Who & what
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Event Sourcing architecture
How did we get here?
How do we use it
Experiences
Wrapping up

Event Sourcing at Studyflow.nl

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Who am I

- Joost Diepenmaat
- Last 5 years have been focused on Clojure
- Technical lead @ studyflow.nl
- @ZeekatSoftware

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Studyflow

- http://www.studyflow.nl
- Secondary education platform
- Currently providing math courses for over 100 schools

What's in the talk

- What is Event Sourcing
- How we implemented it with Rill
- Our experiences
- Rill implementation details are secondary
    - Maybe for another talk
    - Source code for core library is public

Event sourcing as a concept

- CQRS: writes have different needs from reads (queries)
- Domain Events as system of record / source of truth
- Event Store: append only event streams, read in chronological order

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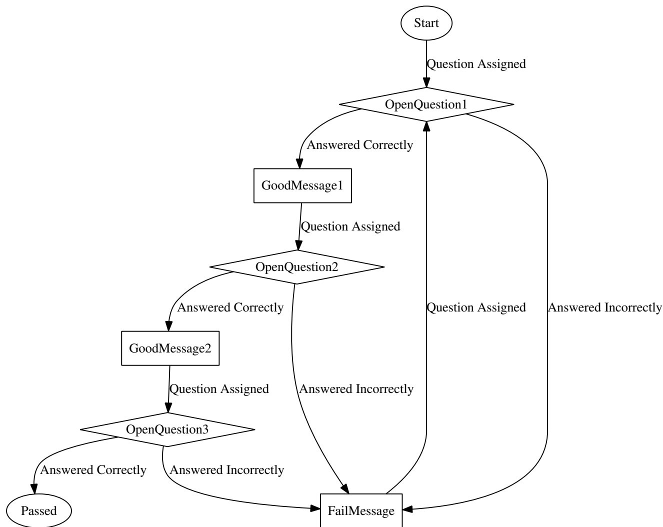
Example: Quiz

- You get assigned a random question
- If you answer correctly, you get shown a message and you can go to the next question
- If you provide a wrong answer, get shown a message and you have to start over
- If you answer 3 questions in a row correctly, you pass

Quiz flow chart



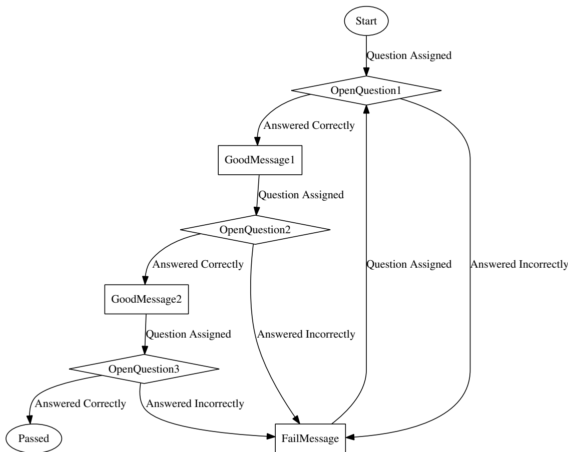
The CRUD strawman

```
{:user-id 1
 :question-id 23
 :answer-state :correct ; or nil or :incorrect
 :question-number 2}
```

What did we lose there?

- Timing: when did user 1 try to answer questions?
- Which questions did user 1 answer?
- How many times did user 1 make a mistake?
- Which mistakes?
- Which questions in our database are difficult?
- What kind of mistakes do users make answering question 45?
- Maybe more stuff *that we will think up in a few months*

Back to the flow chart



What if we store all of these transitions?

Example Domain Event

```
{:rill.message/type
 :quiz/QuestionAnsweredCorrectly,
 :rill.message/timestamp
 #inst "2015-02-11T11:46:55.014-00:00",
 :rill.message/id
 #uuid "276de24f-d7df-478c-a82a-fd97c24a7232",
 :answer "My Answer",
 :question-id 442,
 :user-id 23}
```

Domain Events

- From Domain Driven Design (DDD)
- Record of a thing that *did happen*
- Has *meaning* in the domain
- Records *intent* of change
- Does not change or disappear
- Past tense

