

hackerspace global grid

world domination - one measurement at a time

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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!
- Three hackers from shackspace immediately brainfart
- "This is awesome!"
- "Let's do it!"
- P.S.: hgg is a small part in the bigger scheme of the *Hacker Space Program*

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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.
 - It should be a low cost solution.
 - It should be a low power solution.
- Long term: Add something so we can also send signals

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- 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*
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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
- We join forces

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"Call to arms" talk at 28c3

- After the initial research and proof of concepts we thought it would be nice to have 3 to 5 more folks helping us
- So we handed in a talk for 28c3
- Press feedback was never the same...

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Press feedback

- "Hacker aus Stuttgart - Mit dem Lötkolben ins Weltall"
– *Stuttgarter Zeitung*
- "Hacking im Weltraum - Hacker arbeiten an eigenem Satellitennetzwerk"
– *Golem*
- "Hackers send internet into space"
– *UK Metro*
- "Hackers plan space satellites to combat censorship"
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What hgg definitely isn't

- The *Hacker Space Program's* aim is to have communication infrastructure in place at some point
- *Hackespace Global Grid / hgg* is working on the very basics of this (distributed ground station network)
- However, we (as in hgg) are *not* building an alternative internet at the moment
- We are working on getting something out there which can be used as a platform and starting point to seed other projects and ideas

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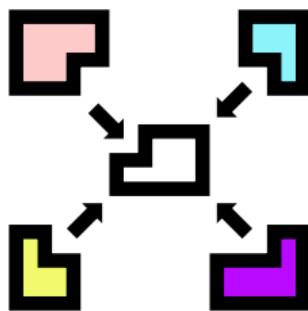
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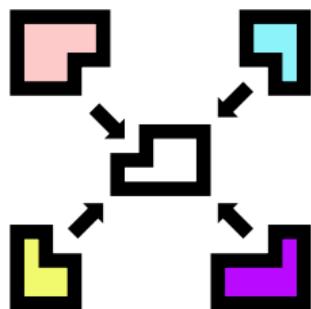
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Build a modular system



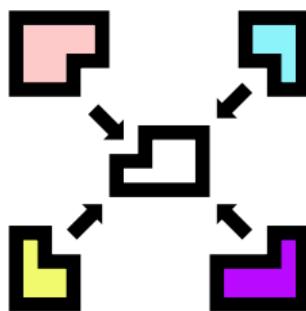
- Easier to develop
- Easier to extend
- Easier to improve

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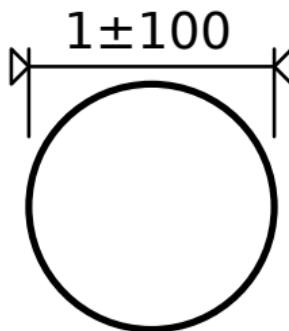
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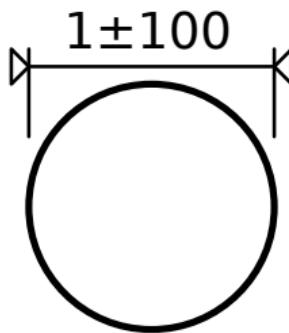
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Make it as accurate as possible



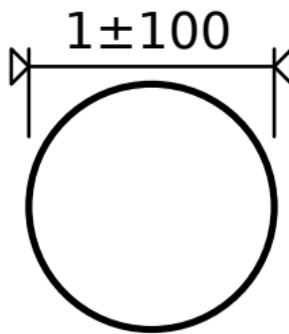
- One second resolution is "boring"
- Let's aim for 100 ns
- Allow scaling up to "ridiculous"

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Measure stuff



- Airplanes
- Satellites
- Background radiation
- Or even just the temperate

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Make it a distributed system



- Many simple measurement stations
- networked together
- providing geo-coded data

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Make it easy to use



- Ideal: build your own
- Realistic: assemble a kit
- Lazy: buy it, plug it in, forget about it

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What is hgg

Who's behind it?

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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What we're actually doing

The core idea

Consolidating existing and new information

- There is already *a lot* of information available
 - HAM radio community
 - Amateur satellite community
 - Hackers & makers
- We're collecting information relevant to the ask
- 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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- FPGA programming in VHDL
- Microcontroller programming in C
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http://www.hackerspaceglobalgrid.com/constellation.html#satellite

http://www.hackerspaceglobalgrid.com/constellation.html#groundstation

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 - Live-track background radiation levels
 - Predict orbital paths of satellites
 - Determine orbital mechanics of satellites
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- Once ground stations start gathering and publishing data, the possibilities are endless
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 - Spot minute changes in the environment over time
 - Accurate, geo-referenced time
 - Basis for assisted GPS solutions
 - and many, many more

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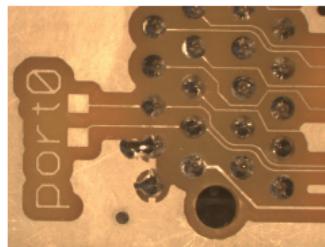
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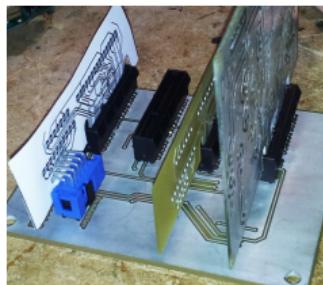
Status quo

