hackerspace global grid

world domination - one measurement at a time

hadez@hgg.aero, @hdznrrd armin@hgg.aero, @rel0c8

shackspace - devision for aerospace research and space exploration

10. Mai 2012

Caveat

- hgg is, at its heart, a *very* technical project
- Fear not! This presentation will give you a general overview and keep technicalities to a minimum

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  - Ambitious goal: 23 years to put a hacker on the moon!
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The first idea

- Short term: Understand how satellite communication works
- Mid term: Setup something so we can receive sat comm
  - Make it simple. Each *hackerspace* should have one.
  - Each Hackerspace means it's global
  - Network the ground stations and build a grid
- Long term: Add something so we can also send signals

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Joining up w/ Constellation

- Andreas Hornig of AerospaceResearch.net ends up giving a talk on Constellation at shackspace
- Both sides immediately notice the similarity in his DGSN and our HGG idea
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- "Hacking im Weltraum - Hacker arbeiten an eigenem Satellitennetzwerk"
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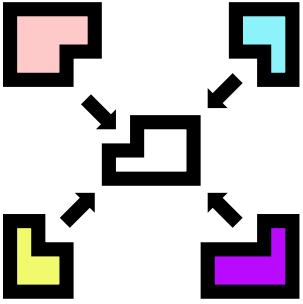

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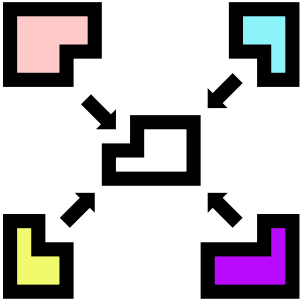

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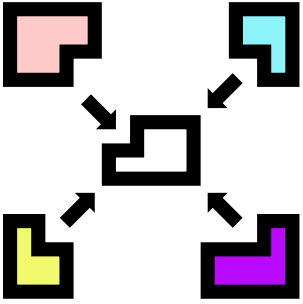

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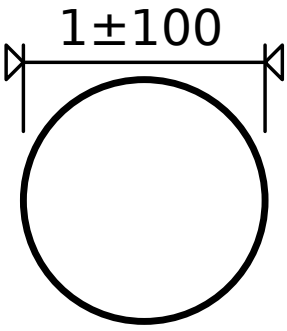

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- Let's aim for 100 ns
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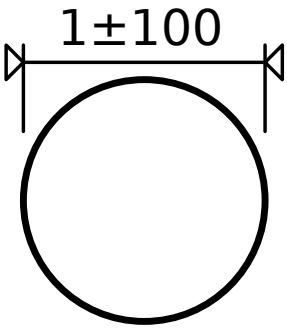

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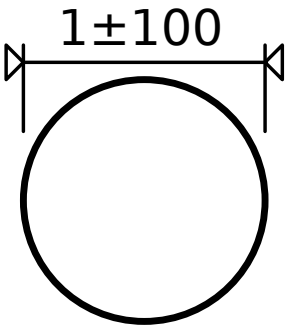

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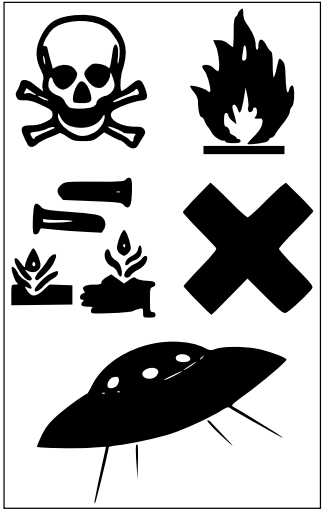

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- Satellites
- Background radiation
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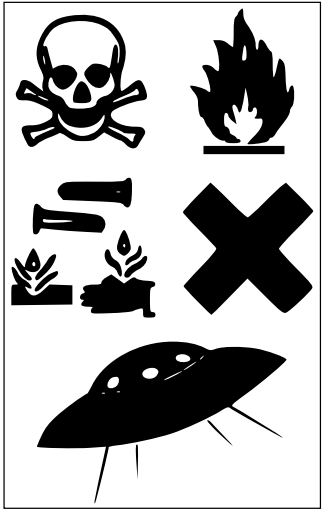

