Erlang in Production

“I wish I'd known that when I started”
Or
“This is nothing like the brochure :-(”

Who the Hell are you?

- ShoreTel Sky
  - http://shoretelsky.com
- “Enterprise Grade” VoIP
- Elevator Pitch

Our Systems

- >9000 endpoints per server
- >150 calls per minute per server (peak)
- Real-time call control and reporting
- People are used to their computer crashing, but not their phone - very low downtime tolerance

Erlang?

- Simple, powerful syntax!
- Highly concurrent!
- Fault Tolerant!
- Hot code loading!
- We love it!
- I want to help *you* love it

It sounds... incredible.
Oh! And every twenty minutes, a kitten comes out!
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Syntax

```
-module(quicksort).
-export([qsort/1]).

qsort([]) -> [];
qsort([Pivot|Rest]) ->
  qsort([ X || X <- Rest, X < Pivot])
    ++ [Pivot]
    ++ qsort([ Y || Y <- Rest, Y >= Pivot]).
```

Highly Concurrent

- Tens of thousands of processes (threads) are no problem
- Each only costs you 1236 bytes of memory
- Primitives for send/receive:

```
NewPid = spawn(?MODULE, f, []),
NewPid ! {message, Message}
...
f() ->
  receive
    {message, M} -> io:fwrite(“~p”, [M])
  end.
```

Fault Tolerant

- Crashes are localised
- Built in restart/recovery system
- Compare with C/C++ :)

Hot Code Loading

- Umm...I'll get to this later :)

Our Erlang Journey

- “Discovered” it at LCA 2007
- Hacked together a dynamic TFTP server
- Hacked together a soft-phone for automated testing
- Now used as the backbone of our call tracking and billing system
- We're rewriting entire core system using Erlang

Overview - I wish we'd known that...

- Dialyzer should be mandatory
- The VM *can* crash
- Message queues “just work”...except when they don't
- The OTP is invaluable
- Integration as a UNIX-style service is lacking
- Hot code loading is...interesting
- System monitoring is vital

