Interactive Robotics with Nerves and Elixir

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The Killer App for Elixir?

Phoenix (phoenixframework.org) is great. If you like Ruby and Rails, Elixir and Phoenix will feel **familiar** but give you more **performance**, **scalability**, and **maintainability**. Rails developers have been known to retool to being **productive** with Phoenix in as little as **two weeks**.

See Brian Cardarella's talk "*Rails to Phoenix*" from RailsConf 2016:
https://www.youtube.com/watch?v=OxhTQdcieQE

The Killer App for Elixir?

Nerves (nerves-project.org) is the true killer app of Elixir. It's not yet widely known outside of the Elixir community, but that is changing quickly (even in this very room, right now).

Nerves is doing to embedded development and Elixir what Rails did for web development and Ruby.

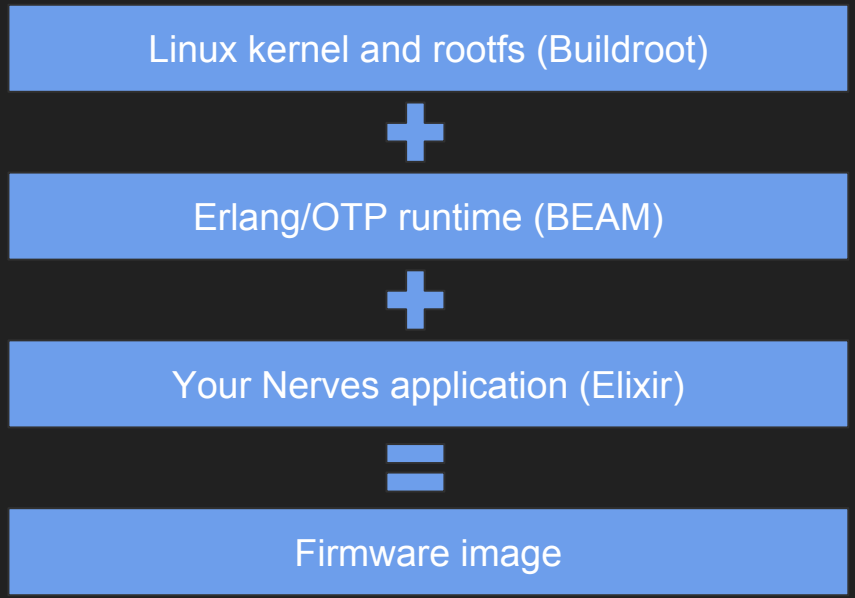
The current statistics from the Elixir community on Slack:
`#phoenix` 12,420+ members, `#nerves` 990+ members

What is Nerves?

Nerves (nerves-project.org) enables you to "*craft and deploy bulletproof embedded software in Elixir*".

Nerves is an umbrella project consisting of **tooling and libraries** enabling the development of **robust, reliable firmware** for **smart hardware** devices written in a **high-level** functional language (Elixir) and running on a **carrier-grade** runtime (Erlang/OTP).

What is Nerves?



- Produces firmware images as small as 18 MB, which includes the Linux kernel, the Erlang/OTP runtime, and your Nerves application
- Firmware images are burned to an SD card for deployment to target hardware
- The firmware boots in a few seconds: your application code can be running in as little 3-4 seconds after power on
- An incredibly stable runtime platform with low and predictable steady-state RAM consumption: on the order of 8 MB, and your application probably will fit in 32 MB

Why Elixir for Embedded Development?