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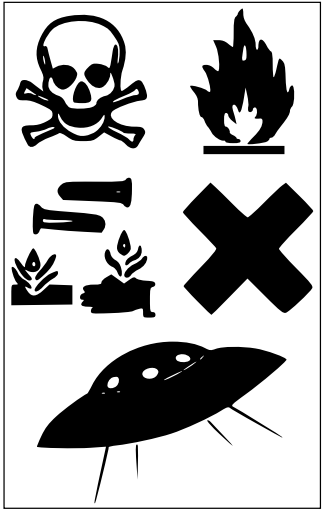

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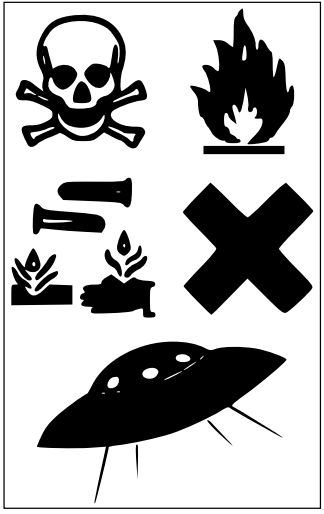

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Who's behind it?

- Just a bunch of folks, really
  - reloc0 & hadez & saeugetier working on hgg
  - -horn- working on Constellation
  - Paweł, Isaac, and a few others working on various projects
- No company or governments
- By hackers, for everyone

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  - Amateur satellite community
  - Hackers & makers
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- Try to make it easier to understand where certain details aren't documented well
- Document our findings, results and failures for others to learn from

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What about applications?

- Constellation
  - Track amateur satellites
  - Using pseudo-ranging w/ multiple receiver stations
- Once ground stations start gathering and publishing data, the possibilities are endless
  - Live track background radiation levels
  - Spot subtle changes in the environment over time
  - Accurate, geo-referenced time
  - Base for assisted GPS solutions
  - and many, many more!

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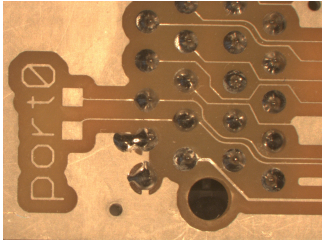
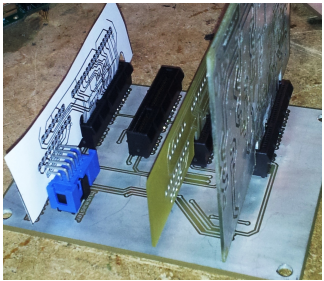
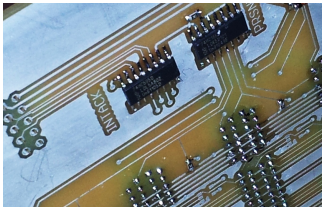
Specification of physical interface between modules



- Modules are connected via a backplane
- PCIe 4x plug w/ custom pinout
- 2x RS485 lanes for inter-module communication
- SPI-ish time broadcast bus
- Differential clock signal for high-res timing signal
- Each module sports storage for calibration data

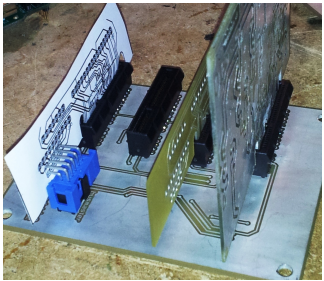
friendship0 backplane

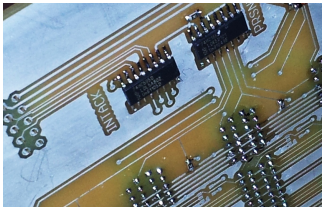




- Four modules slots, one dedicated to bus master module
- ICs for interrupt handling
- Can be easily scaled up, next step eight or nine slots

friendship0 backplane





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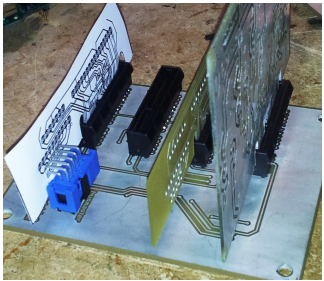