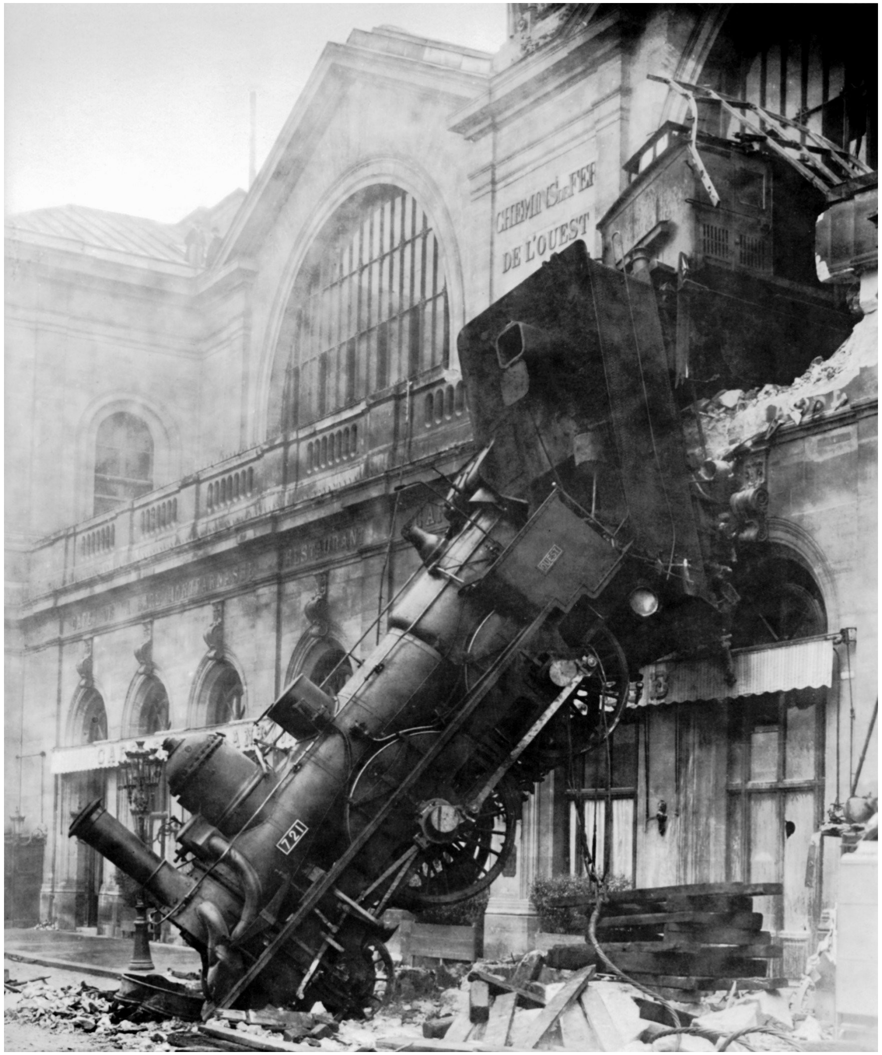
Dialyzer

- Bringing (some) static type-safety to a dynamically typed language

- One run over your code will show you why you need it

How to crash the VM

- Out-Of-Memory
  - Non tail-recursive loops
  - Queue overflow
- Linked-in Drivers or NIFs



Non Tail-Recursive Loops

Good:

```
main_loop() ->
  do_something(),
  wait_for_input(),
  main_loop(). % Tail-call
```

Non Tail-Recursive Loops

Bad:

```
main_loop() ->
  do_something(),
  wait_for_input(),
  main_loop(),
  ok. % Oops
```

Non Tail-Recursive Loops

Also Bad:

```
loop() ->
  A = do_something(),
  case A of
    done -> 1;
    continue -> 1 + loop() % Also oops
  end.
```

Non Tail-Recursive Loops

- Bad(!):

```
foo(X) ->
  try
    case f(X) of
      continue -> foo(A);
      done -> ok
    end
  catch % try-catch must maintain the stack
    _ -> doom()
  end
```

Non Tail-Recursive Loops

- Good:

```
foo(X) ->
   try f(X) of
      % Exceptions thrown here are not caught:
      A -> foo(A); % So the stack is not kept
      _ -> ok
   catch
      _ -> doom()
   end.
```

Queue Overflow

- Message queues are simple and powerful
- ...and can get you in very deep trouble
- How do you do it?
  - Outright overload
  - Selective `receive`

Simple overload

```
% This is called by lots of threads:
log_msg(Msg) ->
  logger ! {log, Msg}.

% But is all handled by one thread:
logger() ->
  receive
    {log, Msg} -> format_and_write(Msg);
    _ -> ok
  end,
  logger().
```

Selective Receive

```erlang
receiver() ->
  % This is O(n):
  receive
     particular_message -> do_lots_of_work()
  end,

  % This is O(1):
  receive
     OtherStuff -> do_other_work(OtherStuff)
  end,
  receiver().
```

Selective Receive

- May not be obvious in your code:
  - `mnesia:transaction/1`

- Can take hours or even days to cause problems (monitor your system!)

- Somewhat mitigated as of R14 with new reference optimisation

New Reference Optimisation

```
R = make_ref(),
server ! {R, MyRequest},
receive
  {R, Resp} -> process_response(Resp)
end
```

New Reference Optimisation

```
% Compiler marks the queue here
R = make_ref(),
server ! {R, MyRequest},
% And only has to check from that mark
receive
  {R, Resp} -> process_response(Resp)
end
```

The Open Telephony Platform (OTP)

- Architectural framework for writing robust long running applications
- Forces you to consider process interaction, failure modes, crash behaviour etc
- Possibly overkill for “small” projects
- Definitely **mandatory** for anything else
- Learn it!