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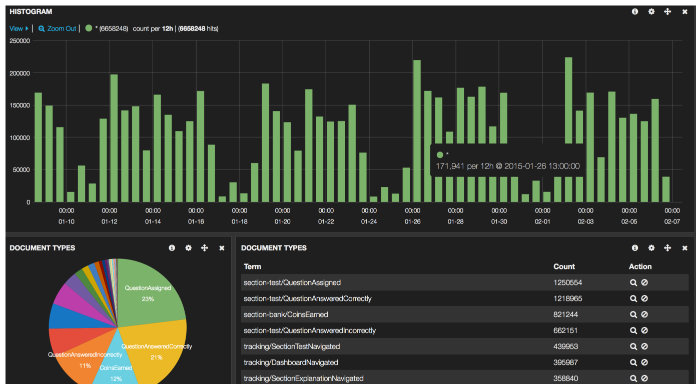
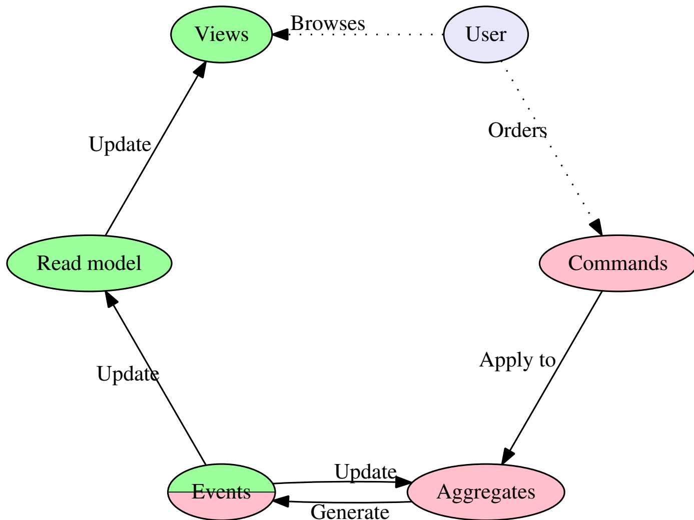
Our service



- Used by about 25000 students
- Answering 1.2 million questions a month
- Over 5 million domain events per month

Outline



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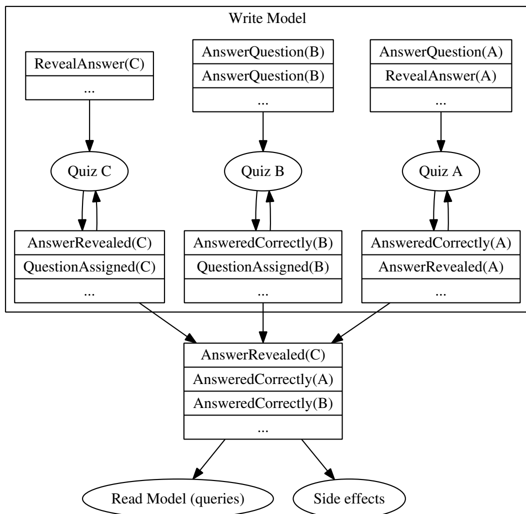
Event sourcing mechanics

- The *write side* state is composed of aggregates
- Commands apply to aggregates to generate events
- Events apply to aggregates to update state
- The *read model* is generated/updated asynchronously from published events

Commands & Events

- Commands either succeed and generate events, or they fail
- Events cannnot fail since you cannot change the past
- Commands are requests, so imperative: "AnswerQuestion!"
- Events are in the past tense: "QuestionAnsweredCorrectly"

Data flow



Why do we use Event Sourcing?

ES architecture matches our core use cases

- track student actions & intents; quite a lot of writes
- potentially complicated reporting
- naturally maps to "real time" event reporting

Advantages

- Simple concepts
- Easily scalable
- One way flow of information
- Queueing, Retrying, Conflict handling..