- This is what the Erlang platform (OTP, BEAM) was designed for (telecomms switches)—good soft-realtime support
- Pattern matching (with bitstring support) is great for implementing wire protocols robustly
- The real world and real hardware is inherently concurrent, asynchronous, and unpredictable—message passing with the actor model is a good way to model that
- Fault tolerance and error recovery actually matter (just let it crash—so long as the user doesn’t notice)

Hobbyist Hardware for Nerves

Raspberry Pi 3 Model B (RPi3)

BeagleBone Green (BBG)

Hobbyist Hardware for Nerves

Raspberry Pi 3 Model B (RPi3)

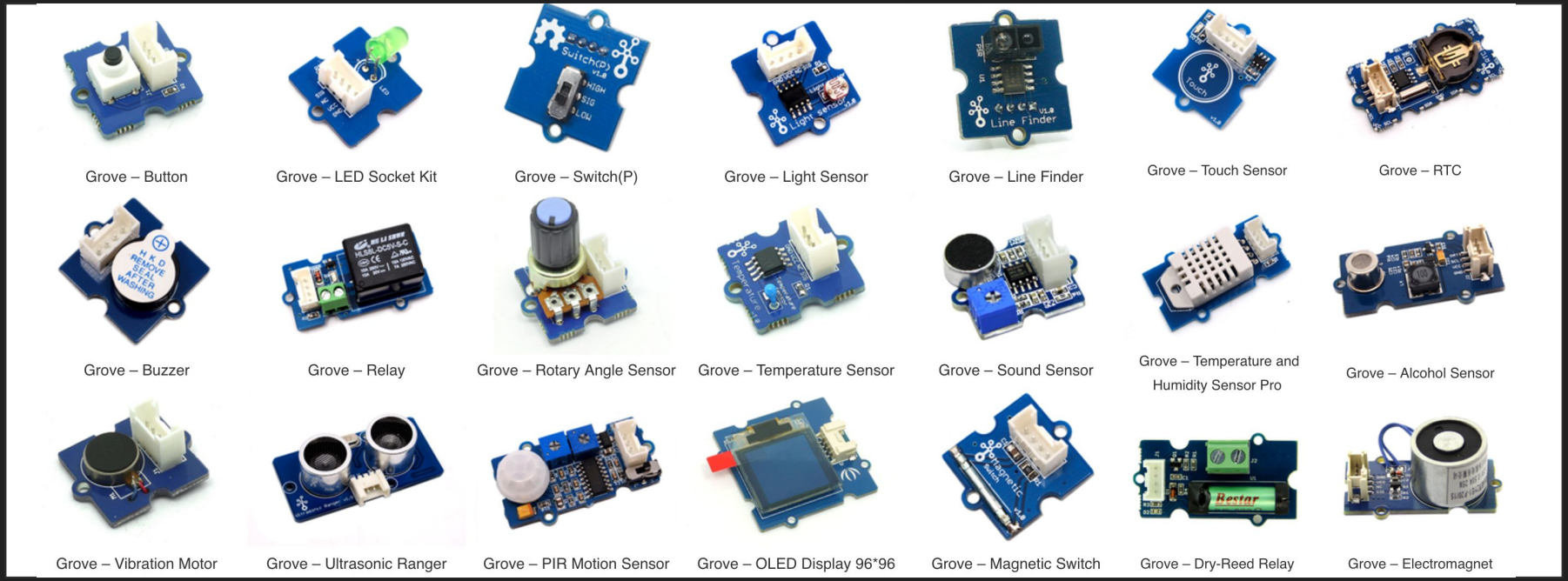
- **$35** MSRP
- 1.2 GHz Cortex-A53 (4× cores)
- 1 GB LPDDR2 RAM
- 4× USB ports, 1× Ethernet port, 1× HDMI port, etc
- 40× GPIO pins
- 802.11n Wi-Fi
- Bluetooth 4.1 and LE

BeagleBone Green (BBG)

- **$39** MSRP
- 1.0 GHz Cortex-A8
- 512 MB DDR3 RAM
- 1× USB port, 1× Ethernet port, micro-HDMI as add-on, etc
- 92× GPIO pins and 2× Grove connectors
- **Open-source hardware**, customizable for production designs

