

SCALABLE AND RELIABLE VIDEO TRANSCODING IN HASKELL

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Haskell Exchange 2015

Full story at: <http://goo.gl/qkKwKm>



```
launchMissile :: IO ()
```

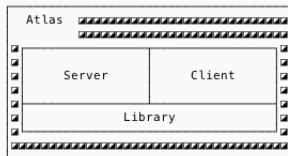
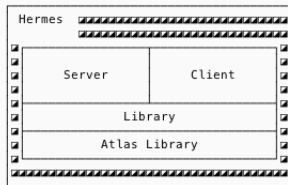
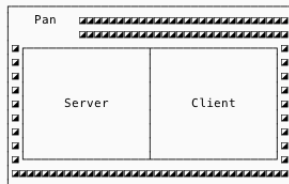
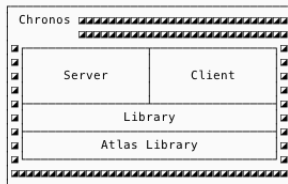




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IRIS' GREEK ZOO



HERMES' EVOLUTION

October, 2013

```
hermes [74aeab2] ⚡ cloc src scripts
  3 text files.
  3 unique files.
  0 files ignored.

http://cloc.sourceforge.net v 1.60 T=0.24 s (12.3 files/s, 762.9 lines/s)
-----
Language          files          blank          comment          code
-----
Haskell              1              22              7              80
Bourne Shell         2              25              2              50
-----
SUM:                  3              47              9             130
-----
```

October, 2015

```
hermes [master] cloc main server src test
 105 text files.
 105 unique files.
  0 files ignored.

http://cloc.sourceforge.net v 1.60 T=0.66 s (159.6 files/s, 26288.3 lines/s)
-----
Language          files          blank          comment          code
-----
Haskell            105           2332           2252           12712
-----
SUM:                105           2332           2252           12712
-----
```

Upon taking the lead on Hermes, I was asked for a couple of requirements to be fulfilled, the most important one being that the system needed to be deployed in a cluster, capable of scaling according to demand.

More specifically, we wanted a system with these desirable properties:

- Scalable

- Fault tolerant

- Distributed

A shared nothing architecture (SN) is a distributed computing architecture in which each node is independent and self-sufficient, and there is no single point of contention across the system.

All problems in computer science can be solved by another level of indirection,” is a famous quote attributed to Butler Lampson

1. RabbitMQ was just the right tool for the job at hand:
 - ~ Easy to setup
 - ~ Can be configured to operate in a federation of nodes
 - ~ Extremely reliable
 - ~ Good Haskell bindings for it (*AMQP*)
2. A question genuinely arise: it seems extremely costly to shuffle video as binary blobs over the queues. Can we avoid that?

To be fair, the media key abstraction was already present in Atlas when I choose RabbitMQ, but it was the perfect fit for it!

THE ELEPHANT IN THE ROOM

What's the elephant in the room?



Why not use Cloud Haskell?

1. CH encourages Erlang-style (i.e. actor based) communication, so nodes should know each other

We do not want that!

2. Peer discovery would have been tricky in a dynamic environment where new machines born and die frequently
3. It wasn't mature enough in 2013, if not for a handful of companies using it

2 DAY COURSE

Well-Typed's Advanced Haskell



The Haskell Consultants

Established 2008

After a couple of months (it was July 2013) Well Typed was hiring. I decided to take pot luck and I applied.

To maximise my chances, I applied to a couple of other positions for Haskell jobs.

Despite the rejections, **I was actually able to face an entire interview doing nothing but Haskell!**



Got rejected by WT, but they said "A client of us might be searching soon..."

LANDING THE TECH JOB I LOVED



On the 29th of August, I applied for a Haskell job @ Iris Connect. Took a train to Brighton, did the interview and was offered the position. **I was officially an Haskeller!**

1. Don't be afraid to take leaps into the dark
2. Life is about opportunities, seize them
3. Try to contribute to a “famous” Haskell OSS
4. Constantly “sharpen your saw”
5. Be receptive, do networking



discovers. develop. share.

A sharing and collaboration CPD platform for teachers via video recording, feedback and introspection.

1. Initially build with RoR, it was rewritten from scratch in Haskell (backend) and RoR + Angular.js (frontend)

- 1.1 Effort initially started by my colleague Chris Dornan and Well Typed

2. The backend is composed by two main projects:

- 2.1 The frontend-facing API server which holds the model and the business logic (**Atlas**)

- 2.2 The video transcoding system (**Hermes**), a highly distributed and fault tolerant system, built on top of RabbitMQ.

WHY HASKELL?



Because software development is a marathon, not a sprint.

"It took me more time writing the specs than implementing the feature itself."



Because we are like Shlemiel the painter.

"I can't help it," says Shlemiel. "Every day I get farther and farther away from the paint can!"

1. The more time it pass, the farther we get from our “paint can”, the mental model we built of the system.
2. In large scale systems, you can have parts that won't be touched for *years*!
 - 2.1 How do you defend yourself when the refactoring or feature time comes?
3. A rich, strong and expressive type system can be your ultimate ally against complexity
 - 3.1 Things like **newtypes** and **ADTs** can help you cure common “diseases” like *Boolean Blindness*

**As universe expands, so does the entropy in your software:
use types to keep it at bay!**

SOME “PROS” OF WORKING IN HASKELL

1. Refactoring is a dream
2. EDSLs are a piece of cake
3. Makes impossible states unrepresentable

1. The type system naturally guides you
2. In Haskell we tend to write small and generic functions
 - 2.1 Cfr. Bob Martin's "Clean Code"
 - 2.2 Most of the time they don't even break as they are written to work on polymorphic types
 - 2.3 Code reuse = profit!

