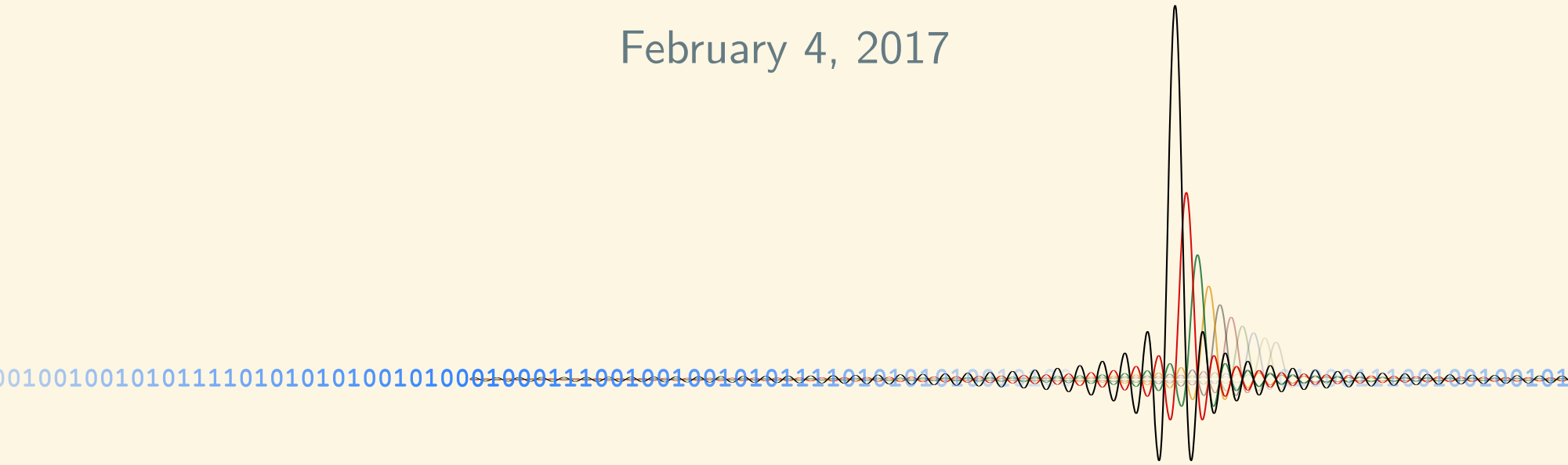
From 0 to 6 GHz in 30 minutes – bootstrap your SDR Experience!

Start from scratch today, hack the EM spectrum tomorrow!