Hobbyist Hardware for Nerves

Seeed Studio's Grove System 100s of sensors and actuators



Example: LEDs and Buttons

```elixir
### Seeed Studio Grove LED

alias Nerves.Grove.LED

{:ok, pid} = LED.start_link(pin)

LED.blink(pid)
```

```elixir
### Seeed Studio Grove Button

alias Nerves.Grove.Button

{:ok, pid} = Button.start_link(pin)

# check if button is pressed:
state = Button.read(pid)
```

Example: Buzzers and OLEDs

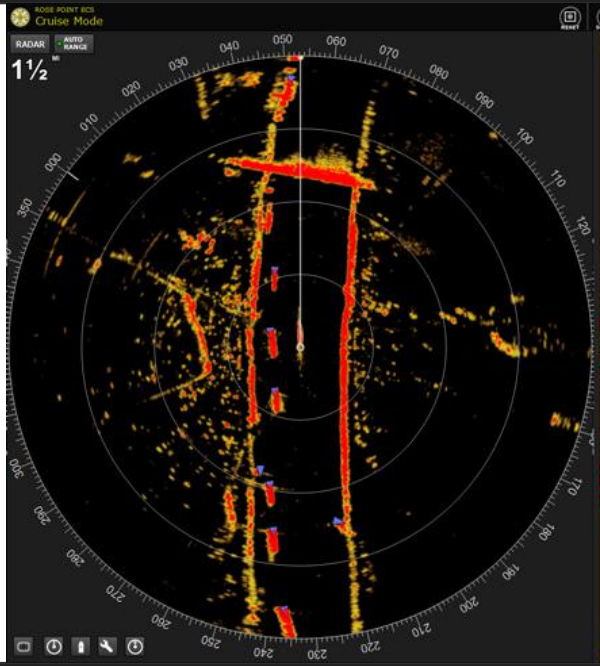
```
### Seeed Studio Grove Buzzer

alias Nerves.Grove.Buzzer

{:ok, pid} = Buzzer.start_link(pin)

# make some ugly noise for 100 ms:
Buzzer.beep(pid, 0.1)
```

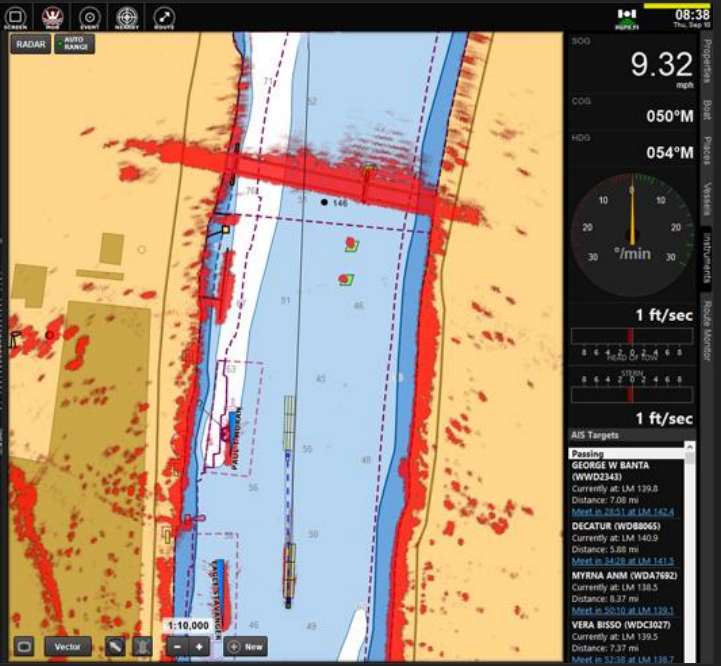
```
### Seeed Studio Grove OLED Display 96×96

alias Nerves.Grove.OLED

{:ok, pid} = OLED.Display.start_link(address)

OLED.Display.reset(pid)

OLED.Display.set_text_position(pid, 0, 0)

OLED.Display.put_string(pid, "Hello, world")
```

