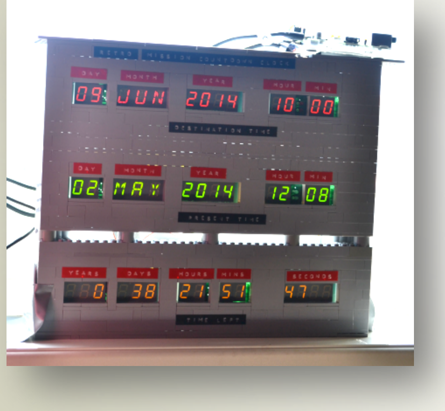
Hobby Electronics With Erlang on the Raspberry Pi



Angela Johansson

EUC 9-10 June 2014

Video – MB Led

- MB Led
- Cool, so this is written in Erlang then?
    - Well, no.
- So what’s your point?
    - It might as well have been written in Erlang!
        - Communicating entities, message passing
        - Choosing leaders, autonomous parts, scaling...
        - State machines, recursion

Let me know if you implement an Erlang version before me!

The Sky is the Limit!

- MB Led

http://mbled.wordpress.com/

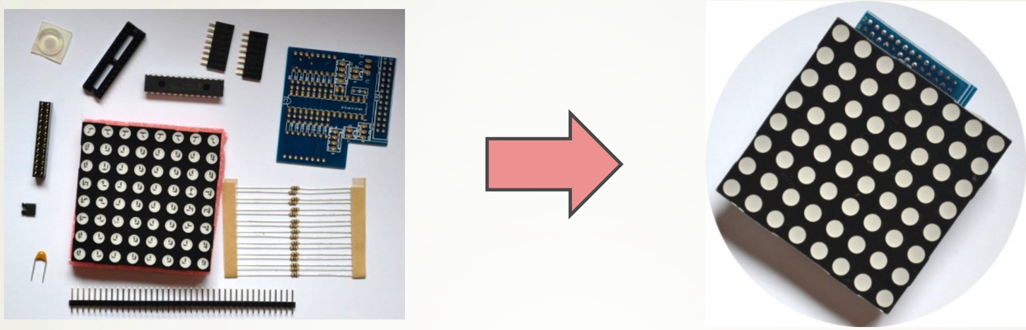
inspired by

- **GLiP -** *(a) Great LED Interactive Puzzle*

http://www.glip.fr/

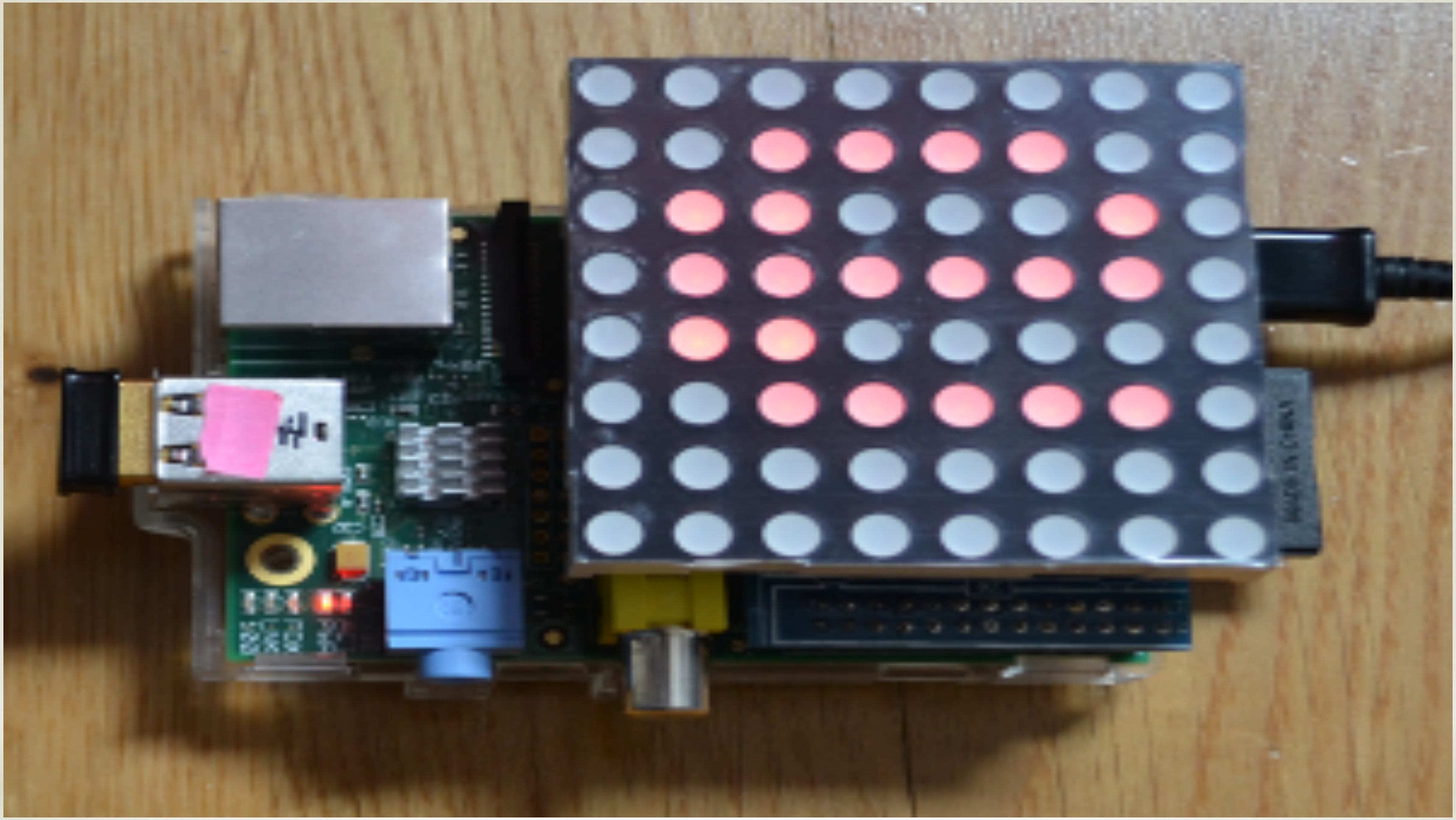
Check it out

- So how and where did you start?
  - I built Adafruit (and other) projects
  - DIY-kits ”IKEA style”

