

hackerspace global grid

world domination - one measurement at a time

hadez@hgg.aero, @hdznrrd timm@hgg.aero, @timmedia



shackspace - devision for aerospace research, space exploration and other improbable sciences

27. Oktober 2012

1 What is hgg

2 What we're actually doing

Once upon a time

- There were 3 guys wanting to understand satellite communications
- Build networked receiver stations just for kicks

Once upon a time

- There were 3 guys wanting to understand satellite communications
- Build networked receiver stations just for kicks

Now

- Joined forces with the Constellation project (Andreas Hornig)
- We're building a distributed measurement network
- Aiming to track HAMSATs

Now

- Joined forces with the Constellation project (Andreas Hornig)
- We're building a distributed measurement network
- Aiming to track HAMSATs

Now

- Joined forces with the Constellation project (Andreas Hornig)
- We're building a distributed measurement network
- Aiming to track HAMSATs

What is hgg

hgg in a nutshell

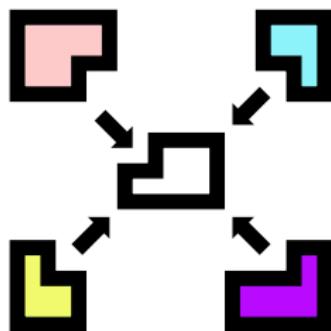
1 What is hgg

- hgg in a nutshell
- Who's behind it?

2 What we're actually doing

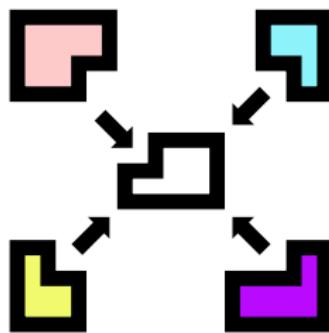
- The core idea
- Status quo
- How to help

Build a modular system



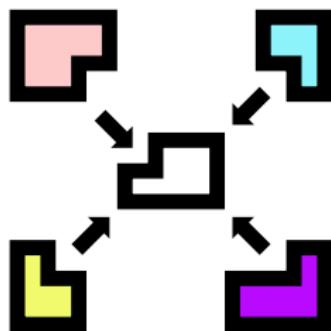
- Easier to develop
- Easier to extend
- Easier to improve

Build a modular system



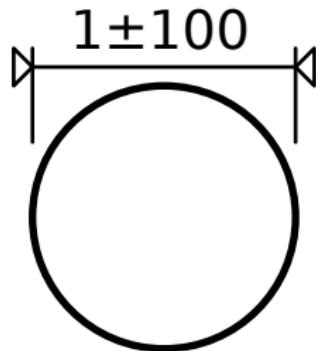
- Easier to develop
- Easier to extend
- Easier to improve

Build a modular system



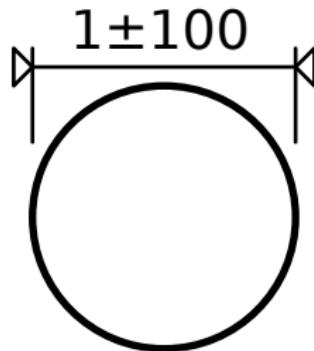
- Easier to develop
- Easier to extend
- Easier to improve

Make it as accurate as possible



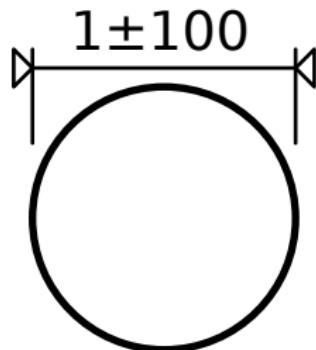
- One second resolution is "boring"
- Let's aim for 100 ns
- Allow scaling up to "ridiculous" (for a hobby project)

Make it as accurate as possible



- One second resolution is "boring"
- Let's aim for 100 ns
- Allow scaling up to "ridiculous" (for a hobby project)

Make it as accurate as possible



- One second resolution is "boring"
- Let's aim for 100 ns
- Allow scaling up to "ridiculous"(for a hobby project)

Measure stuff



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

What is hgg

hgg in a nutshell

Measure stuff



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

Measure stuff



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

What is hgg

hgg in a nutshell

Measure stuff



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

Make it a distributed system



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

Make it a distributed system



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

Make it a distributed system



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

What is hgg

hgg in a nutshell

Make it easy to use



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

What is hgg

hgg in a nutshell

Make it easy to use



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

Make it easy to use



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

What is hgg

Who's behind it?

