Securing Elixir Applications

ElixirConf.EU 2016 - Berlin

Bram Verburg
System Architect, Security Advocate
Cisco

“I am being paid to be paranoid”

Me, just now

Distributed Erlang

- beam @ ephemeral/TCP
- epmd @ 4369/TCP

- Short names: hostname
- Long names: FQDN, IP

```
$ ssh user@example.net  epmd -names
epmd: up and running on port 4369 with data:
name phoenix at port 40831
$ ssh -N -L 4369:localhost:4369  \
  -L 40831:localhost:40831  user@example.net
```

```
$ ssh user@example.net  epmd -names
epmd: up and running on port 4369 with data:
name phoenix at port 40831
$ ssh -N -L 4369:localhost:4369  \
  -L 40831:localhost:40831  user@example.net

$ iex --sname iex@localhost  --remsh phoenix@localhost
Erlang/OTP 18 [erts-7.3] [source] [64-bit] [smp:8:8] [asy

Interactive Elixir (1.2.3) - press Ctrl+C to exit (type h
iex(phoenix@localhost)1>
```

```
$ ssh user@example.net  epmd -names
epmd: up and running on port 4369 with data:
name phoenix at port 40831
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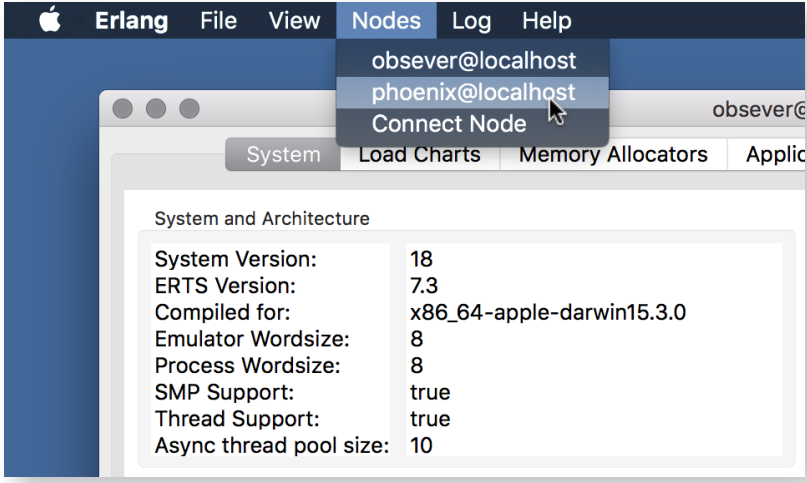
Interactive Elixir (1.2.3) - press Ctrl+C to exit (type h
iex(phoenix@localhost)1>

$ erl -sname observer@localhost  -run observer
```



```
$ iex --sname test1@localhost
[...]
iex(test1@localhost)1>

$ epmd -names
epmd: up and running on port 4369 with data:
name test1 at port 51484
```

```
$ iex --sname test1@localhost
[...]
iex(test1@localhost)1>

$ epmd -names
epmd: up and running on port 4369 with data:
name test1 at port 51484

$ netstat -an | grep 4369
tcp4    0  0  127.0.0.1.4369         127.0.0.1.51485    ESTABL
tcp4    0  0  127.0.0.1.51485        127.0.0.1.4369     ESTABL
tcp6    0  0  *.4369                 *.*                LISTEN
tcp4    0  0  *.4369                 *.*                LISTEN
$ netstat -an | grep 51484
tcp4    0  0  *.51484                *.*                LISTEN
$
```

```
$ ERL_EPMD_ADDRESS=127.0.0.1 iex --sname test1@localhost \
  --erl "-kernel inet_dist_use_interface {127,0,0,1}"
[...]
iex(test1@localhost)1>

$ epmd -names
epmd: up and running on port 4369 with data:
name test1 at port 51635
```

```
$ ERL_EPMD_ADDRESS=127.0.0.1  iex --sname  test1@localhost  \
  --erl "-kernel  inet_dist_use_interface  {127,0,0,1}"
[...]
iex(test1@localhost)1>

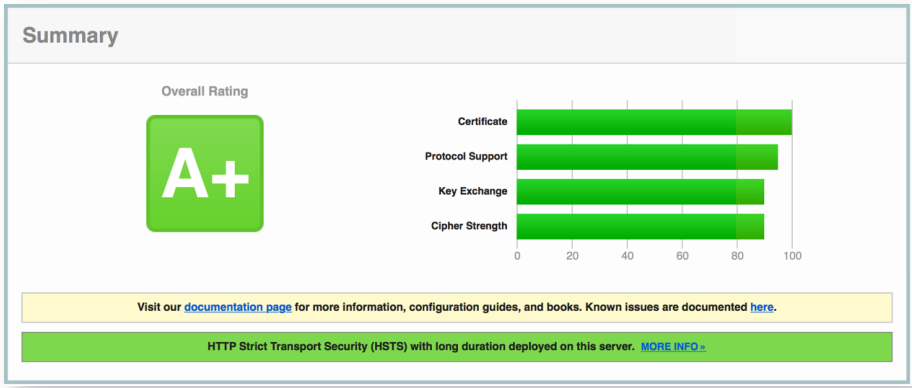
$ epmd -names
epmd: up and running on port 4369 with data:
name test1 at port 51635

$ netstat -an | grep 4369
tcp4    0  0  127.0.0.1.4369         127.0.0.1.51636    ESTABL
tcp4    0  0  127.0.0.1.51636        127.0.0.1.4369     ESTABL
tcp6    0  0  ::1.4369               *.*                LISTEN
tcp4    0  0  127.0.0.1.4369         *.*                LISTEN
$ netstat -an | grep 51635
tcp4    0  0  127.0.0.1.51635        *.*                LISTEN
$
```