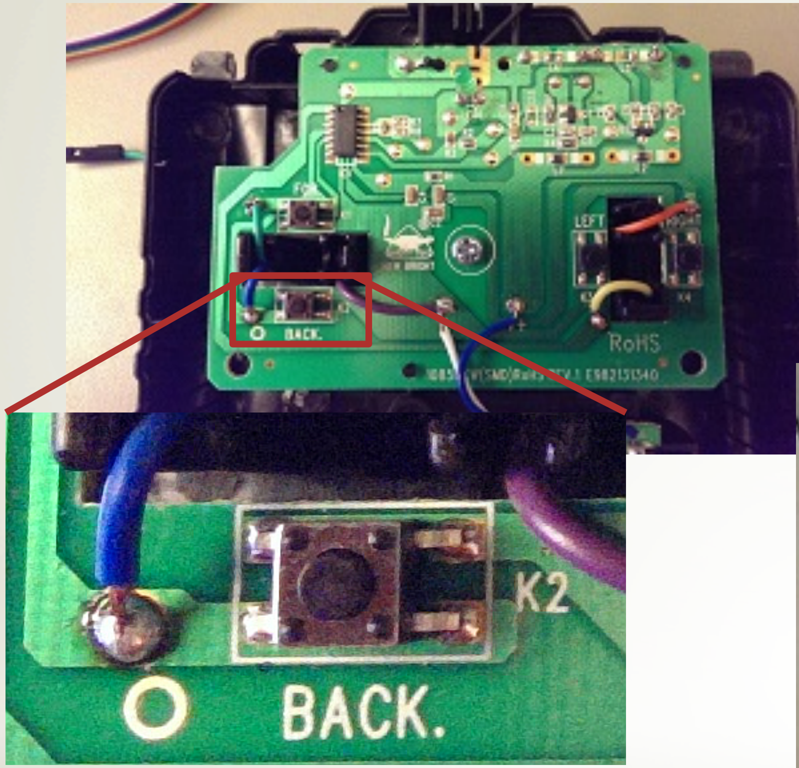


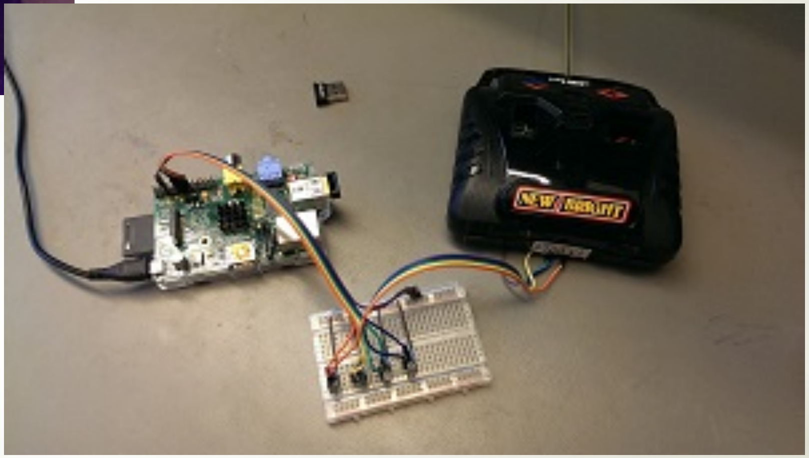
  - You get source code written in Python
    - very similar to Erlang!

Start small, go from there



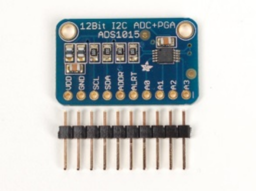
LED matrix fun





It’s not always as difficult as it seems!

- There is so much to choose from!
  - Change something, combine, experiment



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  - Let your imagination roam free –
    What do *you* want to build and what does it do?