1 What is hgg

- hgg in a nutshell
- Who's behind it?

2 What we're actually doing

- The core idea
- Status quo
- How to help

What is hgg

Who's behind it?

Who's behind it?

- Just a bunch of folks, really

- reloc0 & hadez & Timm working on hgg
- -horn- working on Constellation
- Paweł, Isaac, and a few others working on various projects

What is hgg

Who's behind it?

Who's behind it?

- Just a bunch of folks, really
 - reloc0 & hadez & Timm working on hgg
 - -horn- working on Constellation
 - Paweł, Isaac, and a few others working on various projects

What is hgg

Who's behind it?

Who's behind it?

- Just a bunch of folks, really
 - reloc0 & hadez & Timm working on hgg
 - -horn- working on Constellation
 - Paweł, Isaac, and a few others working on various projects

What is hgg

Who's behind it?

Who's behind it?

- Just a bunch of folks, really
 - reloc0 & hadez & Timm working on hgg
 - -horn- working on Constellation
 - Paweł, Isaac, and a few others working on various projects

1 What is hgg

2 What we're actually doing

1 What is hgg

- hgg in a nutshell
- Who's behind it?

2 What we're actually doing

- The core idea
- Status quo
- How to help

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
- Improve documentation where we had found details difficult to understand
- Document our findings, results and failures for others to learn from

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
- Improve documentation where we had found details difficult to understand
- Document our findings, results and failures for others to learn from

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
- Improve documentation where we had found details difficult to understand
- Document our findings, results and failures for others to learn from

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
- Improve documentation where we had found details difficult to understand
- Document our findings, results and failures for others to learn from

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
- Improve documentation where we had found details difficult to understand
- Document our findings, results and failures for others to learn from

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
- Improve documentation where we had found details difficult to understand
- Document our findings, results and failures for others to learn from

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
- Improve documentation where we had found details difficult to understand
- Document our findings, results and failures for others to learn from

Learning the basics

- PCB design
- FPGA programming in VHDL
- Microcontroller programming in C
- Antenna design

Learning the basics

- PCB design
- FPGA programming in VHDL
- Microcontroller programming in C
- Antenna design

Learning the basics

- PCB design
- FPGA programming in VHDL
- Microcontroller programming in C
- Antenna design

Learning the basics

- PCB design
- FPGA programming in VHDL
- Microcontroller programming in C
- Antenna design

Open source everything

- Code available at github.com/shackspace/hgg
- Documentation and planning at hgg.aero/

Open source everything

- Code available at github.com/shackspace/hgg
- Documentation and planning at hgg.aero/

What is it actually good for?

- Public access to all measurement results (don't get cheated)
- Access to infrastructure to deploy your own (measurement) equipment

What is it actually good for?

- Public access to all measurement results (don't get cheated)
- Access to infrastructure to deploy your own (measurement) equipment

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

• Weather monitoring

• Monitoring atmospheric conditions

• Monitoring space weather

• Monitoring orbital debris

• Monitoring solar activity

• Monitoring ionosphere

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

http://www.hackerspace-global-grid.org/constellation.html

http://www.hackerspace-global-grid.org/groundstation.html

http://www.hackerspace-global-grid.org/pseudoranging.html

http://www.hackerspace-global-grid.org/possibilities.html

http://www.hackerspace-global-grid.org/other.html

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
 - Predict orbital decay and atmospheric reentry
 - Track orbital debris
 - Identify potential collision risks
 - Monitor solar activity and space weather
 - Track celestial events like meteor showers or planetary alignments