The OTP - Solving problems you didn't know you had

- Making a “call” to another process.
  First Try:

```
server_proc ! {request, ReqData},
receive
  {response, RespData} -> RespData
end.
```

The OTP

- But how can you be sure it's the right response?

```
Ref = make_ref(),
server_proc ! {request, Ref, ReqData},
receive
  {response, Ref, RespData} -> RespData
end,
```

The OTP

- But what if the server process doesn't exist?

```
case whereis(server_proc) of
   undefined -> {error, noproc};
   Pid ->
      Ref = make_ref(),
      Pid ! {request, Ref, ReqData},
      receive
         {response, Ref, RespData} -> {ok, RespData}
      end
end
```

The OTP

- But what if the server process dies after the call?

```
case whereis(server_proc) of
   undefined -> {error, noproc};
   Pid ->
      Ref = make_ref(),
      Pid ! {request, Ref, ReqData},
      receive
         {response, Ref, RespData} -> {ok, RespData}
         after 5000 -> {error, timeout}
      end
end
```

The OTP

- It'd be nice not to have to wait 5 seconds if the process crashed...

```
MRef = erlang:monitor(process, server_proc),
Ref = make_ref(),
server_proc ! {request, Ref, ReqData},
receive
    {response, Ref, RespData} ->
        erlang:demonitor(MRef),
        {ok, RespData};
    {'DOWN', MRef, _, _} -> {error, no_proc};
    after 5000 ->
        erlang:demoniotr(MRef),
        {error, timeout}
end
```

The OTP

- But What if the remote node doesn't support `erlang:monitor`? (C/Java nodes don't).

- Enough! 12+ Lines of code for a simple “call” is already far too much.

```
gen_server:call(server_proc, {request, ReqData})
```

More OTP Stuff

- Supervision Trees
- Event Handlers (subscribe-notify)
- FSMs

Erlang as a UNIX Service

- Erlang has an embedded heritage
- Turn on the device and walk away
- But this can cause trouble in the UNIX world...

Erlang as a UNIX Service

- Usual startup:
  - `erl -noshell -detached -boot myapp.boot`
  - Always returns 0 - success!
- But...what if some part of startup fails?
- Also, `-detached` means no console output
- No feedback => Unhappy sysadmins

`.pid` Files

- No `.pid` file - cannot easily find VM process on busy machines. Especially if it moves!
- Naive solution: Just write it from your Erlang code...
- But what if your code never runs?
- That's when you might need the `.pid` file most of all!

`heart` to Manage VM Crashes

- `heart` is a built in VM monitoring program
- A nice idea, but can make shutdown of broken VMs difficult
  - `kill -stop` is helpful
- Great for embedded systems
- Not so much for UNIX services

Log Rotation

- Log rotation is...unusual?
- No way to handle `SIGHUP`
- All these quirks together make packaging (`.deb`, `.rpm` etc) challenging.

Our Solution: `erld`

- Same basic principle as GNU `screen`
- Wraps erl and holds its terminal
- Programatically detaches from console
- Logs console output
- Intercepts `SIGHUP` for log rotation
- Returns useful error codes
- Manages crashes/restarts
- Open source (GPL)!
  https://github.com/ShoreTel-Inc/erld

Hot Code Loading

- Great idea!
- Ericsson use it to get insane (reported) uptimes on their AXD 301 switch
- But very few other big projects use it on more than a single module basis. Why not?

Hot Code Loading

- It's really, really hard!
- There's no good tools to help (unless you count rebar)
- The documentation is patchy (but improving)
- There's no easy way to integrate with common package management systems
- It's hard to test

System monitoring

- Erlang's VM has lots of great ways to monitor different parts of your system...
- But that's only useful if you use them
- And if you know what you're looking for

Some Key Monitoring Points

- Number of processes
  - `length(erlang:processes())`
- Queue length (esp. for busy processes)
  - `erlang:process_info(Pid, message_queue_len)`
- Total Memory Use
  - `erlang:memory/0,1`

Take-Home Messages

- Understand tail-calls
- Keep your message queues short
- Be careful of selective receives
- You will need to work to get your Erlang project to behave as a UNIX service
- Hot code loading is far harder than you think
- Monitor your system
- Use the OTP
- Use Dialyzer

Questions?

bduggan@shoretel.com

Thanks!

- The End.