Commercial Products Based on Nerves

Commercial Radar Interface

http://www.rosepoint.com/commercial-radar-interface/





Future Products Based on Nerves

Anything and everything…

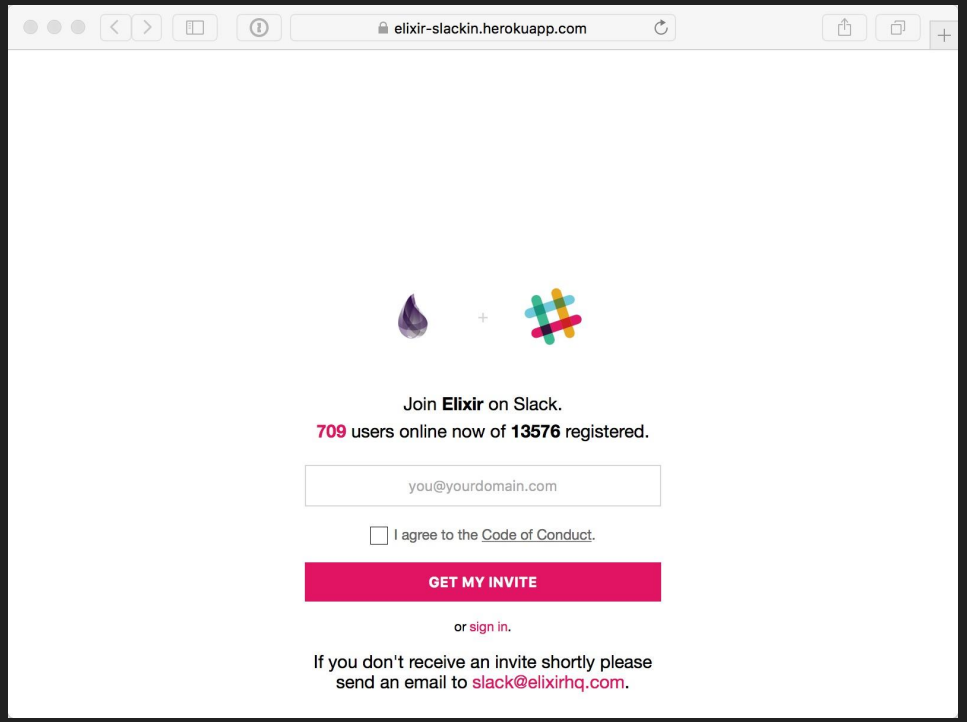
Your imagination is the limit.

Installing Nerves (on Macs)

https://hexdocs.pm/nerves/installation.html

```
$ brew update
$ brew install erlang elixir
$ brew install fwup squashfs coreutils

$ mix local.hex
$ mix local.rebar

$ mix archive.install \
  https://github.com/nerves-project/archives/raw/master/nerves_bootstrap.ez

$ mix nerves.new hello_nerves
```

Join the Nerves Community



- Sign up for an account at: https://elixir-slackin.herokuapp.com/
- Join the `#nerves` channel
- Currently 990+ members (March 2017)

- http://nerves-project.org/

What is Conreality?

Consensus Reality (aka **Conreality,** conreality.org) is a live-action augmented-reality, tactical wargame platform currently in an early development phase.

Conreality is built chiefly using Elixir and Nerves.

Reality is Boring

Let’s make it more interesting

Reality is Boring

“Anyone who sees a hurricane coming should warn others. I see a hurricane coming.

“<u>Over the next generation or two, ever larger numbers of people, hundreds of millions, will become immersed in virtual worlds and online games.</u> While we are playing, things we used to do on the outside, in “reality,” won’t be happening anymore, or won’t be happening in the same way. You can’t pull millions of person-hours out of a society without creating an atmospheric-level event.

“If it happens in a generation, I think [this] century will see a social cataclysm larger than that caused by cars, radios, and TV, combined. . . . The exodus of these people from the real world, from our normal daily life, will create a [cataclysmic] change in social climate.”

