Practical Experience Building a Modern Trading System (Crystal) with Rust & MongoDB

Outline

1. What is Crystal?
2. Architecture/Technology Choices
3. Live Coding Example (Product Management w. Atlas)
4. Future Plans

What is Crystal?

Crystal is a platform for Sales & Trading to allow seamless workflows, scalable pricing/risk calculations and low latency execution.

This presentation will focus on Crystal's workflow capabilities in the Securitization Market.

Brief Background on Securitization Trading

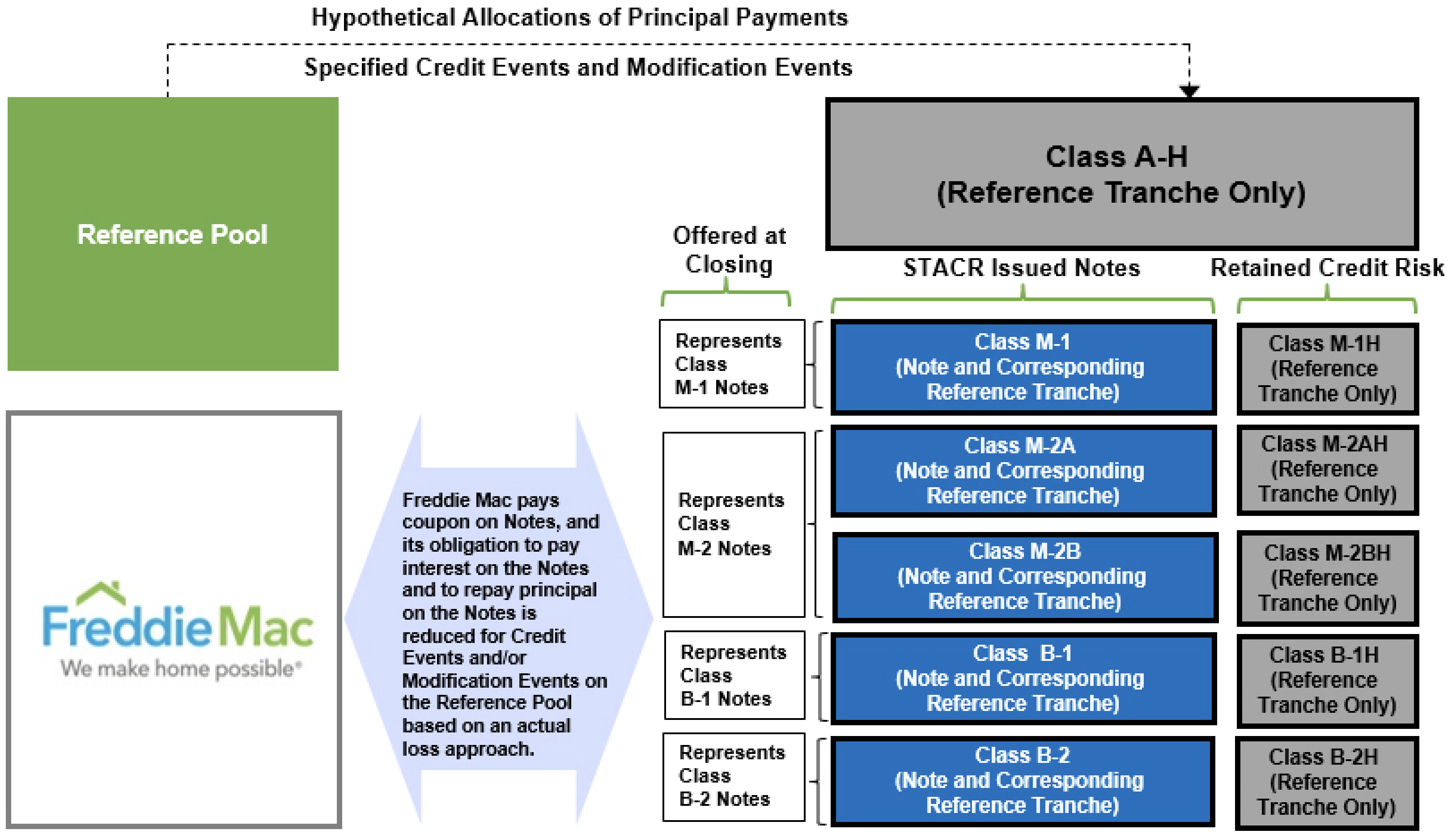
- When you take a series of assets (like mortgages for example) and package them you are securitizing them. For example:

Asset	Size($k)
Mortgage 1	52
Mortgage 2	140
Mortgage 3	30
Mortgage 4	225
Mortgage ...	
Mortgage 5,000	126
Total	1,000,000

After Securitization Becomes...