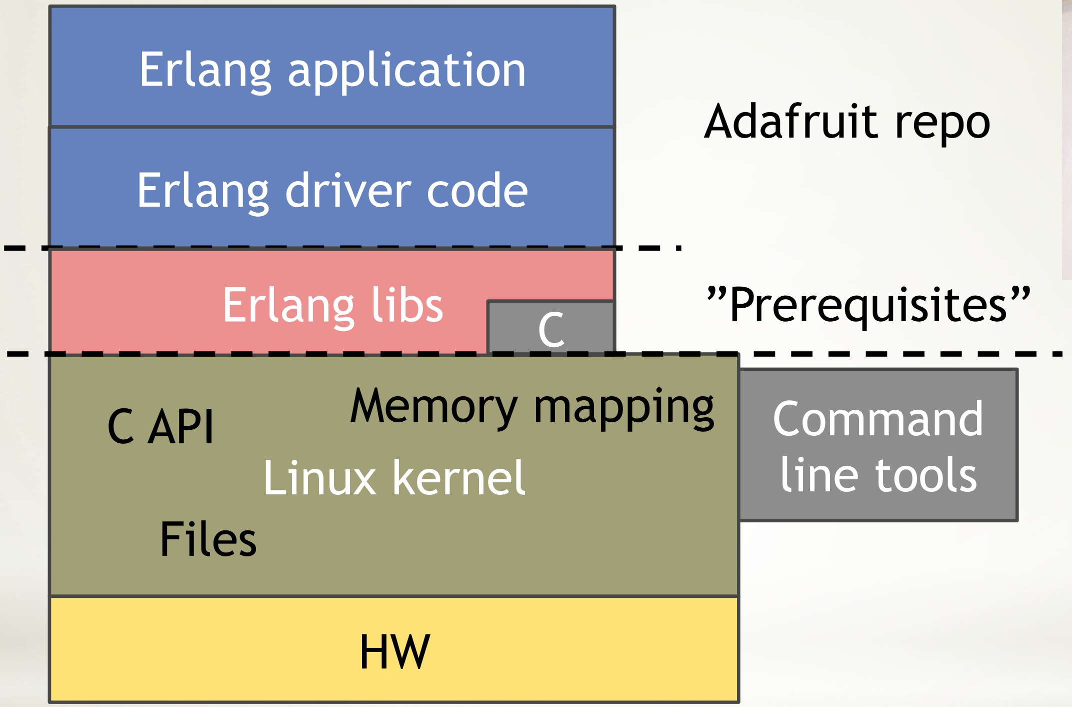
Have fun!

*So why use Erlang?

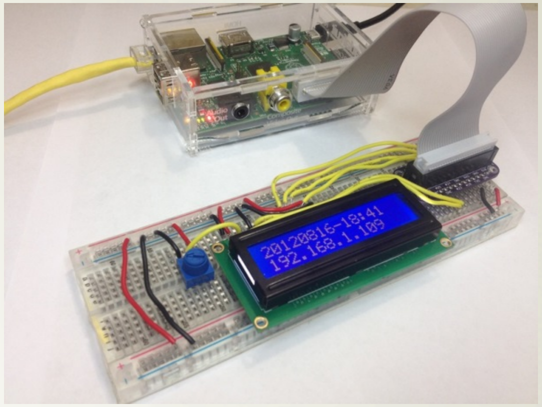
1. Simply because it’s possible.
2. Your code will design and write itself.
3. Erlang is ideal for talking to HW: communication, state machines, fault tolerance, value crunching…
4. You want to extend your code later on. Add an Erlang touch!

Why not use Erlang?
… when it’s a Raspberry Pi

- Where does Erlang fit into this?
  - First, understand the existing code

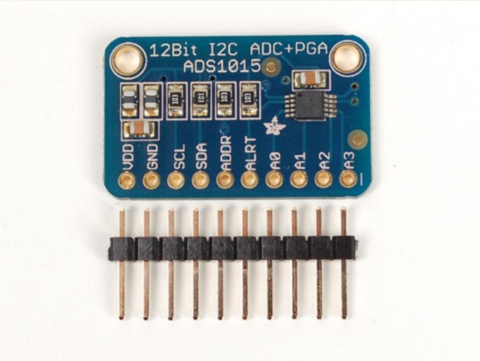


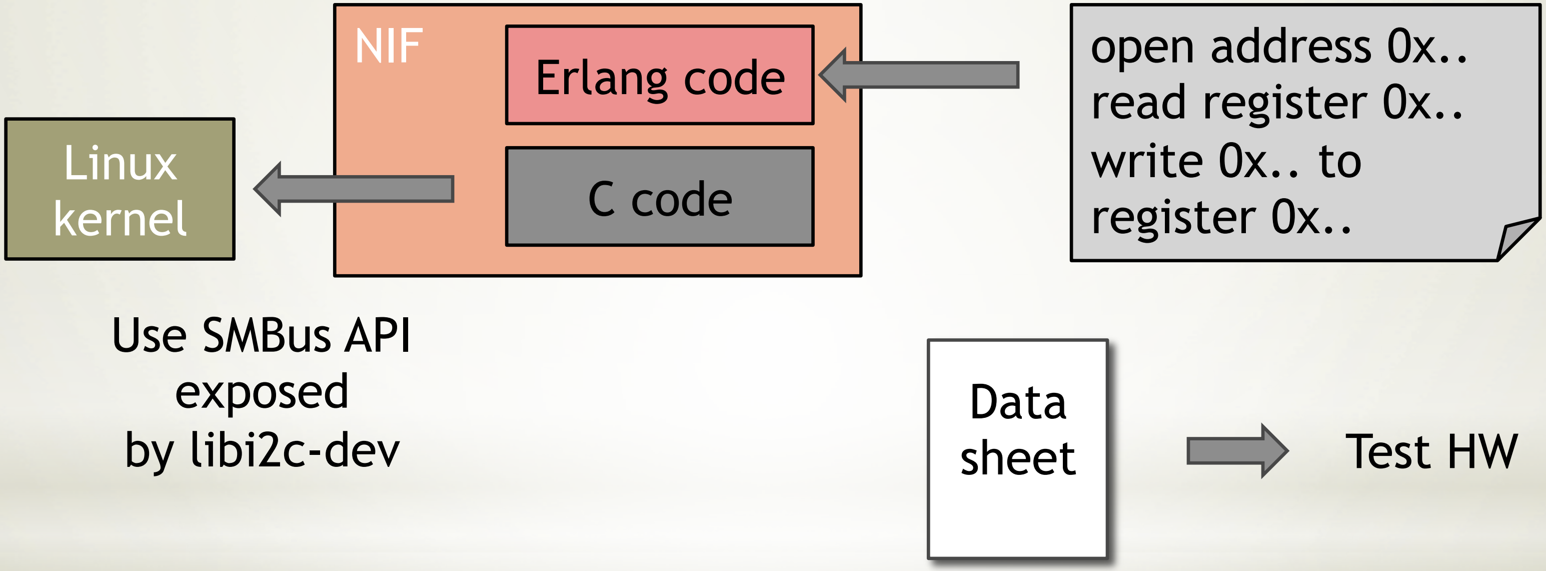
OS



It's a piece of cake!