- Cookies provide limited security
  - Use *inet_tls_dist* for hardening
- Know when not to use it:
  - Over WAN connections
  - Between application tiers

TLS and :ssl

- Server considerations:
  - Does the application need a reverse proxy?
  - Will there be a load balancer?
  - Is TLS offload needed, for performance?
  - Do I trust Erlang/OTP's TLS implementation?



https://www.ssllabs.com/ssltest/index.html

```
config :app, App.Endpoint,
  http: [port: 4000],
  https: [port: 4001,
    certfile: "priv/cert/cert.pem",
    keyfile: "priv/cert/privkey.pem",
    cacertfile: "priv/cert/chain.pem",
    dhfile: "priv/cert/dhparams.pem",
    secure_renegotiate: true,
    honor_cipher_order: true,
    ciphers: [
      {:ecdhe_rsa, :aes_128_gcm, :null},
      {:ecdhe_rsa, :aes_256_gcm, :null},
      {:ecdhe_rsa, :aes_128_cbc, :sha256},
      {:ecdhe_rsa, :aes_256_cbc, :sha384},
      {:ecdhe_rsa, :aes_128_cbc, :sha},
      {:ecdhe_rsa, :aes_256_cbc, :sha},
```

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      {:ecdhe_rsa, :aes_128_gcm, :null},
      {:ecdhe_rsa, :aes_256_gcm, :null},
      {:ecdhe_rsa, :aes_128_cbc, :sha256},
      {:ecdhe_rsa, :aes_256_cbc, :sha384},
      {:ecdhe_rsa, :aes_128_cbc, :sha},
      {:ecdhe_rsa, :aes_256_cbc, :sha},
```

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config :app, App.Endpoint,
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      {:ecdhe_rsa, :aes_256_gcm, :null},
      {:ecdhe_rsa, :aes_128_cbc, :sha256},
      {:ecdhe_rsa, :aes_256_cbc, :sha384},
      {:ecdhe_rsa, :aes_128_cbc, :sha},
      {:ecdhe_rsa, :aes_256_cbc, :sha},
```

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config :app, App.Endpoint,
  http: [port: 4000],
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    dhfile: "priv/cert/dhparams.pem",
    secure_renegotiate: true,
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    ciphers: [
      {:ecdhe_rsa, :aes_128_gcm, :null},
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      {:ecdhe_rsa, :aes_128_cbc, :sha},
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      {:dhe_rsa,  :aes_256_cbc,  :sha256},
      {:dhe_rsa,  :aes_128_cbc,  :sha},
      {:dhe_rsa,  :aes_256_cbc,  :sha},

