Battlefield report: Bittorrent protocol implementation

Analysis of using Erlang and Haskell

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Sep 27, 2010

Overview

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Priming:	What is it, really?
Actors!	You have hundreds of independent processes ...
War diary:	Musings over the implementations.

History

Etorrent - A bittorrent client implemented in Erlang

- Erlang/OTP implementation
- Initial Checkin, 27th Dec 2006
- Had first working version around early 2008
- 5 KSLOCs

Combinatorrent - A bittorrent client in Haskell

- GHC (Glasgow Haskell Compiler) implementation
- Initial checkin: 16th Nov 2009
- First working version less than 2.5 months after
- Implements an actor-like model on top of STM (Software Transactional Memory)
- 4.1 KSLOCs

Ackowledgements

This is joint work; try to make it easy to contribute:

Etorrent: Tuncer Ayaz, Magnus Klaar

Combinatorrent: Alex Mason, Andrea Vezzozi, “Astro”, Ben Edwards, John Gunderman, Roman Cheplyaka, Thomas Christensen

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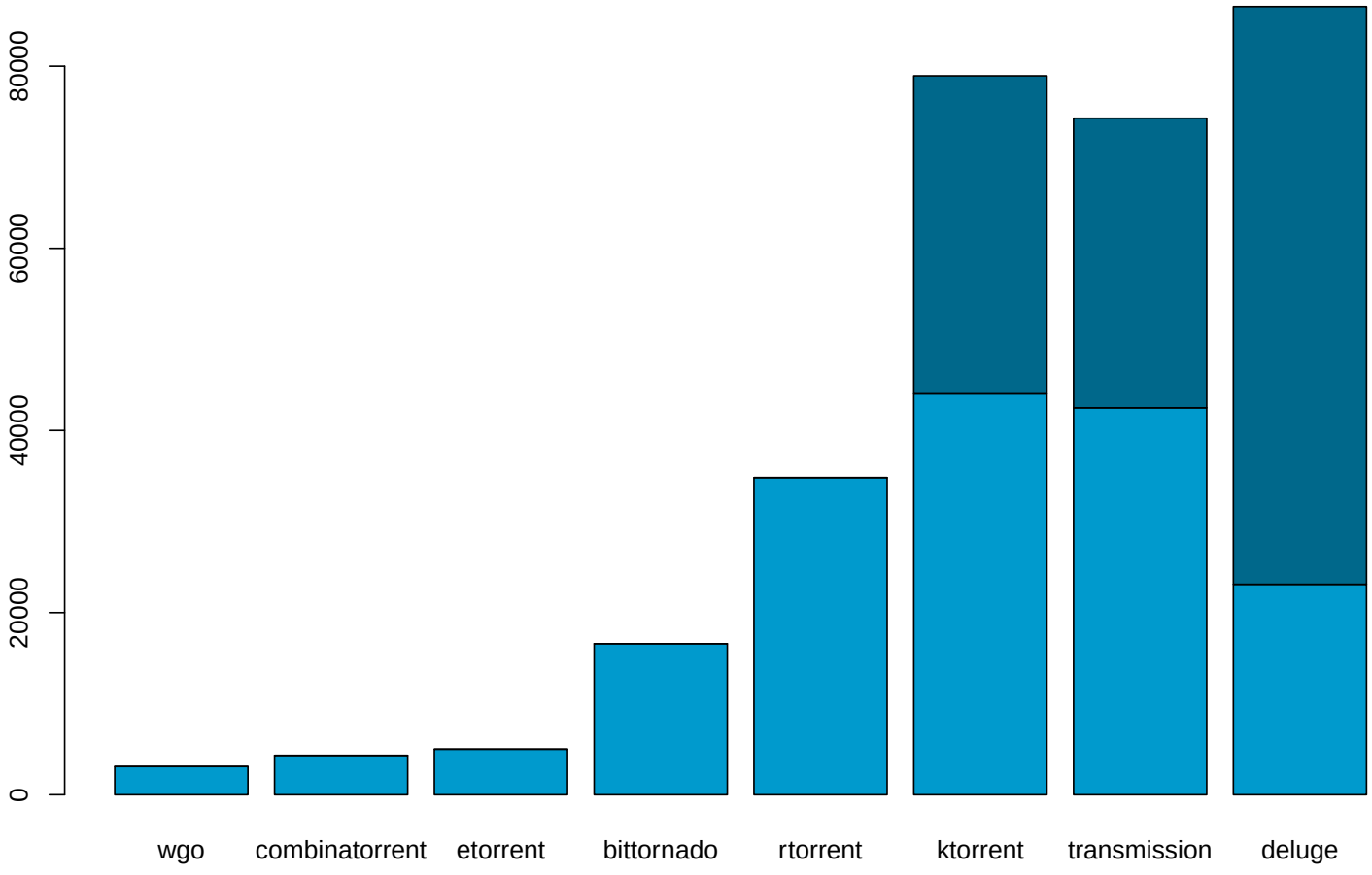
- Gauge the effectiveness of modern functional programming languages for real-world problems.
- BitTorrent is a good "Problem Set"