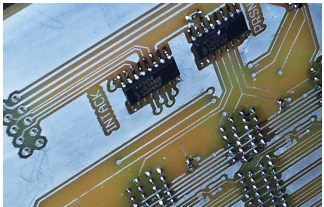

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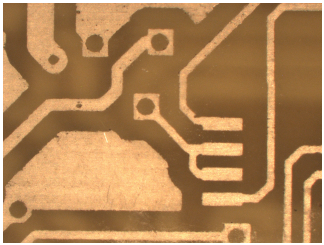
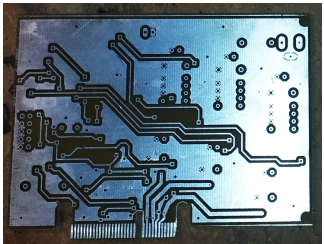
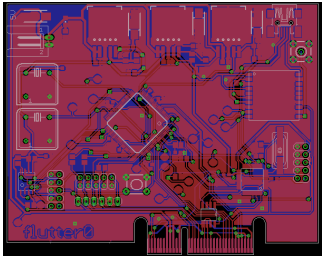
braeburn0 & 1 power supply module





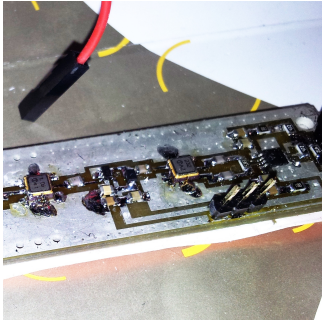
- Single external power source
- All voltages generated on-board, stabilized
- In-system voltage level monitoring
- braeburn1 using PC power supply

flutter0 high precision distributed time source module



- Spartan3 FPGA for high-res timing (<100 ns)
- ATmega 168 for lo-res timing (1 s to 1/10th s)
- Low cost GPS module w/ external antenna support

dash0 proof of concept



- ADS-B receiver based around miniADSB module
- Easily track commercial aircrafts
- Perfect for verifying pseudo ranging algorithms

celestia0 bus master module

- Manages interrupt requests by modules
- Arbitrates resources
- Enumeration of available modules

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dash0 ADSB receiver module

- Built around the proof of concept
- Most likely CPLD-based decoding of Manchester-encoded signal
- Contributions by Pawel
- Perfect to test pseudo-ranging because ADSB signal contains GPS location data already (ground truth)
- Your own fligt tracking radar at home? Hell, yeah!

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- Protocol spoken between modules and master
- Handles data exchange and enumeration

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Testing timing accuracy

- First level test: 2x ground stations w/ flutter module
- Second level test: 5 ground stations w/ flutter module

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Calibration

- High accuracy measurement requires diligent calibration
- Receiver, decoder, communication lags
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- Test pseudo ranging and timing
- This will decide whether tracking would already work with our timing resolution
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- Review everything
- Make improvements where necessary
- Manufacture pre-series
- Hand ground stations out to other hackerspaces and interested subsubsectionies

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- Arduino module
  - Probably the easiest way to prototype
  - Make it available to an already large community
- Environment sensors
  - Measure ALL the things
  - Temperature, humidity, barometric pressure, seismic waves, radiation, technical stuff, time, wind, ...

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Satellites!

- Not impossible, though not really *our* goal

Why we have not asked for donations, yet

- Offers from heartwarming to ridiculous
- Still doing research and feasibility studies
- No guarantee that it'll ever work (chances are good, though)
- No money asked, no one disgruntled if it fails.

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  - There's a list of open tasks. Pick one or add one!
- GitHub
  - All source code, schematics and layouts available at github.com
  - Issue tracking. Find a problem, raise an issue!
- Public mailing list
  - lists.shackspace.de/listinfo/constellation
  - Fairly low traffic at the moment, this might change in the forseeable future
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shack
stuttgart hackerspace

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Questions!

Pretty please :)