Marcus Müller

FOSDEM 2017

February 4, 2017



From theory to practice

Engineering in theory

- Analyze the situation
- Implement
- Improve

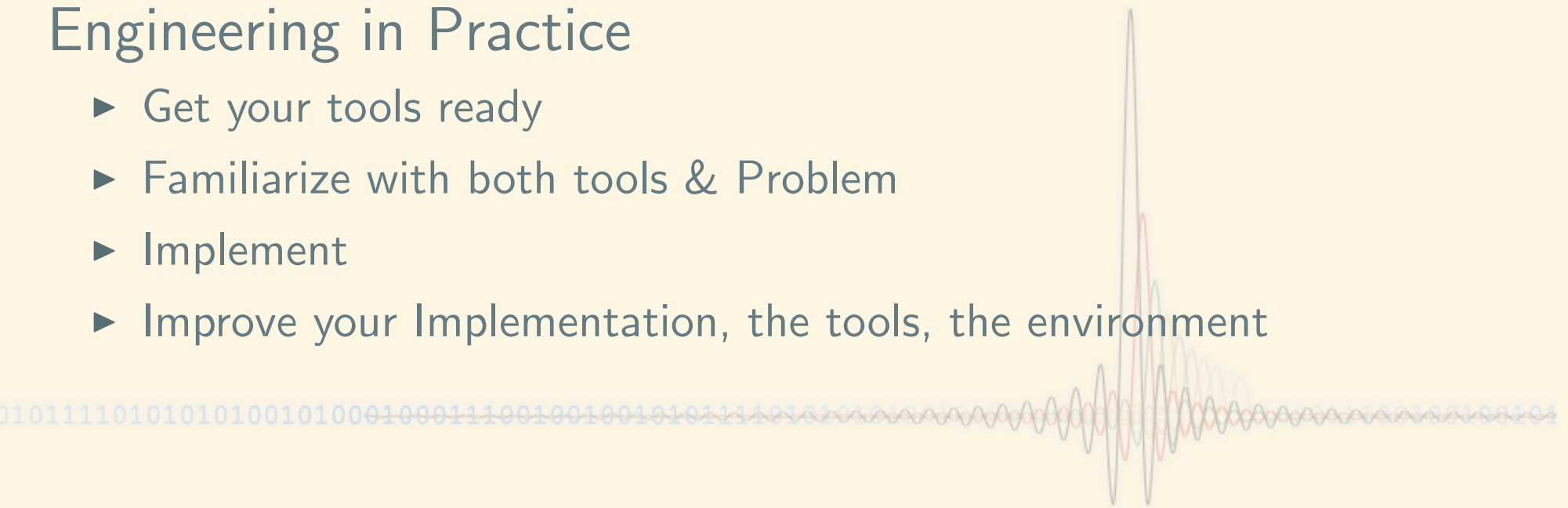
From theory to practice

Engineering in theory

- Analyze the situation
- Implement
- Improve

Engineering in Practice

- Get your tools ready
- Familiarize with both tools & Problem
- Implement
- Improve your Implementation, the tools, the environment