- So, what did you do then?
  - Googled ”I2C Linux”
  - Took some C-code, wrote a NIF




NIF

Erlang code

C code

Linux kernel

open address 0x..
read register 0x..
write 0x.. to
register 0x..

Use SMBus API
exposed
by libi2c-dev

Data sheet

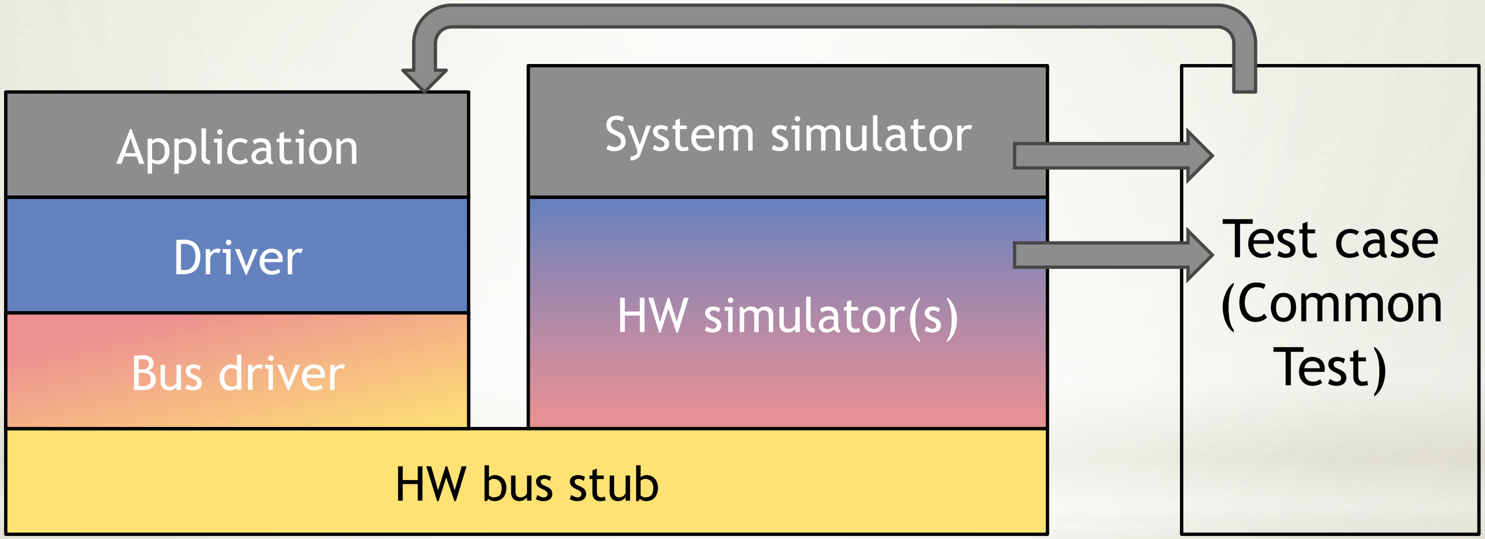
Test HW

Yes, it’s really that easy.

- Once written, the libs can of course be reused
  1. My code: git://github.com/drimtajm/erlang-rpi-hw-drivers
     - Upcoming feature: SPI support
  2. From the author of Mockgyver: WPI git://github.com/klajo/wpi
     - Uses the Wiring Pi library (C code)
  3. ALE - Erlang Actor Library for Embedded git://github.com/esl/erlang_ale
     - From Erlang Solutions
- Or write your own…

Your choice

- Why not work test driven?
  - Unit testing with Mockgyver and Proper
  - System testing with common test
    - Simulators and messages



Testing is good for you

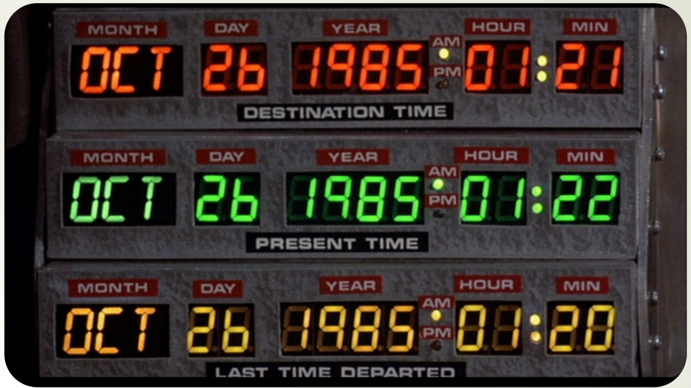
```
setup() ->
   [...]
   %% Mock I2C interface methods
   ?WHEN(i2c_interface:open_i2c_bus(_Address) -> {ok, ?HANDLE}),
   ?WHEN(i2c_interface:close_i2c_bus(_Address) -> ok),
   [...]
   {ok, Pid} = ads1015_driver:start_link(),
   Pid.

[...]

init_should_open_i2c_bus_test(_) ->
   ?WAS_CALLED(i2c_interface:open_i2c_bus(?I2C_ADDRESS)).

terminate_should_close_i2c_bus_test(Pid) ->
   ads1015_driver:stop(),
   wait_for_exit(Pid),
   ?WAS_CALLED(i2c_interface:close_i2c_bus(?HANDLE)).
```