— **Edward Castronova**, *Exodus to the Virtual World* (2007)

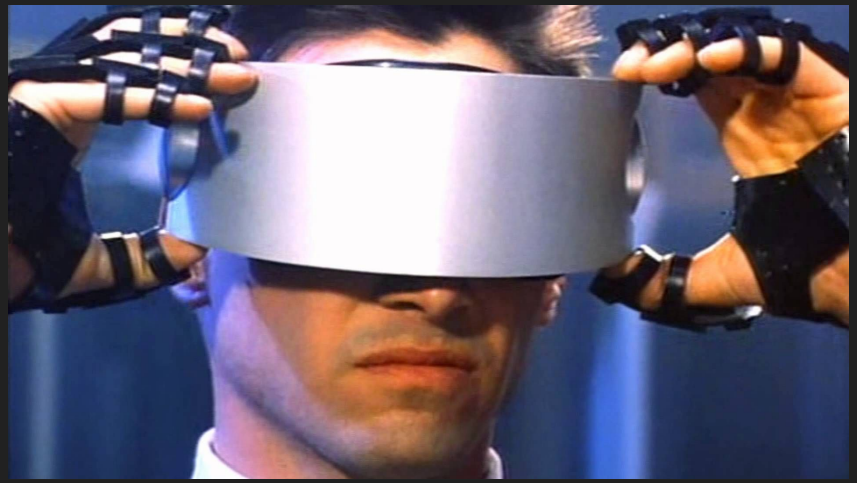
Reality is Broken

“Gamers want to know: Where, in the real world, is that gamer sense of being fully alive, focused, and engaged in every moment? Where is the gamer feeling of power, heroic purpose, and community? Where are the bursts of exhilarating and creative game accomplishment? Where is the heart-expanding thrill of success and team victory?

“While gamers may experience these pleasures occasionally in their real lives, they experience them almost constantly when they’re playing their favorite games. **The real world just doesn’t offer up as easily the carefully designed pleasures, the thrilling challenges, and the powerful social bonding afforded by virtual environments. . . . Reality, compared to games, is broken.**”

— **Jane McGonigal**, *Reality is Broken: Why Games Make Us Better and How They Can Change the World* (2011)

2016: VR and AR, At Long Last



Virtual Reality (VR)

Johnny Mnemonic (1995)

Augmented Reality (AR)

Iron Man (2008)

Say No to VR

VR as a Solution to the Fermi Paradox?

“I suggest a different, even darker solution to the Paradox. Basically, I think the aliens don’t blow themselves up; they just get addicted to computer games.

“They forget to send radio signals or colonize space because they’re too busy with runaway consumerism and virtual-reality narcissism. They don’t need Sentinels to enslave them in a Matrix; they do it to themselves, just as we are doing today.

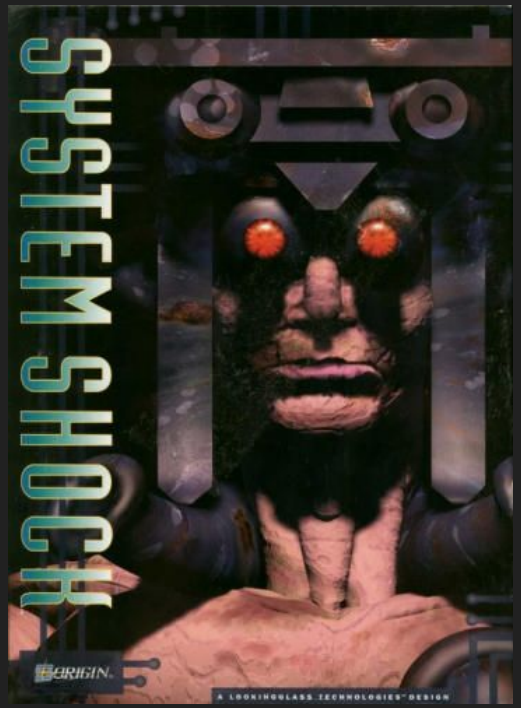
“Once they turn inwards to chase their shiny pennies of pleasure, they lose the cosmic plot. They become like a self-stimulating rat, pressing a bar [which] feels…ever so good.”