KSLOCs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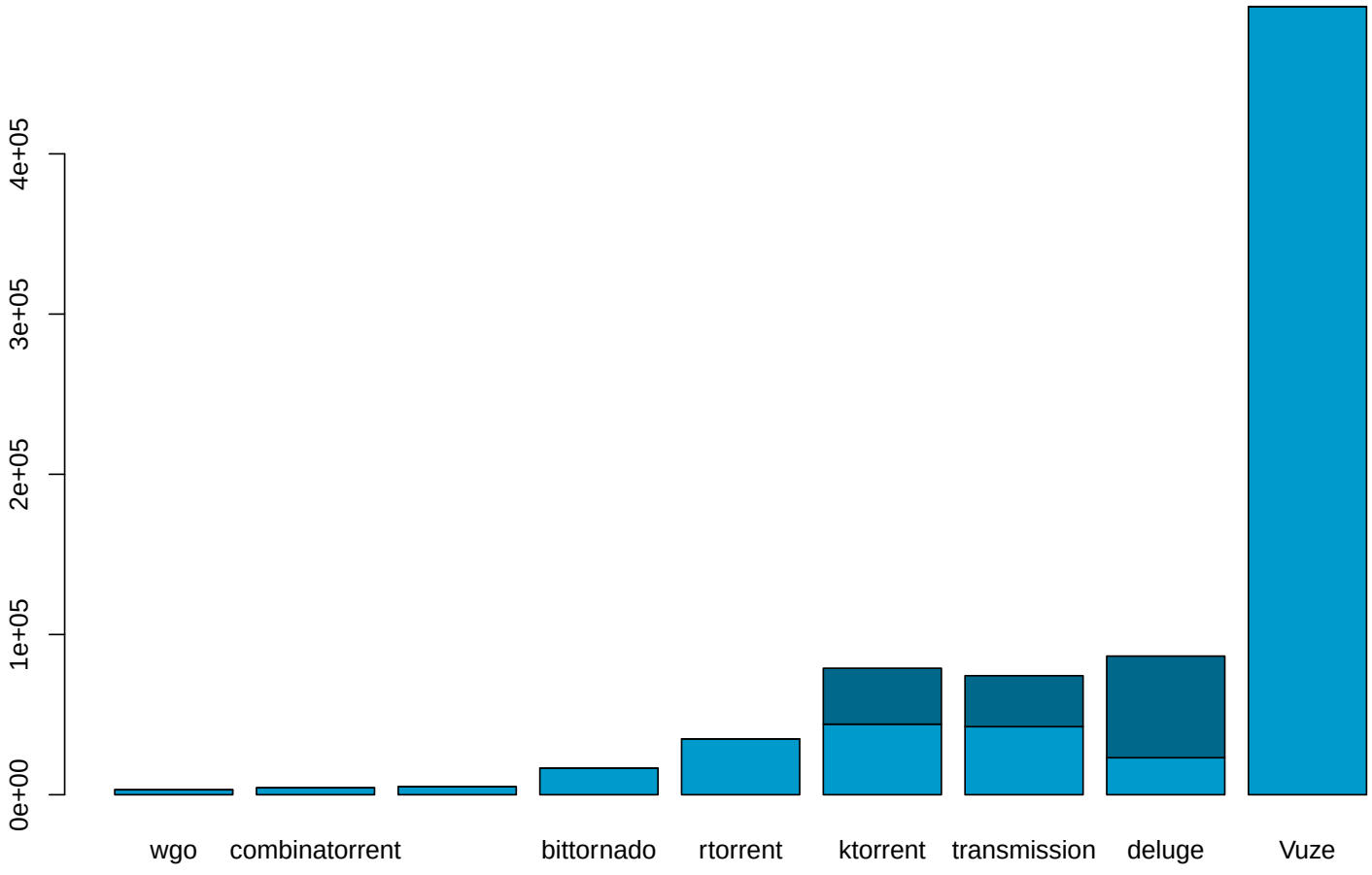
KSLOCs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2e+05
3e+05
4e+05
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Vuze