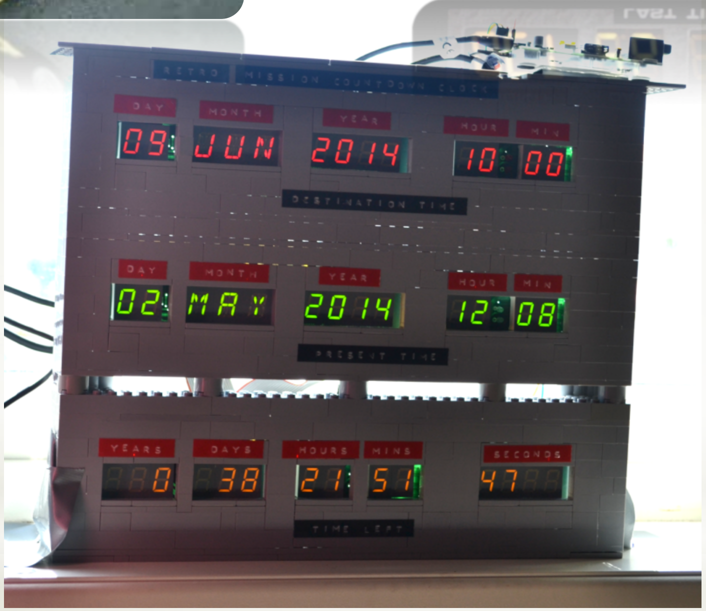
Mockgyver

```
prop_set_status_bit_always_sets_status_bit() ->
   ?FORALL(BitPattern, word_value(),
           begin
              NewBitPattern =
                 ads1015_driver_lib:set_status_bit(BitPattern),
              is_integer(NewBitPattern)
                 and ((NewBitPattern band ?STATUS_BIT) > 0)
           end).

prop_decodes_encoded_data_rate() ->
   ?FORALL(DataRate, data_rate_value(),
           DataRate ==
              ads1015_driver_lib:decode_data_rate(
                 ads1015_driver_lib:encode_data_rate(DataRate))).

data_rate_value() ->
   oneof([128, 250, 490, 920, 1600, 2400, 3300]).
```

Proper

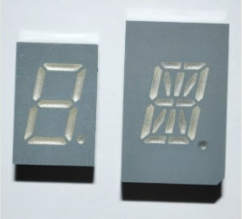
- Back to the Future

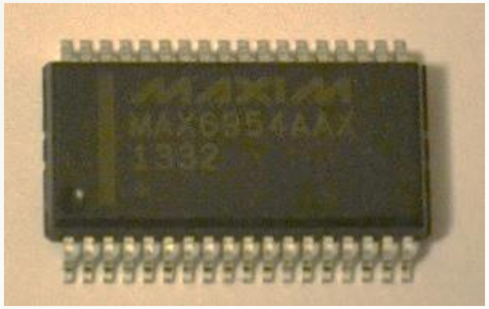




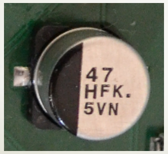
Build something new

- How hard can it be?!
  - Actually, it turned out to be as easy as I imagined
  - But: Routing was time-consuming in Eagle
    and I left the surface mounting part to an expert



