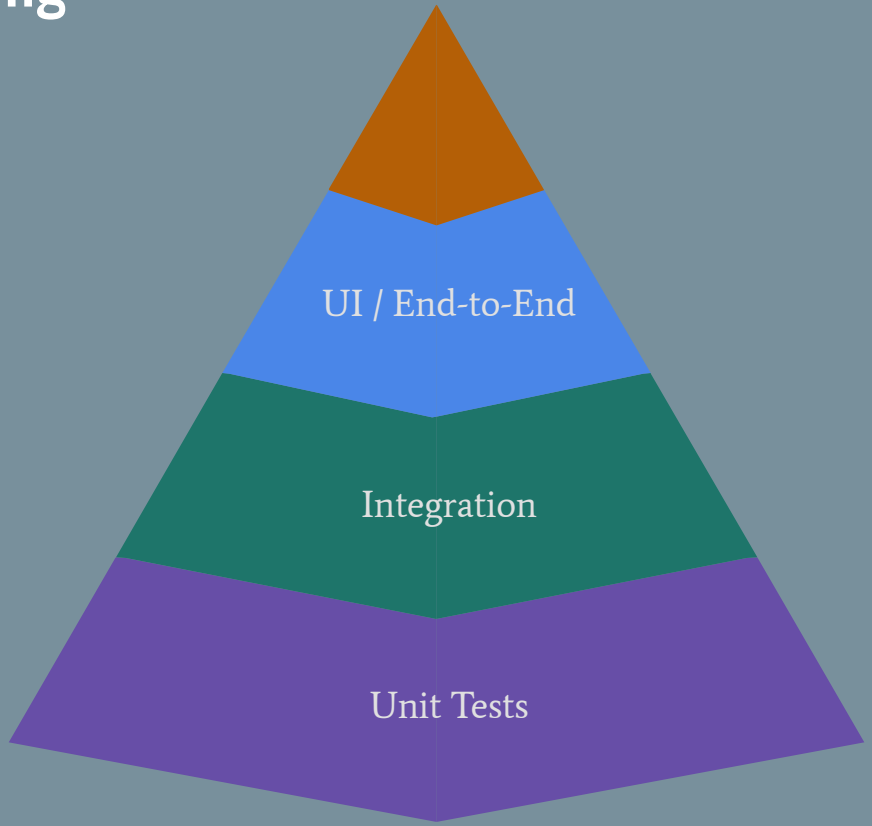
```
curl https://api.stripe.com/v1/charges \
    -u sk_test_BQokikJOvBiI2HlWgH4olfQ2: \
    -H "Idempotency-Key: AGJ6FJMkGQIpHUTX" \
    -d amount=2000 \
    -d currency=usd \
    -d description="Charge for Brandur" \
    -d customer=cus_A8Z5MHwQS7jUmZ
```

https://stripe.com/blog/idempotency

Click to your Heart's Content

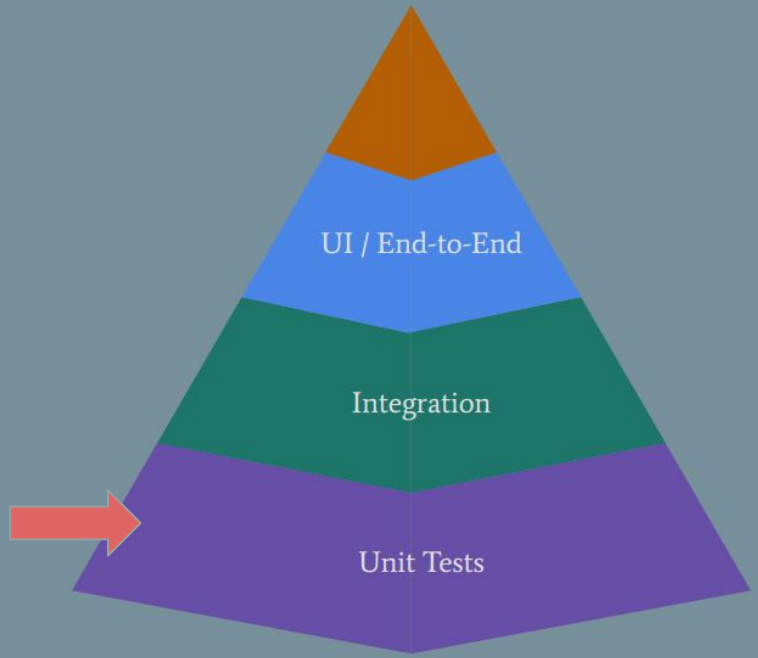
Fundamentals - Testing

Your code will get tested,
one way or another.