— **Geoffrey Miller**, *Why We Haven’t Met Any Aliens* (2006)
http://seedmagazine.com/content/article/why_we_havent_met_any_aliens/

Cyberpunk Games

Dystopian virtual reality at its best

Cyberpunk Games

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NATURALS
AUKCE

Live-Action Games

Bringing dystopia back home

Live-Action Games Today

- Historical reenactment
- LARPs
- Paintball
- Airsoft
- Laser tag
- Office games (e.g., nerf guns)
- Geocaching
- Rudimentary AR
  - Ingress
  - Pokemon Go


DRONEDeer

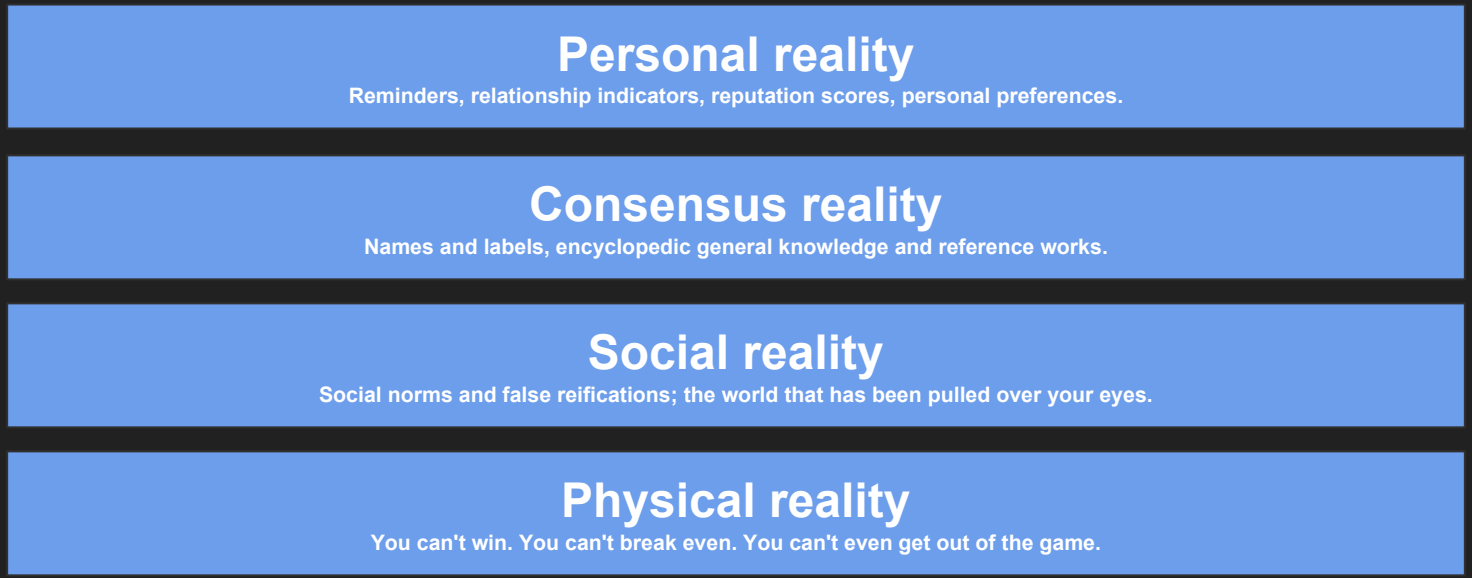
Augmented Reality

It’s all about the man-machine I/O interface


MIXED REALITY VIDEO CAPTURED FROM THE HOLOLENS


JOBMONKEY
inspiration
guru
JOB MONKEY
URGENT
3 NEW MESSAGES
virtuality
FEEL
POINTS MANAGER
JOB MONKEY
LEVEL
4
23
Dark Augmented
Reality