Liability	**Size($mm)**
Security A	500
Security B	350
Security C1	50
Security C2	50
Security R	60
Total	1,010

An actual example:


Hypothetical Allocations of Principal Payments
Specified Credit Events and Modification Events
Reference Pool
Freddie Mac
We make home possible
Freddie Mac pays coupon on Notes, and its obligation to pay interest on the Notes and to repay principal on the Notes is reduced for Credit Events and/or Modification Events on the Reference Pool based on an actual loss approach.
Class A-H (Reference Tranche Only)
Offered at Closing
STACR Issued Notes
Retained Credit Risk
Represents Class M-1 Notes
Class M-1 (Note and Corresponding Reference Tranche)
Class M-1H (Reference Tranche Only)
Represents Class M-2 Notes
Class M-2A (Note and Corresponding Reference Tranche)
Class M-2AH (Reference Tranche Only)
Class M-2B (Note and Corresponding Reference Tranche)
Class M-2BH (Reference Tranche Only)
Represents Class B-1 Notes
Class B-1 (Note and Corresponding Reference Tranche)
Class B-1H (Reference Tranche Only)
Represents Class B-2 Notes
Class B-2 (Note and Corresponding Reference Tranche)
Class B-2H (Reference Tranche Only)

Freddie Mac may sell a portion of their retained vertical slice, but has agreed to maintain ownership of at least 5% of the M-1 and M-1H, M-2A and M-2AH, M-2B and M-2BH and B-1 and B-1H Reference Tranches and intends to maintain ownership of at least 75% of the B-2 and B-2H Reference Tranches

After these securities are created they trade via:

1. Voice/email Auction: using an informal auction run by the seller called a Bid Wanted in Competition (BWIC). For example:

Id	Security Name	Of	Cf
A9484	Security A	500	140
B8374	Security D	200	30
A9023	Security C	325	325
A1739	Security Z	50	45

2. Private or Semi-Private B2B Trading: Email, Voice or Chat is the main mechanism

Together, these are called Over The Counter (OTC) trading because it is not on an exchange.

BWIC Workflow

Step #	Step	Today	Crystal v1
1	Client Sends BWIC to 1-40 Dealers	Email	Email
2	Trader anonymized and Forwards to Sales	Email	Crystal
3	Sales forwards to their client	Email	Email
4	Trader Analyzes securities (asset history, interest rate scenarios, yield targets, etc...)	Spreadsheets/SQL	Crystal
5	Trader Adds Price Talk	Email	Crystal
6	Sales collected client feedback	Spreadsheet	Crystal
7	Trader Adds Final Bid	Spreadsheet	Crystal
8	Trader sends bids to seller	email	email

Architecture/Technology Choices

- System Requirements
    - Performance
        - "Chat" <75ms response time
        - Analysis of 5mm assets x ~500 columns of data x 30 years of monthly history = ~15TB
        - Real time pivot (<75ms) of 2mm assets x 1 month = ~16GB
        - parallel stream upload of data from our clients
    - Customization
        - Clients specify the metadata for assets
    - Safety
        - Small startup
        - No room for bugs
    - Cost
        - need the flexibility to hire consultants for particular features and release them immediately

- MVP Architecture
  - Meteor (Node/Mongo|Galaxy/Atlas)
  - *from zero lines of code to production in 6 weeks*
- Crystal v1
  - How do we scale to the data requirements listed above?
  - we were confident mongo could scale, but what about the node server?

Non-scientific comparison

Requirement	OCaml	Haskell	TypeScript	C++	Go	Rust
Extreme Speed	n	n	n	y	?	y
Easy to Learn	n	n	y	y	y	y
Extreme Safety	y	y	n	n	n	y

Rust is the first language I've worked with where I am totally relaxed when I write code.

- **Ownership:** The ownership model ensures minimum resource usage
- **Types:** Ultra strict typing ensures the vast majority of errors are caught at compile time

Other benefits:

- **Result/?:** easier to use than Try/Catch -- simple to pass types for specific errors
- **Option:** an absolute dream to work with. better than null or it's equivalents
- **Linking to other libraries:** cargo has all the modern package maintenance features. coming from a c++ background thinks like `csv = { git = "https://github.com/BurntSushi/rust-csv.git", rev = "d0642c500b7ea4b4e19d45aa19f10743063a3f57" }` are amazing.
- **Tests:** Test are trivial to add as they are built into the language.
- **.unwrap():** it is easy to filter for these and prevent them from getting into production code (forcing the developer to handle all cases unless it is just a test script)
- **functional style:** can easily manipulate data structures w/o loops

```
let product_id_fieldnames: Vec<&String> = product_metadata_map
        .product_id_fieldnames()
        .into_iter()
        .filter(|x|product_headers_map.contains_key(*x))
        .collect();
```

- **serde:** brilliant, fast, type safe parsing library
- **documentation:** docs.rs is spectacular for helping you find the package you need
- **Rust is Rust:** other languages drop into c or asm to achieve speed. nearly all of is written in
- **const:** let is const by default

Things I try to avoid:

- **Arc's:** Not understanding how these worked caused a significant memory leak
- **bleeding edge libraries:** I initially tried (despite it being a prototype) using mongodb-labs/mongo-rust-driver-prototype. It worked perfectly on windows and mac, but when we went to production on linux it was 40x slower!
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Coding Example

Notes:

- https://github.com/adam-p/markdown-here/wiki/Markdown-Cheatsheet