Specification of physical interface between modules



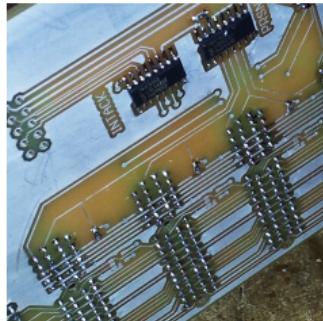
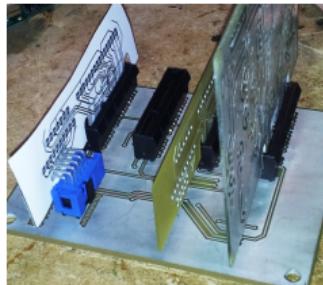
- Modules are connected via a backplane
- PCIe 4x plug w/ custom pinout
- 2x RS485 lanes for inter-module communication
- SPI-ish time broadcast bus
- Differential clock signal for high-res timing signal
- Each module sports storage for calibration data

friendship0 backplane



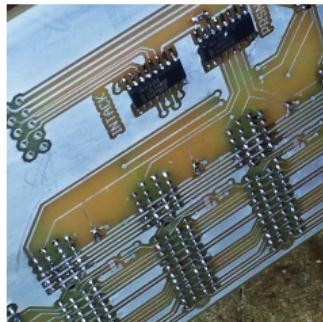
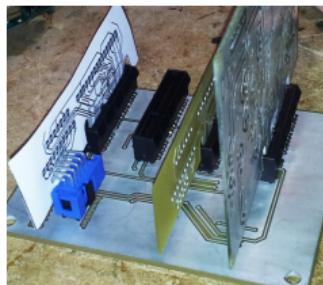
- Four modules slots, one dedicated to bus master module
- ICs for interrupt handling
- Can be easily scaled up, next step eight or nine slots

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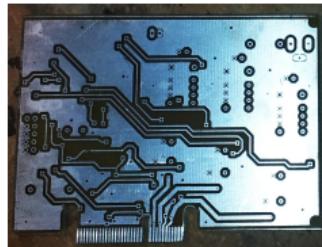
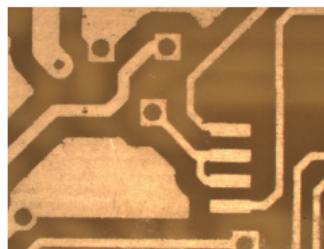
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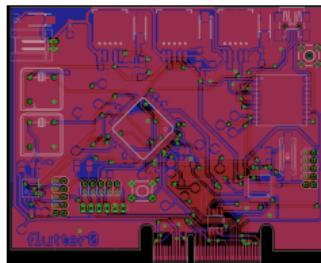
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braeburn0 & 1 power supply module



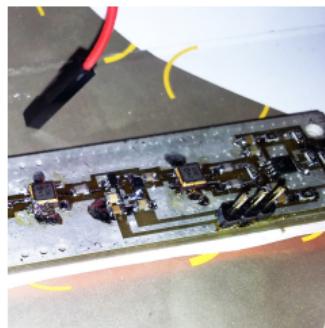
- Single external power source
- All voltages generated on-board, stabilized
- In-system voltage level monitoring
- braeburn1 using PC power supply

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

hackerspace global grid

On the horizon

celestia0 bus master module

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

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

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magic0 bus protocol

- 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
 - Phase error
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Deploying 5+ systems

- Test pseudo ranging and timing
- This will decide whether tracking would already work with our timing resolution
- If not, timing resolution could be scaled up by factor 10 easily

Quality tests and review

- Review everything
- Make improvements where necessary
- Manufacture pre-series
- Hand ground stations out to other hackerspaces and interested subsectionies

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More modules

- Arduino module

- Probably the easiest way to prototype
- Make it available to an already large community

- Environment sensors

Temperature, humidity, light, motion, ...
... and many more

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More modules

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- Environment sensors

- Measure ALL the things

Temperature, humidity, light, motion, sound, air quality, water level, ...

... and many more sensors are available

More modules

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 - Probably the easiest way to prototype
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 - Measure ALL the things
 - Temperature, humidity, barometric pressure, seismic waves, radiation, tectonic drift, 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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- After prototype works good enough
- Before rolling out on a bigger scale (think 10+)

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Keep in touch

- Wiki

- Edit away at <http://hgg.aero/>
- There's a list of open tasks. Pick one or add one!

- GitHub

Check out the [GitHub organization](#) for the latest projects and code snippets. You can also contribute to the [open source projects](#) there.

- Public mailing list

Join the [public mailing list](#) to stay up-to-date on the latest news and developments. It's a great way to connect with other members of the community and ask questions.

- twitter

Follow us on [Twitter](#) for the latest news and updates.

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- All source code, schematics and layouts available at github.com

- Pull requests welcome, or just drop us a line if you have questions

- Public mailing list

- mailinglist@hgg.aero

- You can also join the mailing list via the [hgg.aero](http://hgg.aero/mailman/listinfo) website

- If you're not sure what to do, just drop us a line

- twitter

- [@hgg_aero](https://twitter.com/hgg_aero)

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 - <https://lists.hackerspace.de/listinfo/constellation>
 - You can subscribe to the mailing list via the link above or via the "Subscribe" button in the footer of this slide.
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Pretty please :)