So ultimately is not just about the strong type system, is about Haskell's (and Haskellers) natural tendency towards **composition** and **parametricity**.

EDSLS ARE A PIECE OF CAKE

```
fromPreset :: MediaFile -> MediaFile
-> Maybe Atlas.VideoFilter
-> VideoPreset -> Maybe VideoRotation
-> LogLevel -> [T.Text]
fromPreset filename outFilePath flt vpres vi ll =
  let cli = ffmpegCLI $ mconcat [
    i $ toTextIgnore filename
  , loglevel ll
  , fromVideoPreset vpres
  , isVideoRotated vi <?> resetRotateMetadata
  , yuv420p
  , vf [rotateMb vi]
  , isJust flt <?> vf_technicolor
  , o_y_ext (toTextIgnore outFilePath) (Left vpres)
  ]
  in T.words cli
```

Real world scenario:

```
-- | Creates a new Supervisor.  
-- Maintains a map <ThreadId, ChildSpec>  
newSupervisor :: IO Supervisor  
  
-- | Start an async thread to supervise its children  
supervise :: Supervisor -> IO ()  
  
-- | forkIO-inspired function  
forkSupervised :: Supervisor  
               -> RestartStrategy  
               -> IO ()  
               -> IO ThreadId
```

Example usage:

```
main = do
  sup <- newSupervisor
  supervise sup
  _ <- forkSupervised sup OneForOne $ do
    threadDelay 1000000
    print "Done"
```

Can you spot a potential bug?

Nothing in the types is forcing us to call `supervise` before actually supervising some thread!

```
main = do
  sup <- newSupervisor
  -- Wrong! We forgot to start the supervisor...
  _ <- forkSupervised sup OneForOne $ do
    threadDelay 1000000
    print "Done"
```

As Haskellers, we can certainly do better!

PHANTOM TYPES TO THE RESCUE!

Phantom Types allow us to “embed” constrain on our types, together with smart constructors.

```
data Uninitialised
data Initialised

data Supervisor_ a = Supervisor_ {
    -- record fields (omitted)
}

type SupervisorSpec = Supervisor_ Uninitialised
type Supervisor = Supervisor_ Initialised
```

Let's now slightly change our API to be this:

```
-- | Creates a new Supervisor.  
newSupervisor :: IO SupervisorSpec  
  
-- | Start an async thread to supervise its children  
supervise :: SupervisorSpec -> IO Supervisor
```

What did we get? Let's try to run the “wrong” snippet again...

```
main = do
  sup <- newSupervisor
  _ <- forkSupervised sup OneForOne $ do
    threadDelay 1000000
    print "Done"
```

What did we get? Let's try to run the “wrong” snippet again...

```
main = do
  sup <- newSupervisor
  _ <- forkSupervised sup OneForOne $ do
    threadDelay 1000000
    print "Done"
```

GHC will complain:

```
Couldn't match type Control.Concurrent.Supervisor.Uninitialised
      with Control.Concurrent.Supervisor.Initialised
Expected type: Supervisor
Actual type: Control.Concurrent.Supervisor.SupervisorSpec
```

1. This is because now we require a `Supervisor` to be initialised first
2. The type system prevented us making a silly mistake
 - 2.1 Failed with a very useful error message
3. Profit!

This is just a small example (this is only one of the possible solutions), but the benefits are real.

`https://github.com/adinapoli/threads-supervisor`

1. Slow(ish) Compilation
2. Cabal Hell



1. It's a problem all non-interpreted languages have to deal with
2. GHC indeed does incremental compilation, building only what's changed
3. It's even slower if..
 - 3.1 You have TH (Template Haskell) in your code
 - 3.2 You are building with profiling enabled

If you want faster feedback loop, consider using `ghci`

It's the aggregate of more than one problem, which most of the time results in "I couldn't install package X (easily)"

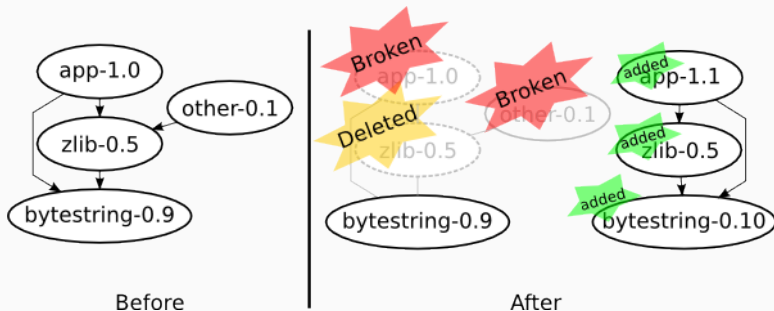


Figure 1: Image courtesy of Well Typed Ltd

1. Sandboxes mitigate the issue

```
cabal sandbox init  
cabal install
```

2. “Package aggregates” can help

Stackage

Haskell LTS

Nix and NixOS

3. Broader solutions are in the pipeline

Edward Z. Yang’s “Backpack”

Thank you.

Questions?

My road to Haskell

<http://www.alfredodinapoli.com/posts/2014-04-27-my-road-to-haskell.html>

Don Stewart - Haskell in the large

<http://code.haskell.org/~dons/talks/dons-google-2015-01-27.pdf>

Joel Spolsky - Back to Basics

<http://www.joelonsoftware.com/articles/fog0000000319.html>