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Core ideas match Clojure's / FP pretty well

- Immutability
- Aggregates as reductions
- Events & Commands are data
- Append-only data store

Technologies we currently use

Clojure web app (ring, hiccup etc)

- Authentication system
- Administration & Teacher front end

Om / Reagent

- Student applications

Ruby on Rails

- Publication & content editing service

Hooked together using event streams

Rill Event Sourcing

- Clojure Event Sourcing toolkit/library
- Developed in house
- EPL license
- Using Postgres as the durable store
- Event Store uses subset of the geteventstore.com functionality
- `https://github.com/rill-event-sourcing/`

Rill Concepts

- Aggregates are reductions of event streams

```
(ns rill.aggregate
  (:require [rill.message :as message]))

(defmulti handle-event
  "Take an event and return the new
state of the aggregate"
  (fn [aggregate event]
    (message/type event)))

(defn update-aggregate
  [aggregate events]
  (reduce handle-event aggregate events))
```

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Messages are data

- Commands and events are maps
- Prismatic's Schema for validation & documentation

Example definition

```
(defevent QuestionAnsweredIncorrectly
  :course-id m/Id
  :chapter-id m/Id
  :student-id m/Id
  :question-id m/Id
  :inputs {m/FieldName s/Str}
  chapter-quiz-id)
```

Example event

```
{:rill.message/number 2,
 :rill.message/timestamp
 #inst "2015-02-10T15:19:39.827-00:00",
 :rill.message/id
 #uuid "6f3d10d6-0aac-4ecc-b8c1-a6c297e10c6b",
 :rill.message/type
 :chapter-quiz/QuestionAnsweredIncorrectly,
 :inputs {"_INPUT_1_" "2",
          "_INPUT_2_" "0"},
 :question-id
 #uuid "24f80676-6d1c-4a31-906b-533878270a9b",
 :student-id
 #uuid "2b45e104-821e-4f73-aa15-a5109267214c",
 :chapter-id
 #uuid "1e8d8c4b-0581-4400-bd7d-a66d0500621e"}
```

Handling async/eventual consistency

Show user the effect of *their* actions *now*

- Other user's effect may be propagated slowly
- Command execution returns generated events/number

Standard web pages

- Execute command, redirect to view
- View blocks (refreshes) until event/number is seen

ClojureScript apps

- Execute command, return generated events
- Temporarily refresh global app state

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ClojureScript frontend

- Domain Events are a nice synchronization medium
- SPAs need to deal with eventual consistency
- ClojureScript works nice enough
- Move part of the read-model / querying to the client
- Keep command handling on the server

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- What works well
- What needs attention

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Testing is straightforward

- It's all data!
- Use in-memory store for command and integration tests
- Use plain events for unit testing read-side

Testing commands example

```
(def initial [fixture/course-published-event
              (events/started chapter-id student-id)
              (events/question-assigned
               chapter-id student-id question-id)])
(def expected [(events/question-answered-correctly
                chapter-id student-id question-id
                inputs)
               (events/question-assigned
                chapter-id student-id question-2-id)])
(def command (chapter-quiz/submit-answer!
              course-id chapter-id student-id
              question-id 1 inputs))

(is (command-result= [:ok expected]
                     (execute command initial)))
```

Server performance is great

- Average $<$ 15 ms response time for our busiest application
- Slowest write $<$ 30 ms
- Slowest read $<$ 100 ms (can be improved)

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Write logic is constrained

- The system of record and its state is relatively easy to understand
- Things that do go wrong tend to stand out
- Determining aggregate roots is important

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You can trust an append-only event stream

- You almost never need to modify written events
- Bugs in the read side of the system have less impact on the write side
- Since you track what's going on you can recover better from bugs
- It's really hard to lose data
- Data-pollution tends to come from runaway processes generating too many events

Multiple views of the same aggregate

- Command view
- Query views
- Front end view for stateful clients

Some of this can possibly be made easier/automated
Some of this is inherent to the CQRS split

- commands need few narrow, shallow aggregates
- queries and views want wide and deep data

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Building & adjusting read models

- We use in-memory (non-durable) read models for everything
- Usually straightforward to implement
- Boring & easy to make mistakes (which events apply to this view?)
- Makes deployment slow

Partial performance fixes:

- Sharding & Filtering
- Caching / durable read model

Recommended references

- `http://docs.geteventstore.com/`
- "Event Sourcing Pattern" on MSDN
- "Domain Driven Design" E. Evans
- "Implementing Domain-Driven Design" V. Vernon
- "Patterns of Enterprise Application Architecture" M. Fowler et. al.

Contact

Rill `https://github.com/rill-event-sourcing/`

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We love to talk to you if you're interested in using Rill!

Thanks!

Davide Taviani, Gijs Stuurman, Remco van t Veer, Steven Thonus & Edo van Royen.