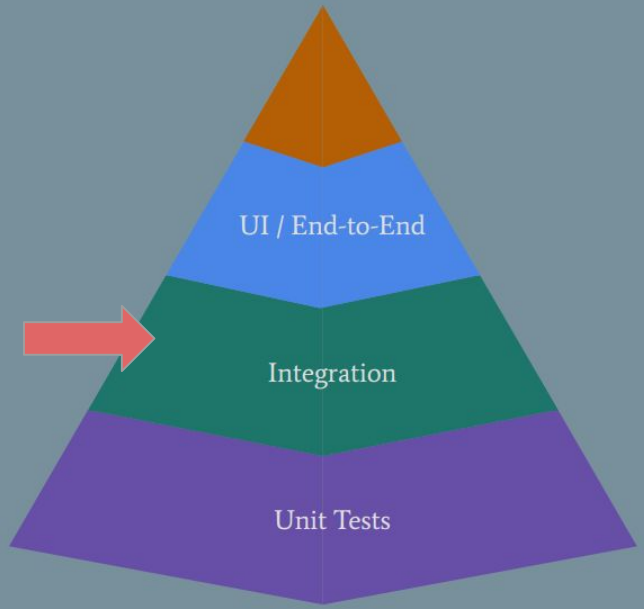
Unit Tests

- Fast (seconds)
- Isolated
- Mocks and Stubs
- Domain/Business Logic



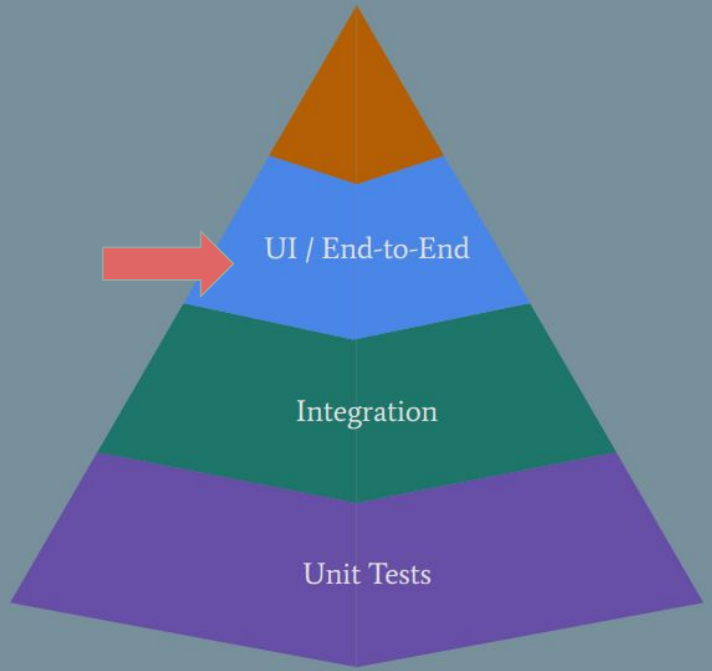
Integration Tests

- Slower than unit tests but should still be fast
- Test multiple components working together
- Possibly from real infra



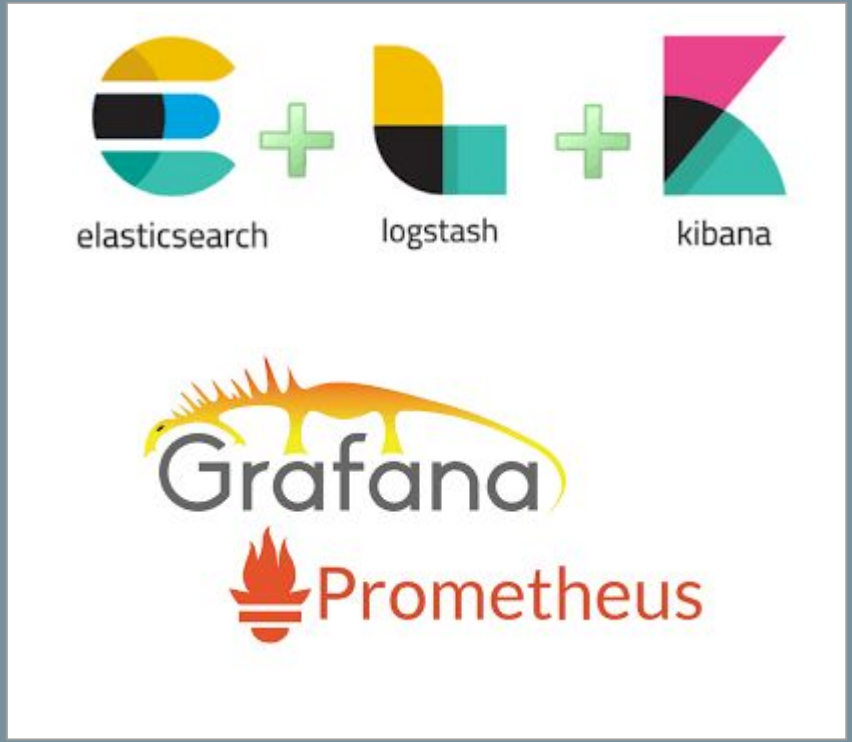
UI / End-to-End

- Slower, sometimes fragile
- Real calls against staging environments
- Go through entire “flows”



Fundamentals - Logging and monitoring

- Log enough to be useful
- Avoid logging entire objects
- Understand your key metrics



Q&A