      {:dhe_rsa,  :"3des_ede_cbc",  :sha},
      {:rsa,  :aes_128_cbc,  :sha},
      {:rsa,  :aes_256_cbc,  :sha},
      {:rsa,  :"3des_ede_cbc",  :sha},
    ]
  ],
```

```
      {:dhe_rsa,  :aes_128_gcm,  :null},
      {:dhe_rsa,  :aes_256_gcm,  :null},
      {:dhe_rsa,  :aes_128_cbc,  :sha256},
      {:dhe_rsa,  :aes_256_cbc,  :sha256},
      {:dhe_rsa,  :aes_128_cbc,  :sha},
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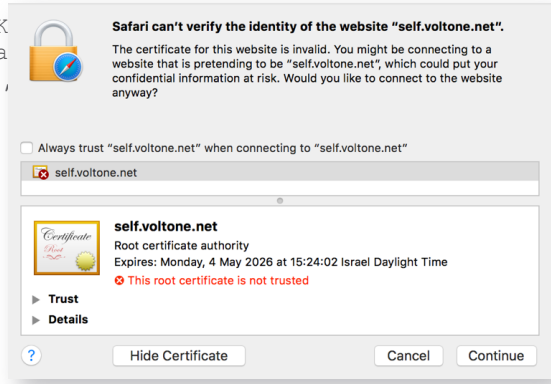
      {:dhe_rsa,  :"3des_ede_cbc",  :sha},
      {:rsa,  :aes_128_cbc,  :sha},
      {:rsa,  :aes_256_cbc,  :sha},
      {:rsa,  :"3des_ede_cbc",  :sha},
    ]
  ],
```

- With Plug/Phoenix, use Plug.SSL
  - “HTTP Strict Transport Security”
  - Tell browser to only ever use HTTPS
  - Prevent downgrade attack
  - Prevent cookie hijacking

```
iex(1)> :inets.start && :ssl.start
:ok
iex(2)> :httpc.request 'https://self.voltone.net'
{:ok,
 {{'HTTP/1.1', 200, 'OK'},
  [{'date', 'Sat, 07 May 2016 07:20:18 GMT'},
   {'server', 'Cowboy'},
   #...
```

```
iex(1)> :inets.start && :ssl.start
:ok
iex(2)> :httpc.request 'https://self.voltone.net'
{:ok,
 {{'HTTP/1.1', 200, 'OK
  [{'date', 'Sat, 07 Ma
   {'server', 'Cowboy'},
   #...
```



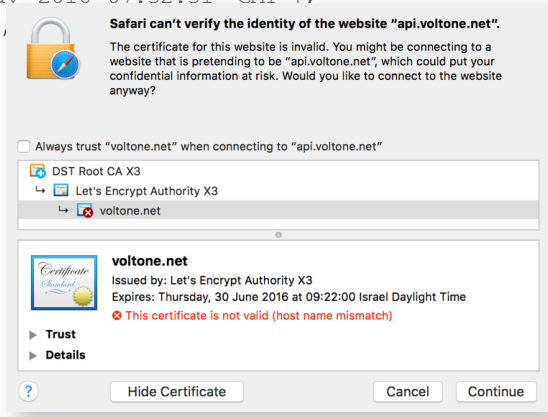
```
$ wget -q https://curl.haxx.se/ca/cacert.pem
$ iex --app inets --app ssl
iex(1)> :httpc.set_options(socket_opts: [
  verify: :verify_peer , cacertfile: 'cacert.pem'])
:ok
iex(2)>
```

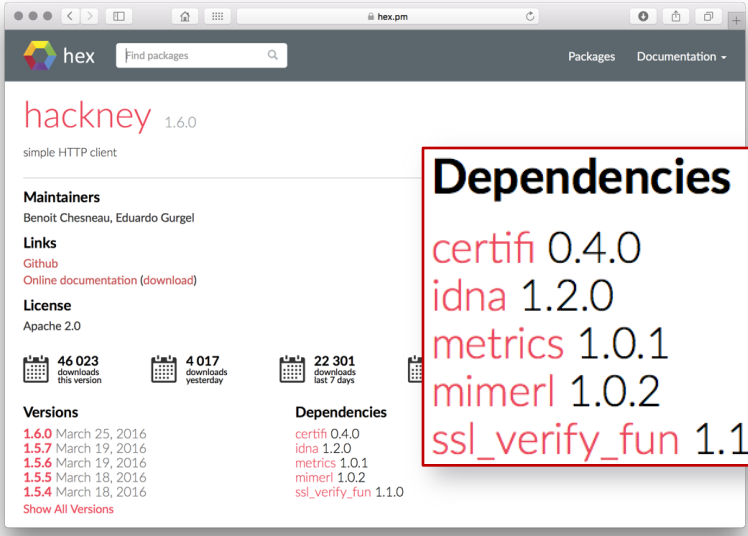
```
$ wget -q https://curl.haxx.se/ca/cacert.pem
$ iex --app inets --app ssl
iex(1)> :httpc.set_options(socket_opts: [
  verify: :verify_peer, cacertfile: 'cacert.pem'])
:ok
iex(2)> :httpc.request 'https://self.voltone.net'