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 minute changes in the environment over time
 - Accurate, geo-referenced time
 - Basis for assisted GPS solutions
 - and many, many more

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 minute changes in the environment over time
 - Accurate, geo-referenced time
 - Basis for assisted GPS solutions
 - and many, many more

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 minute changes in the environment over time
 - Accurate, geo-referenced time
 - Basis for assisted GPS solutions
 - and many, many more

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 minute changes in the environment over time
 - Accurate, geo-referenced time
 - Basis for assisted GPS solutions
 - and many, many more

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 minute changes in the environment over time
 - Accurate, geo-referenced time
 - Basis for assisted GPS solutions
 - and many, many more

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 minute changes in the environment over time
 - Accurate, geo-referenced time
 - Basis for assisted GPS solutions
 - and many, many more

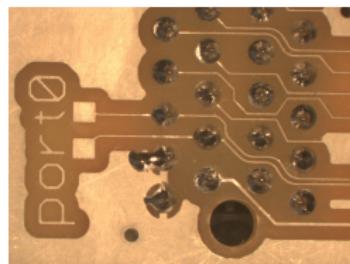
1 What is hgg

- hgg in a nutshell
- Who's behind it?

2 What we're actually doing

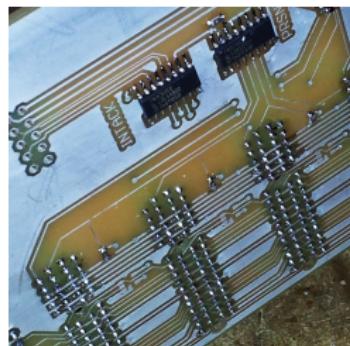
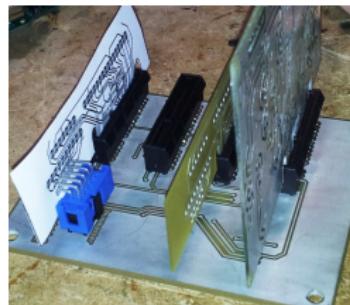
- The core idea
- Status quo
- How to help

Specification of physical interface between modules



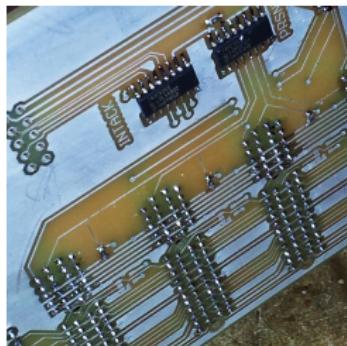
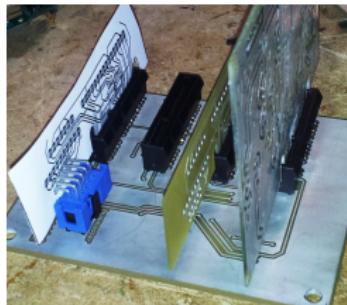
- Modules are connected via a backplane
- PCIe 4x plug w/ custom pinout
- 2x RS485 lanes for inter-module communication
- SPI-ish time broadcast bus
- Differential clock signal for high-res timing signal
- Each module sports storage for calibration data

friendship0 backplane



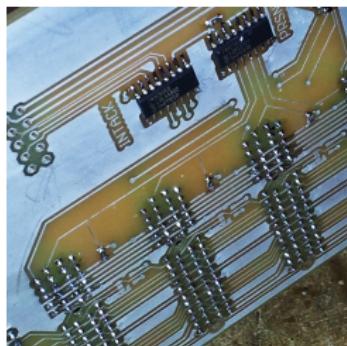
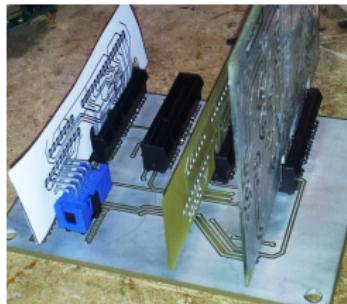
- Four modules slots, one dedicated to bus master module
- ICs for interrupt handling
- Can be easily scaled up, next step eight or nine slots