HTTP vs BitTorrent

BitTorrent is about *Content distribution*. Some key differences:

HTTP

- Simple
- Stateless
- One-to-many
- "Serial"
- Upstream bandwidth heavy

BitTorrent

- Complex
- Stateful
- Peer-2-Peer
- "Concurrent"
- Upstream bandwidth scales proportionally with number of consumers

In BitTorrent everything is sacrificed for the last point.

Key concepts

One: A stream of bytes is split into *pieces* and exchanged among peers with a message-passing protocol.

Two: Swarm intelligence

Beehives, Ant colonies, wasps.

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Each client acts *independently* with a 10 second memory, only evaluates downstream bandwidth; unless it is *seeding*.

Mantra: *Be friendly to your established friends, but be optimistic about gaining new ones*
Mimics human interaction.

Actor models

"Island model"

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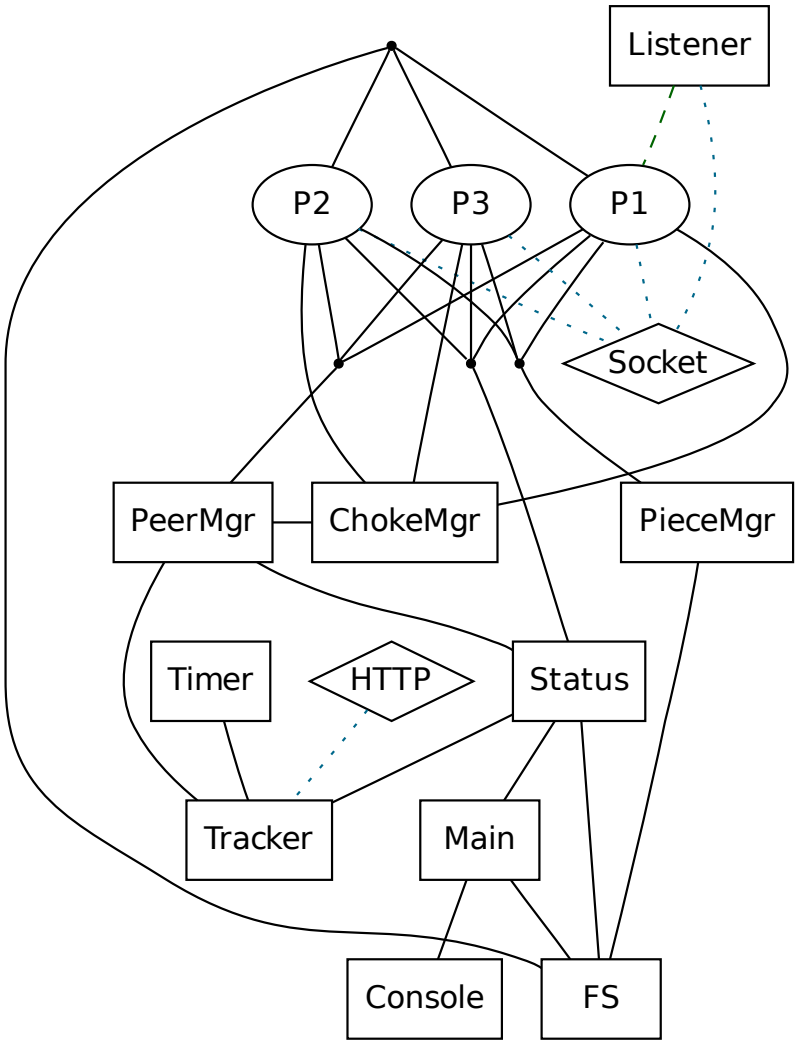
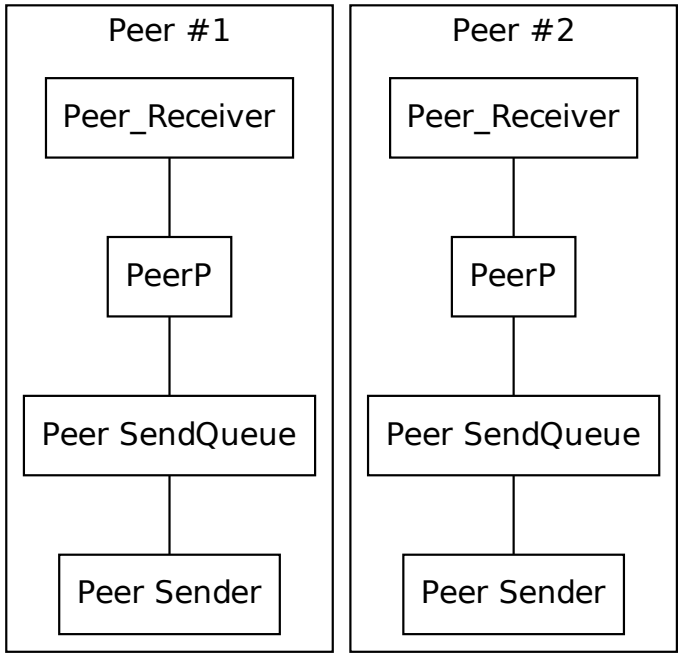
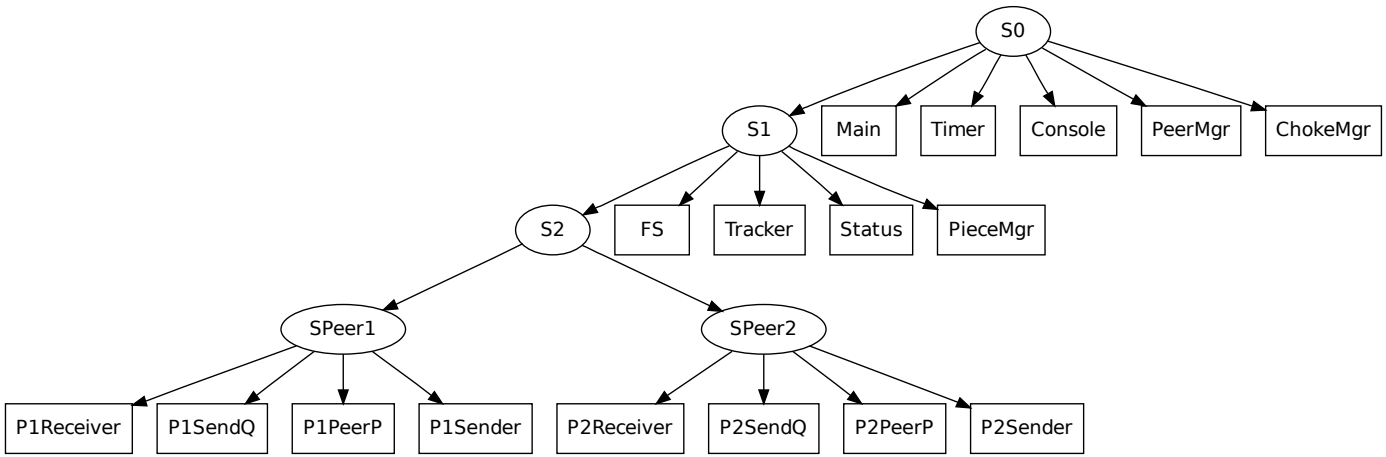
- Cheap processes (green, userland based)
- Fast CTX switch
- Process Isolation, message pass is persistent or a copy