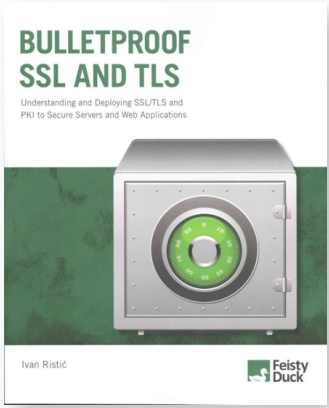
10:22:00.087 [error] SSL: :certify:
ssl_handshake.erl:1488:Fatal error: bad certificate
{:error,
 {:failed_connect,
  [{:to_address, {'self.voltone.net', 443}},
   # ...
```

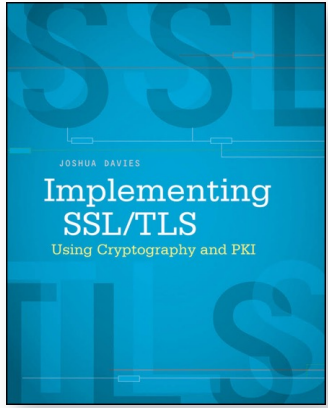
```
iex(3)> :httpc.request 'https://api.voltone.net'
{:ok,
 {{'HTTP/1.1', 200, 'OK'},
  [{'date', 'Sat, 07 May 2016 07:32:31 GMT'},
   {'server', 'Cowboy'},
   # ...
```

```
iex(3)> :httpc.request 'https://api.voltone.net'
{:ok,
 {{'HTTP/1.1', 200, 'OK'},
  [{'date', 'Sat, 07 May 2016 07:32:31 GMT'},
   {'server', 'Cowboy'},
   # ...
```





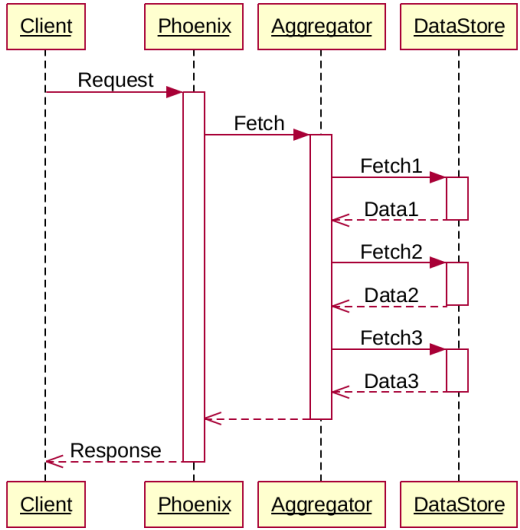


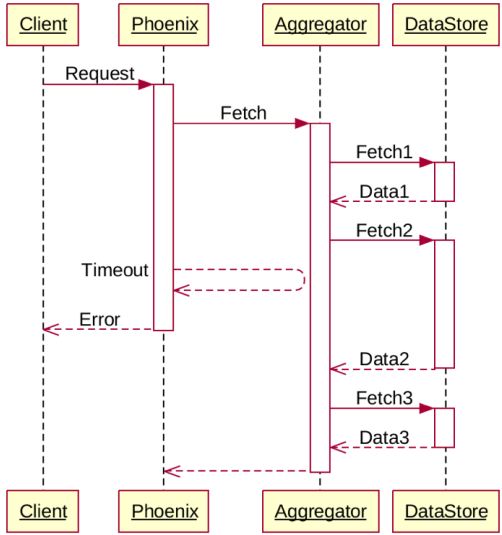


Denial of Service

- Atom table
  - Default size: 1.048.576 entries
  - No garbage collection
  - Overflow will crash the BEAM
- Mitigation
  - Use strings, or *String.to_existing_atom/1*

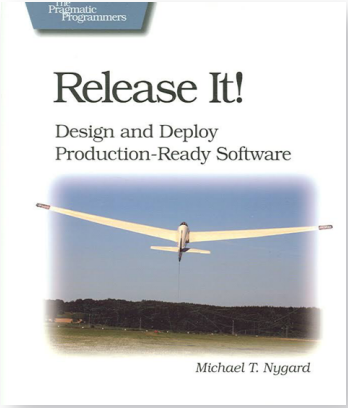
- Process and Port limits
  - Defaults: 262.144 and 65.536
  - Overflow causes error response
- Mitigations
  - Limit at the edge (e.g. :ranch)
  - Monitor and alert

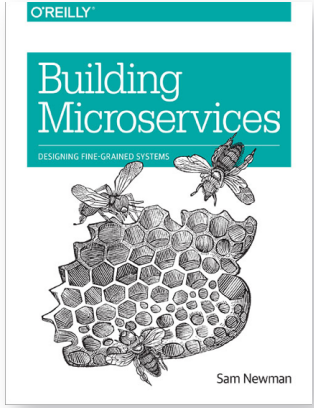




- Fail fast
- Backpressure

- Compare Microservices:
  - Add circuit breakers and bulkheads





Odds and Ends

- Phoenix response times
  - Low latency, low jitter
- More susceptible to timing attacks
  - For instance, username enumeration
- Beware of DoS attacks
  - E.g. Comeonin's *dummy_checkpw/0*