friendship0 backplane



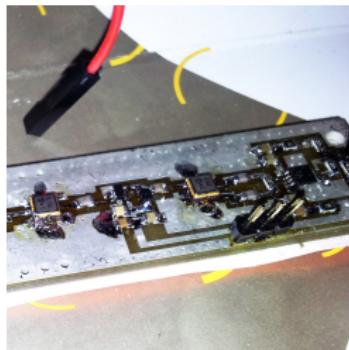
- Four modules slots, one dedicated to bus master module
- ICs for interrupt handling
- Can be easily scaled up, next step eight or nine slots

friendship0 backplane



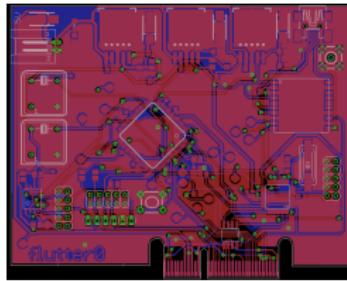
- Four modules slots, one dedicated to bus master module
- ICs for interrupt handling
- Can be easily scaled up, next step eight or nine slots

dash0 proof of concept



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

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

1 What is hgg

- hgg in a nutshell
- Who's behind it?

2 What we're actually doing

- The core idea
- Status quo
- How to help

Join us

- We meet almost every Saturday at shackspace, the stuttgart hackerspace

Keep in touch

- Wiki

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

- GitHub

<https://github.com/hackerspace-global-grid>
A public repository for the Hackerspace Global Grid project.

- Public mailing list

hgg@lists.hackerspace.global.grid
A public mailing list for the Hackerspace Global Grid project.

- twitter

https://twitter.com/hackerspace_g

Keep in touch

- Wiki

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

- GitHub

<https://github.com/hackerspace-global-grid>

Check out our repository for code, documentation, and other useful files.

- Public mailing list

mailinglist@hackerspace-global-grid.org

Join our public mailing list to receive updates about the project and its progress.

- twitter

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

Keep in touch

- Wiki
 - Edit away at <http://hgg.aero/>
 - There's a list of open tasks. Pick one or add one!
- GitHub
 - All source code, schematics and layouts available at [github.com](https://github.com/hackerspace-global-grid)
 - Pull requests welcome
- Public mailing list
 - hgg@lists.hackerspace.global.grid
 - Subscriptions and management via <https://lists.hackerspace.global.grid>
- twitter
 - https://twitter.com/hackerspace_g

Keep in touch

- Wiki
 - Edit away at <http://hgg.aero/>
 - 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
 - hgg@lists.hackerspace.global
 - <https://lists.hackerspace.global/mailman/listinfo/hgg>
- twitter
 - [@hackerspaceglobal](https://twitter.com/hackerspaceglobal)

Keep in touch

- Wiki
 - Edit away at <http://hgg.aero/>
 - 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

- twitter

Keep in touch

- Wiki
 - Edit away at <http://hgg.aero/>
 - 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.hackerspace.de/listinfo/constellation
 - A place to discuss anything related to the project, the space or the community.
 - <https://mailman.hackerspace.de/mailman/listinfo/constellation>
- twitter
 - [@hackerspaceglobalgrid](https://twitter.com/hackerspaceglobalgrid)
 - A place to keep up to date with what's happening at the space.

Keep in touch

- Wiki
 - Edit away at <http://hgg.aero/>
 - 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 foreseeable future.
- twitter

http://hgg.aero

Keep in touch

- Wiki
 - Edit away at <http://hgg.aero/>
 - 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 foreseeable future.
- twitter

http://hgg.aero

Keep in touch

- Wiki
 - Edit away at <http://hgg.aero/>
 - 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 foreseeable future.
- twitter

@GlobalGrid

Keep in touch

- Wiki
 - Edit away at <http://hgg.aero/>
 - 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 foreseeable future.
- twitter
 - [@hxglobalgrid](https://twitter.com/hxglobalgrid)

Keep in touch

- Wiki
 - Edit away at <http://hgg.aero/>
 - 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 foreseeable future.
- twitter
 - @hxglobalgrid