Levels of Reality



Tactical Software

Open source **all** the things

Open Source **All** The Things

- After several decades of open source eating up the software industry, we now have almost any conceivable software available in open-source form…
  - **Infrastructure**: Operating systems, web servers
  - **Networking:** Web browsers, email clients, secure messaging
  - **Entertainment**: Games, game engines, graphics engines, 3D engines
  - **Design**: Graphics editors, 3D modeling tools, CAD
  - **Boring yet essential**: Accounting software, ERP, POS
  - *etc etc etc …*

- However, what we do ***not*** have is **open-source tactical software.**

Tactical Software

- What exists today, inadvertently:
  - Open-source autopilots for planes/quadcopters
    - However, mainly focused aerial photography
  - Open-source physics engines
    - However, stark choice between exaggerated physics for games or slow, accurate simulation of molecular dynamics
- Examples of what does **not** exist:
  - Physics engines with support for accurate terminal ballistics
    - Ensure a turret's or drone's airsoft or nerf gun pellet hits its intended target
  - Open-source targeting systems
    - Physical and semantic models for motion prediction
    - Laser guidance for object tracking

Technology

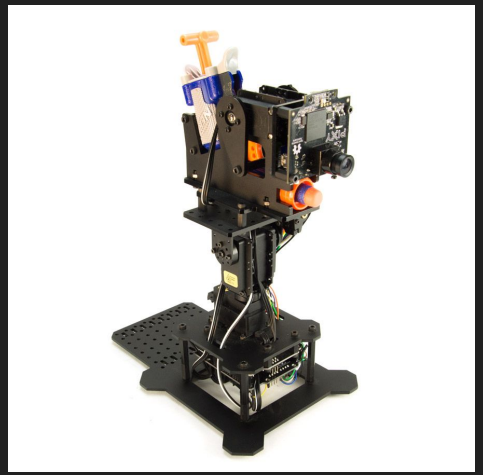
A*, APM, BBB/BBG(W), BEC, BTLE, Buildroot, C/C++, CoAP, DMA, DW1000, ESC, Elixir, Erlang, FPV, GAP, GATT, GPIO, Gazebo, I2C, IRC, LIDAR, Lua, MATLAB, MQTT, MAVLink, Nerves, NFC, OPTO, OpenCV, PCB, POSIX, PPM, Prolog, PWM, PX4, PXFmini, QEMU, RDF, RK4, ROS, RPi, RTLS, SBEC, SLAM, SPI, TCP, TDOA, UART, UBEC, UDP, USB, UVC, UWB, V4L2, seL4, …