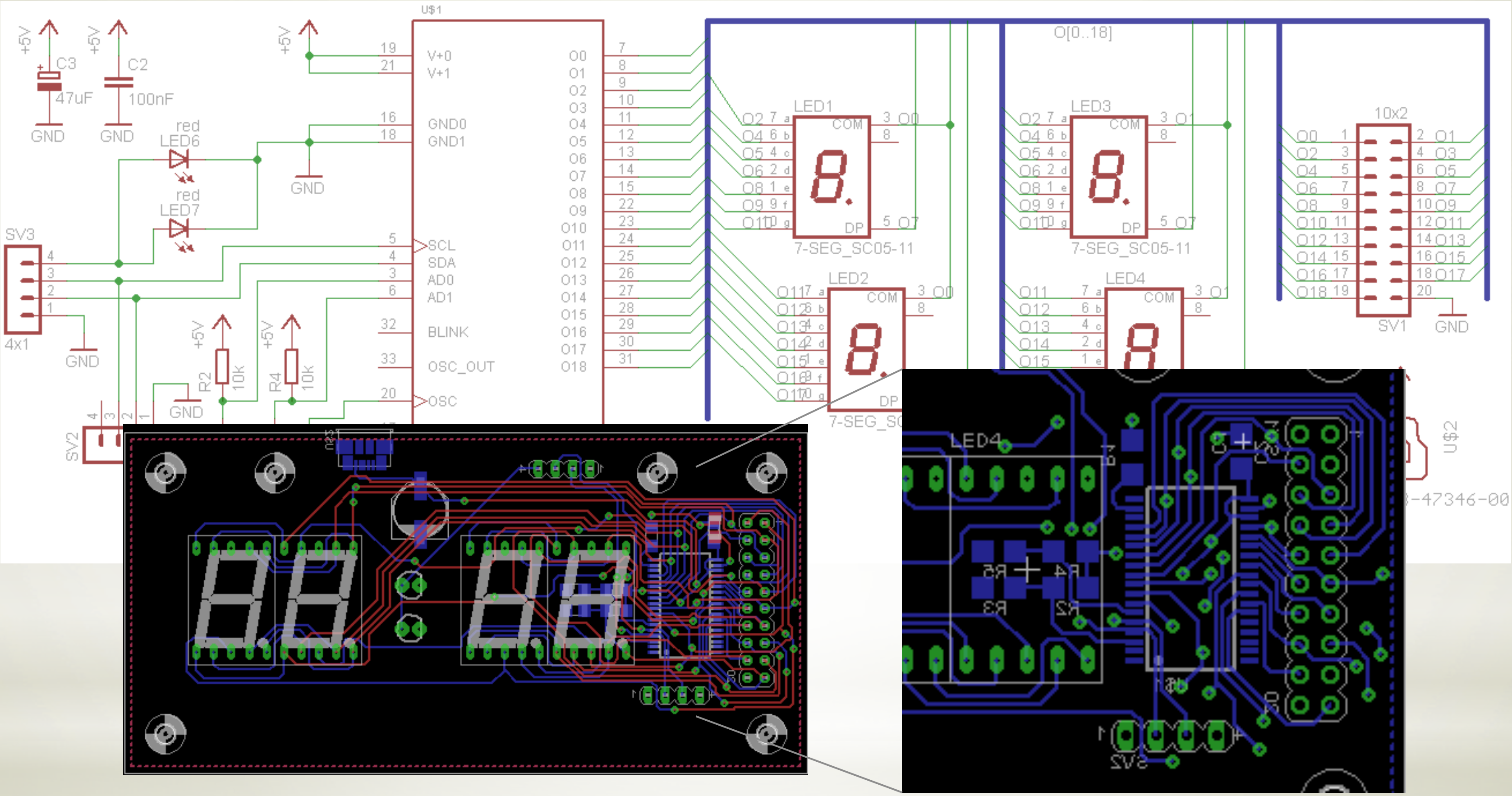


Data sheet



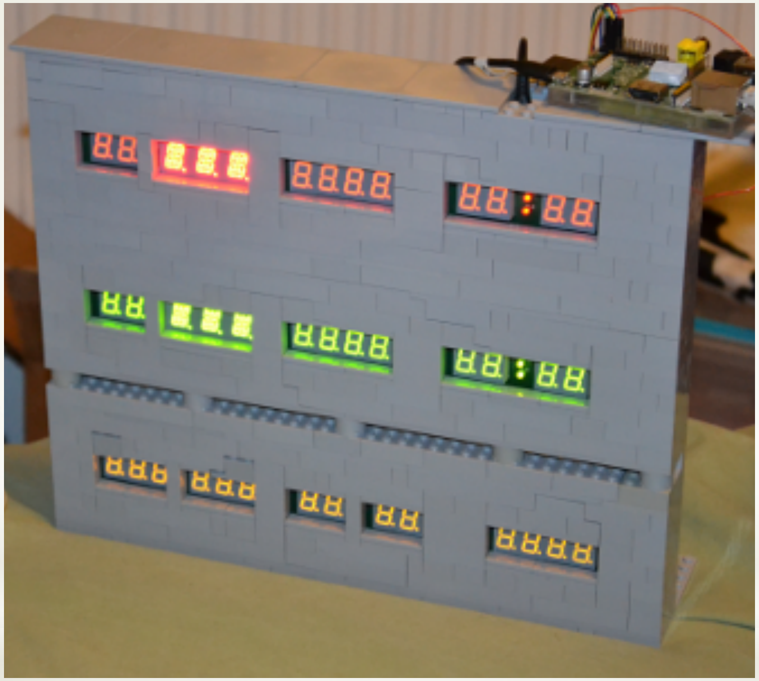
Let the hardware do most of the job for you

”KISS”



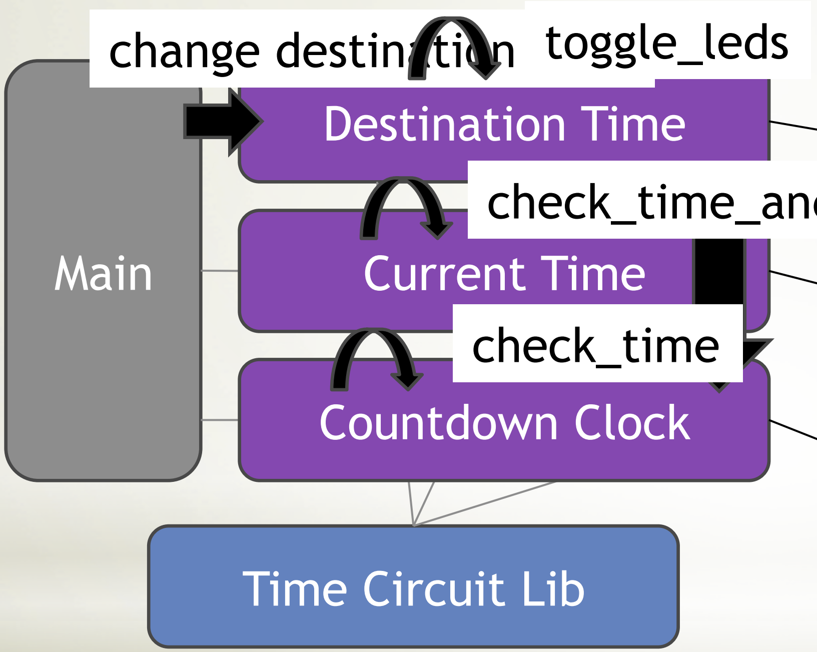
”Simple” is relative…

- Putting it together
  - Display test mode
  - I only needed my I2C primitives



Step by step…

- Tell us about the software!
  - ”Thrown together” to make it work
  - At least **some** thoughts behind the desgin