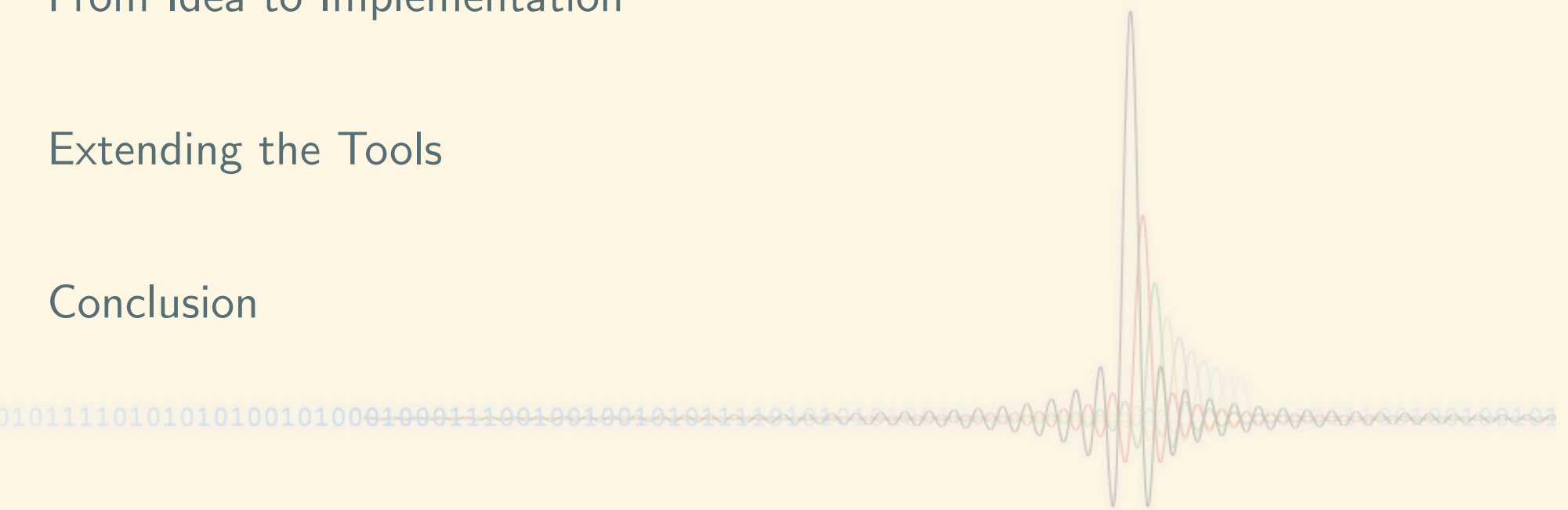
Introduction

Getting GNU Radio

From Idea to Implementation

Extending the Tools

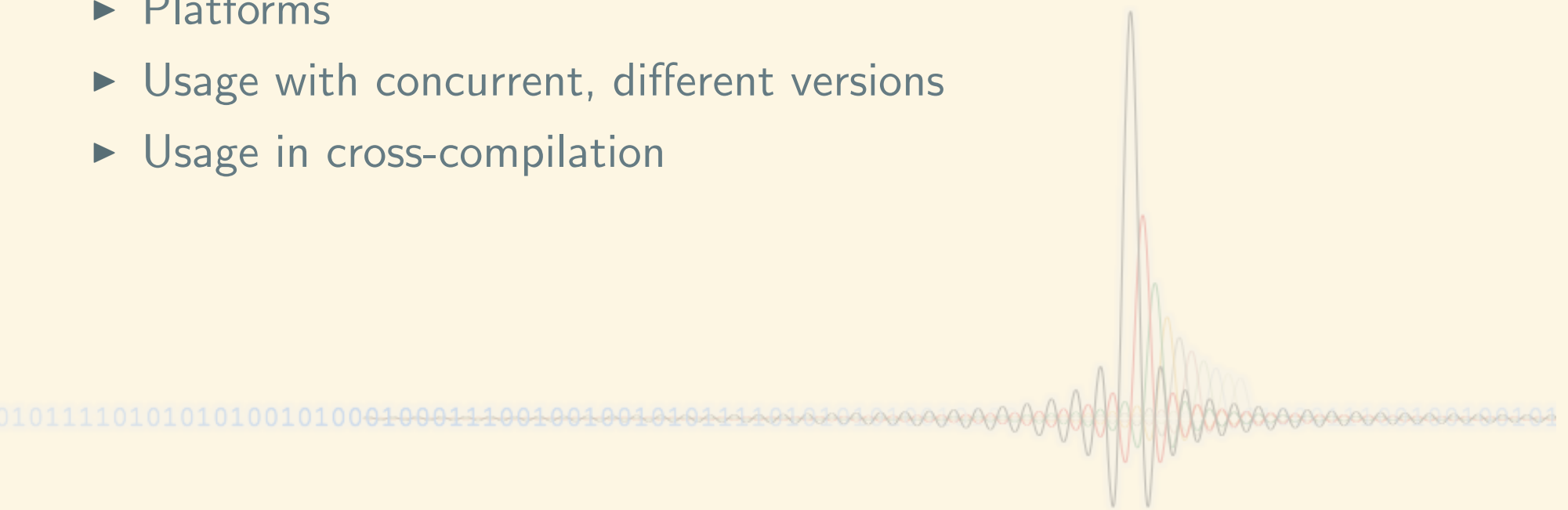
Conclusion



Getting GNU Radio

Challenging:

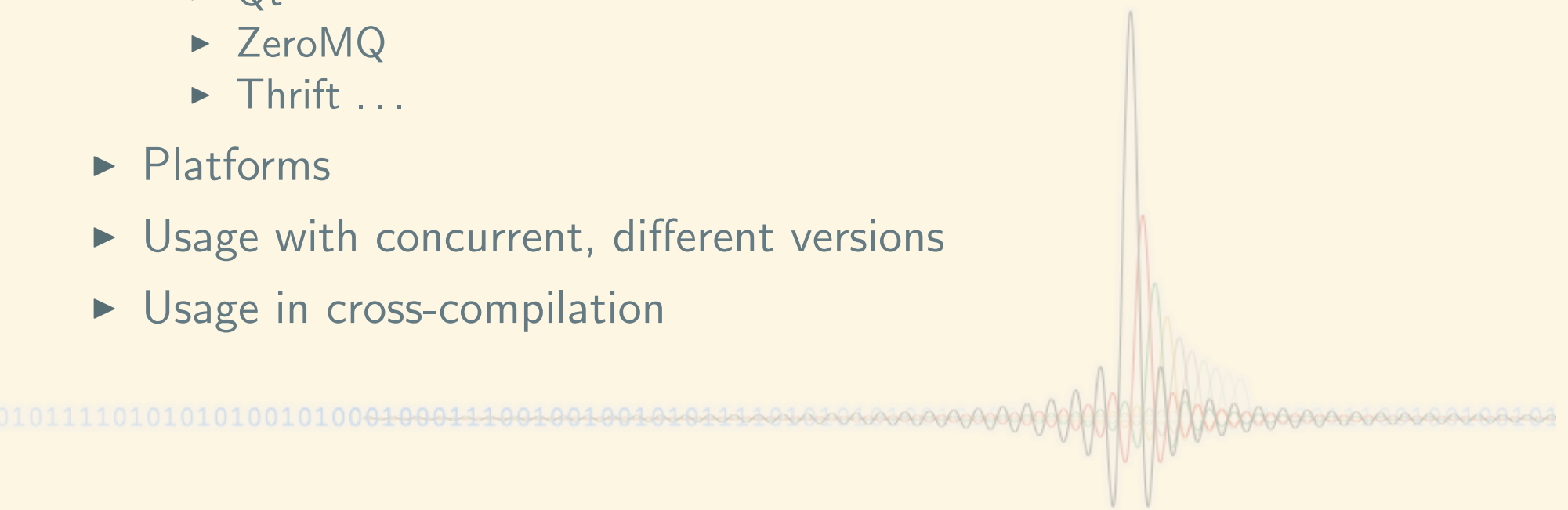
- Dependencies
- Platforms
- Usage with concurrent, different versions
- Usage in cross-compilation