```
iex(1)> {:ok, {_, [{:abstract_code, {_, ast}}]}} =
          String |>
          :code.which |>
          :beam_lib.chunks([:abstract_code])
iex(2)> ast |>
          :erl_syntax.form_list |>
          :erl_prettypr.format |>
          IO.puts
//...
to_atom(string@1) ->
    erlang:binary_to_atom(string@1, utf8).

to_integer(string@1, base@1) ->
    erlang:binary_to_integer(string@1, base@1).
:ok
iex(3)>
```

- Compile without debug info:
  - `mix compile --no-debug-info`
- Strip :abstract_code chunk:
  - :beam_lib.strip_files/1
  - :beam_lib.strip_release/1
- Encrypt debug info

Thank you!

- IRC: voltone
- Twitter: @voltonez

- Questions? Or bonus section?

Bonus section: Phoenix as a TLS test server

```
config :app, App.Endpoint,
  http: [port: 4000],
  https: [
    port: 4001,
    # Default certificate file
    certfile: "priv/cert/cert.pem",
    keyfile: "priv/cert/privkey.pem",
    cacertfile: "priv/cert/chain.pem",
    sni_fun: &App.ssloptions/1
  ],
  # ...
```

```
config :app, App.Endpoint,
  http: [port: 4000],
  https: [
    port: 4001,
    # Default certificate file
    certfile: "priv/cert/cert.pem",
    keyfile: "priv/cert/privkey.pem",
    cacertfile: "priv/cert/chain.pem",
    sni_fun: &App.ssloptions/1
  ],
  # ...
```

```
def ssloptions('www.localtest.me'), do: []

def ssloptions('expired.localtest.me'), do:
  [certfile: 'priv/cert/expired.crt']
```

```
def ssloptions('www.localtest.me'), do: []

def ssloptions('expired.localtest.me'), do:
  [certfile: 'priv/cert/expired.crt']

def ssloptions('sslv3.localtest.me'), do:
  [versions: [:sslv3]]

def ssloptions('3des.localtest.me'), do:
  [
    ciphers:[
      {:ecdhe_rsa, :"3des_ede_cbc", :sha},
      {:dhe_rsa, :"3des_ede_cbc", :sha},
      {:rsa, :"3des_ede_cbc", :sha}
    ]
  ]
```

```
$ openssl s_client -connect localhost:4001 \
  -CApath myrootca.pem \
  -servername expired.localtest.me
```


CISCO