change destination

toggle_leds

Destination Time

check_time_and_toggle_leds

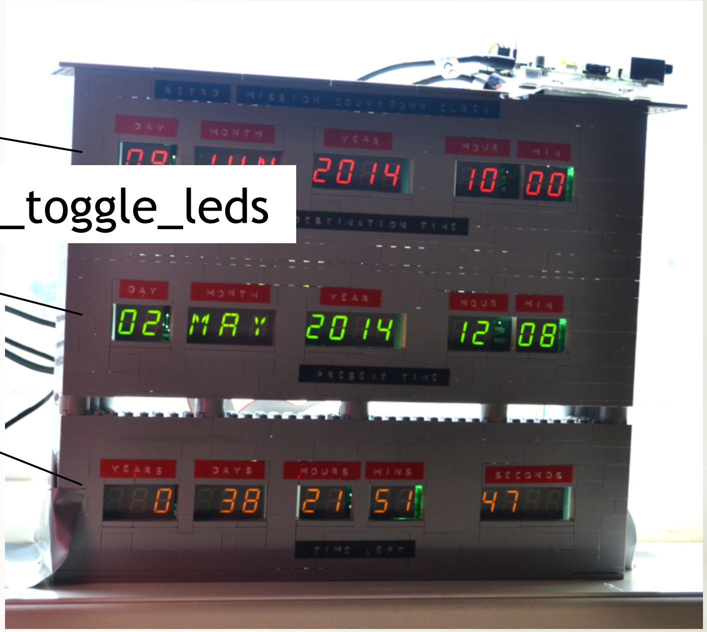
Main

Current Time

check_time

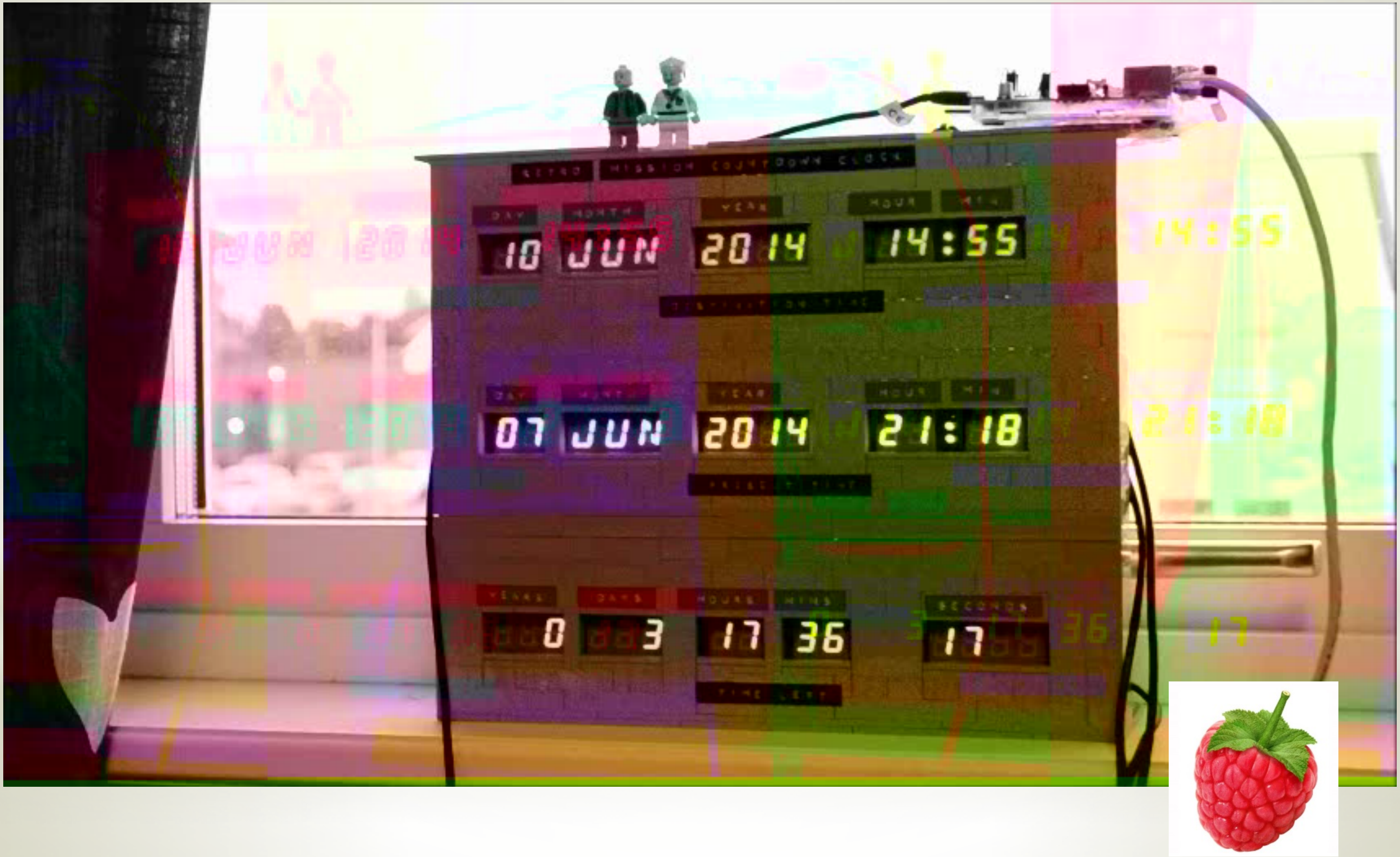
Countdown Clock

Time Circuit Lib

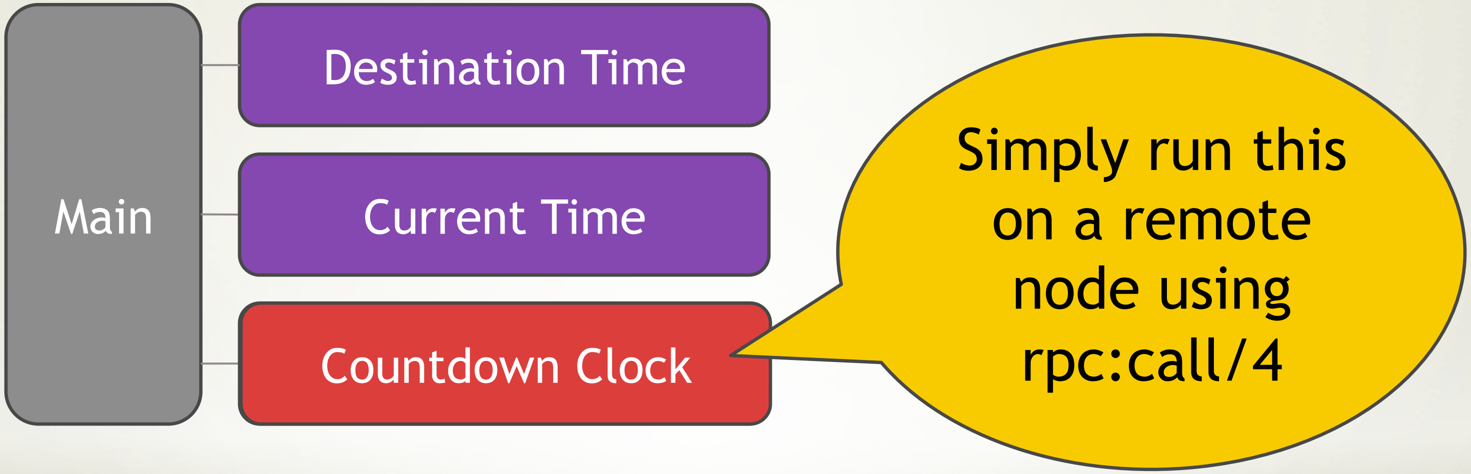


It works!

Demo


RETRO MISSION COUNTDOWN CLOCK
DAY
MONTH
YEAR
HOUR
MIN
10 JUN 2014 14:55
DESTINATION TIME
DAY
MONTH
YEAR
HOUR
MIN
07 JUN 2014 21:18
PRESENT TIME
YEARS
DAYS
HOURS
MINS
SECONDS
0 3 17 36 17
TIME LEFT

- So, what about communication?
  - ”Connected by Cybercom”
  - Make the system distributed, just ”for fun”



Main

Destination Time

Current Time

Countdown Clock

Simply run this on a remote node using rpc:call/4

In a *connected world*, Erlang rules!

- Is there bluetooth support for Erlang?
  - Strangely, I found nothing when I googled
  - I would like to send binaries ”the Erlang way”
  - **Bluez** provides a bluetooth stack in Linux
  - RFCOMM (”*serial port emulation*”) can be used to transfer data, you only need to create sockets
  - So I wrote a NIF against Bluez
    - Cards must be put in ”scan mode”
    - Packets are ”concatenated” when they arrive

If it doesn’t exist, write it yourself

```
go() ->
   [...]
   {ok, Socket} = bluetooth_interface:create_rfcomm_socket(),
   ok = bluetooth_interface:bind_bt_socket(Socket, ?PORT,
                                           LocalMac),
   ok = bluetooth_interface:bt_socket_listen(Socket),
   Pid = spawn_link(?MODULE, socket_acceptor, [self(), Socket]),
   receive
      {Pid, done} -> ok
   after 60000 ->