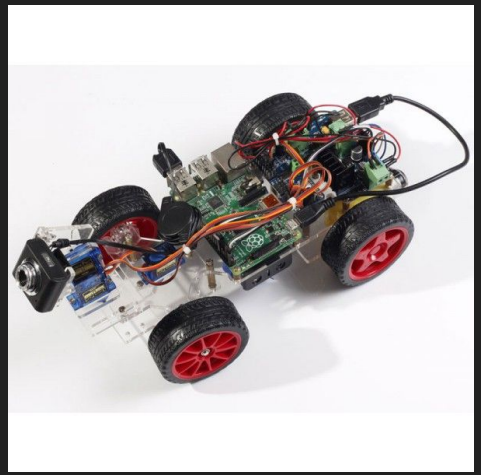
Concept Hardware

Rapid iteration through 3D printing

WIP Concepts

- Laser Turret MkI
- Scout Car MkI
- Recon Drone MkI
- Assault Drone MkI

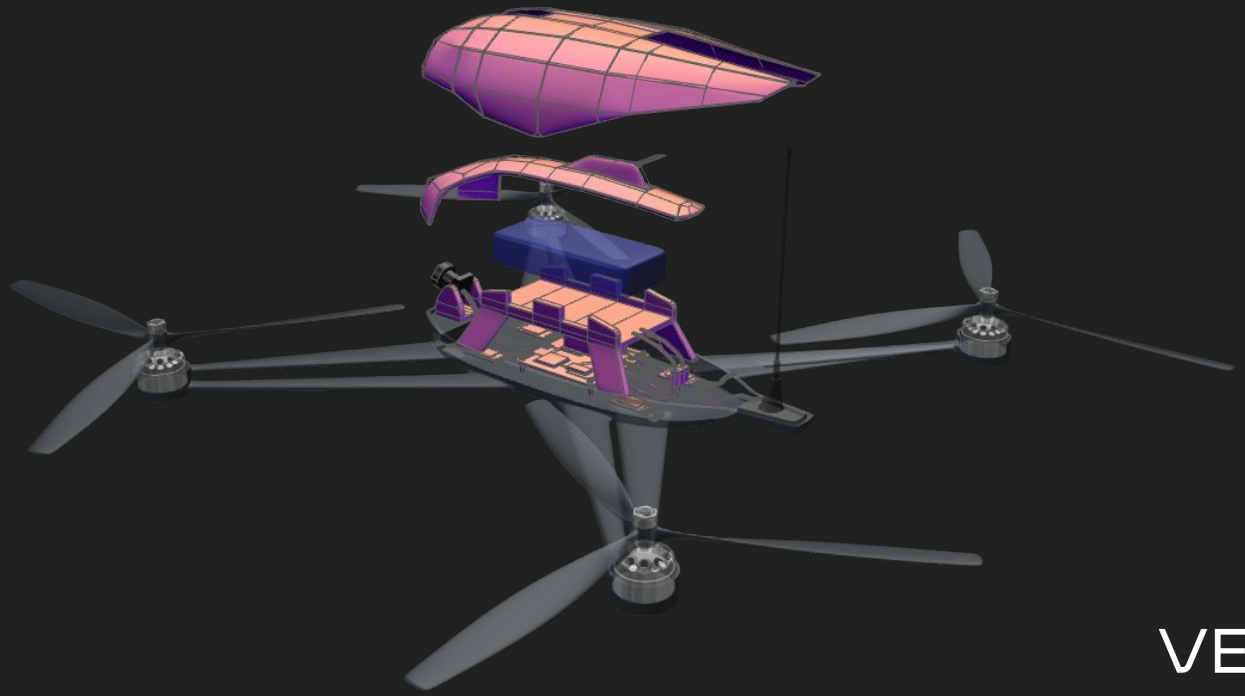




WIP Concepts

VECTARY

WIP Concepts



VECTARY

Team in Berlin and Bratislava

- @ab0032 (Alexander)
- @bendiken (Arto)
- @dankomorny (Dan)
- @gilcherry (Gilbert)
- @joecoin (Joerg)
- @mikegogulski (Mike)

Hackathons in Berlin and Bratislava

- Semi-regular hackathons in Berlin and Bratislava
- Gather in one place to work on proof-of-concepts and integrate individual work being done separately in Berlin and Bratislava
- **The next Conreality Hackathon will take place in Berlin the first week of April 2017**

Contribution Opportunities

- Designers, coders, hackers, makers
  - A chance to participate in something **tangible** (non-abstract, unlike so much software), **highly challenging**, and, most of all, **plain old fun**

- Promotional partnerships with design shops and hackerspaces
  - Exposure at a number major annual conferences as well as regular meetups in hackerspaces that we'll be giving talks at:
    - ProgressBar Hackerspace in Bratislava (2017)
    - HCPP17 in Prague (Oct 6-8, 2017)
    - Chaos Communication Congress (34C3) in Hamburg (Dec 2017)
    - FOSDEM 2018 in Brussels (Feb 2018)
    - *etc etc etc …*

Дякую!

Find me at:

http://ar.to & **@bendiken**