Communication (Link)





Process Hierarchy (Location)



Bigraphs

$$\text{Bigraph} = \text{Hypergraph} + \text{Tree}$$

Do not confuse with bipartite graphs.

Hypergraph is the *link*-graph
Tree is the *location*-graph

Robustness

Robustness is key to good programming:

- Semantics (segfault, Null, of-by-one, ...)
- Proactive: Haskell
  - Type system
- Reactive: Erlang
  - Crashes, restarts
  - Supervisors
  - Redundancy

Ideas from both areas are needed in robust software!

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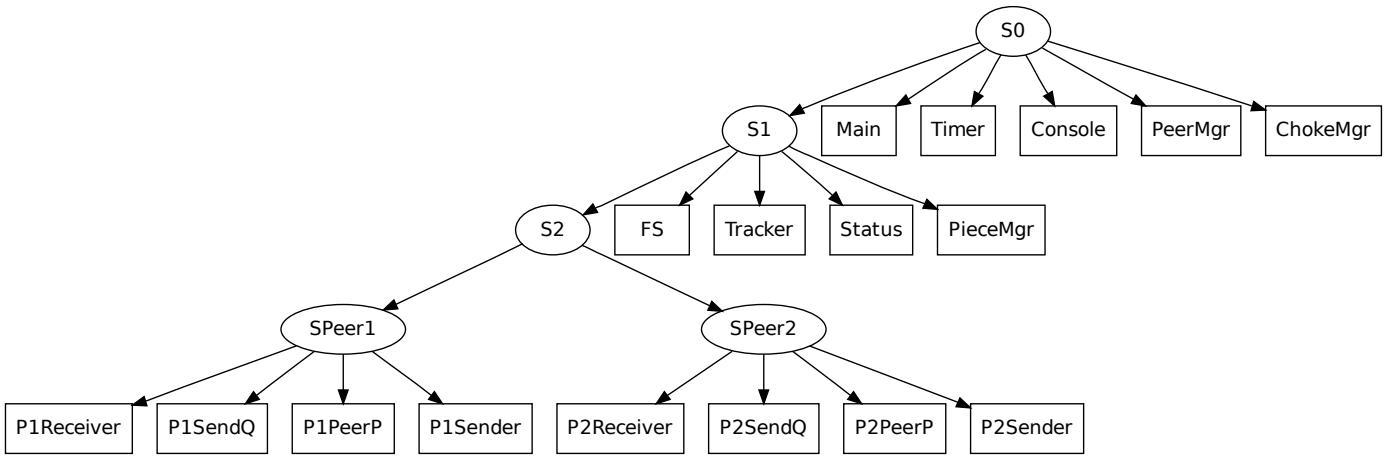

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Solution: Use ByteString for binary data in Haskell, binaries/iolists in Erlang.

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- Close to being clay: you can model actors easily
- Excellent community - vibrant; practitioners and academics.
- QuickCheck - (John Hughes, Wednesday)

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- Academic compilers, stability suffer
- Some libraries are *extremely* complex type-wise

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- Interpreted language, but implementation is heavily optimized
- Again, excellent community!

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- Dynamic typing (Dialyzer project helps, processes are small (< 500 lines)

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Both: Expect to manipulate your process model quite a bit.

Repositories

We use github for all code:

`http://www.github.com/jlouis`

Look for *etorrent* and *combinatorrent*