      error(timeout)
   end,
   bluetooth_interface:close_bt_socket(Socket).

socket_acceptor(Caller, Socket) ->
   {ok, Socket2, RemoteAddress} =
      bluetooth_interface:bt_socket_accept(Socket),
   receive_loop(Socket2),
   Caller ! {self(), done},
   ok.
```

Bluetooth - server side

```erlang
go() ->
   {ok, Socket} = bluetooth_interface:create_rfcomm_socket(),
   Pid = spawn(?MODULE, socket_connector, [self(), Socket,
                                           RemoteMac]),
   receive
      {Pid, done} -> ok
   end,
   bluetooth_interface:close_bt_socket(Socket).

socket_connector(Caller, Socket, RemoteMac) ->
   ok = bluetooth_interface:bt_socket_connect(Socket, ?PORT,
                                              RemoteMac),
   Data = erlang:term_to_binary({self(), greetings}),
   ok = bluetooth_interface:bt_socket_send(Socket, Data),
   [...]
   Data2 = term_to_binary("Bye!"),
   ok = bluetooth_interface:bt_socket_send(Socket, Data2),
   timer:sleep(10000),
   Caller ! {self(), done},
   ok.
```

Bluetooth - client side

- So do you plan on developing this further?
  - Absolutely!
  - But I would like some help from you...
  - Ideally, one would like to have the same support in Erlang as for TCP sockets/inet – **bnet**!
  - Make use of bluetooth services – **ebpmd**?
  - Facilitate automatic card setup/configuration
  - Rewrite it as an Erlang port
  - Support for Windows (Widcomm?)
  - Other suggestions?

Let me know
if you’re interested!

Angela Johansson

angela.johansson@gmail.com

Twitter & Github:
@drimtajm