Getting GNU Radio

Challenging:

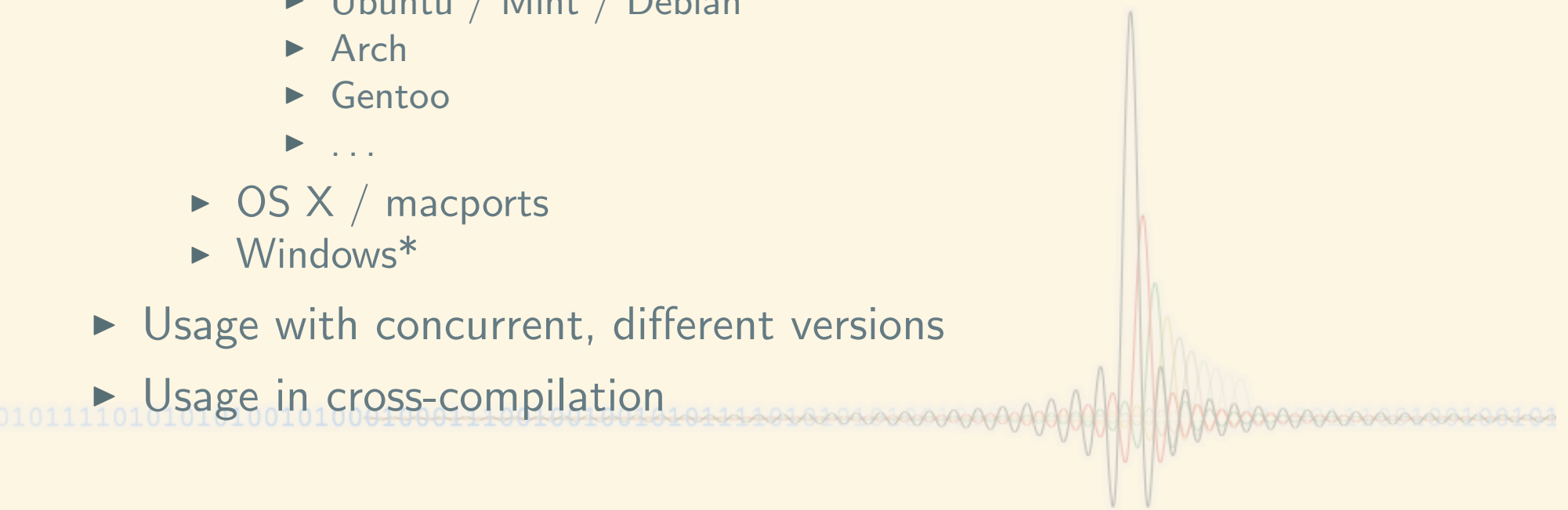
- Dependencies
  - Python
  - Boost
  - Qt
  - ZeroMQ
  - Thrift . . .
- Platforms
- Usage with concurrent, different versions
- Usage in cross-compilation



Getting GNU Radio

Challenging:

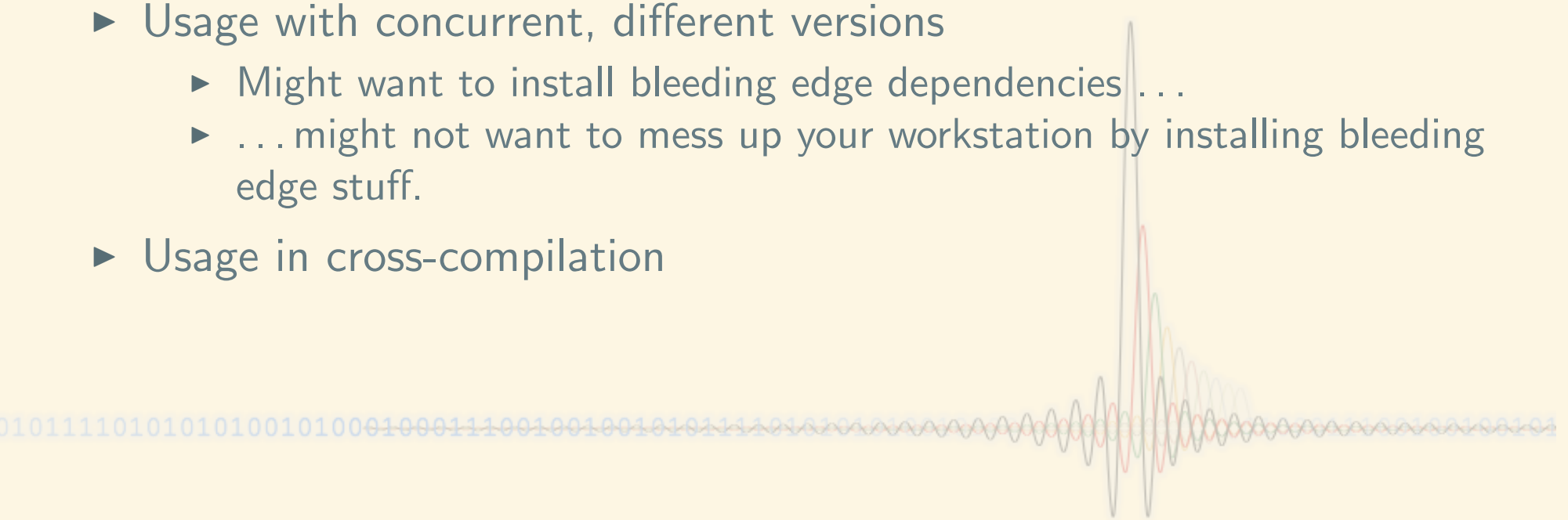
- Dependencies
- Platforms
  - Linux
    - Fedora / CentOS / RHEL
    - Ubuntu / Mint / Debian
    - Arch
    - Gentoo
    - ...
  - OS X / macports
  - Windows*
- Usage with concurrent, different versions
- Usage in cross-compilation



Getting GNU Radio

Challenging:

- Dependencies
- Platforms
- Usage with concurrent, different versions
  - Might want to install bleeding edge dependencies . . .
  - . . . might not want to mess up your workstation by installing bleeding edge stuff.
- Usage in cross-compilation



Getting GNU Radio

Optimal solution for dependency hell: **Well-kept distro packages**

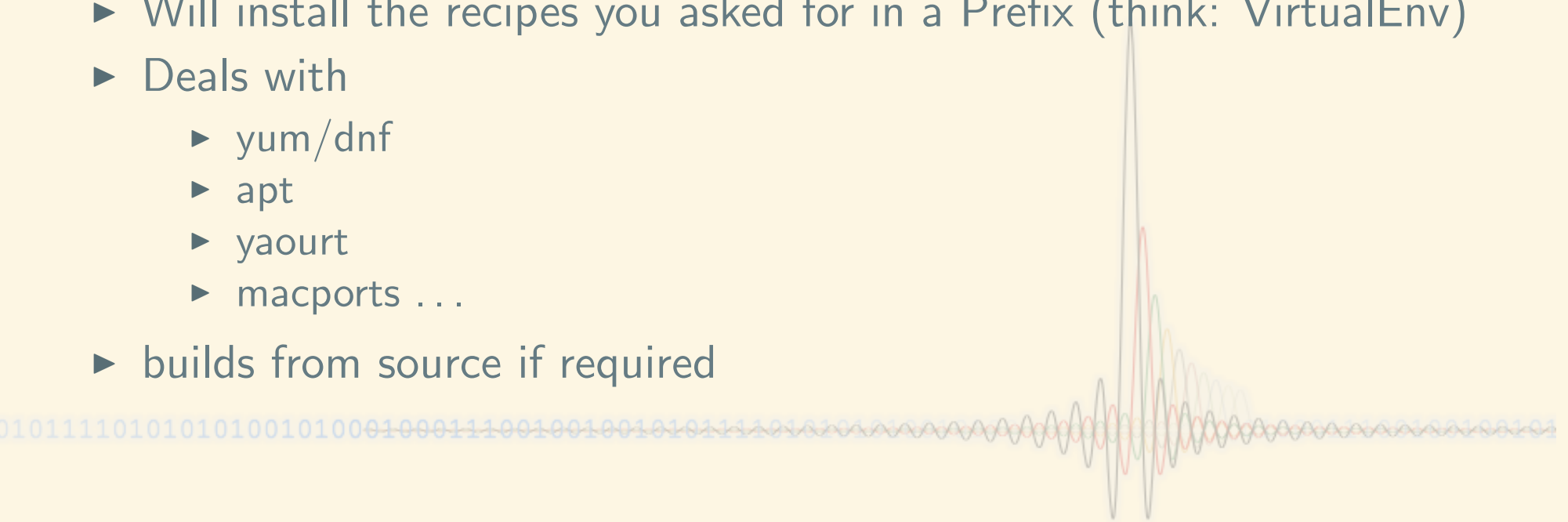
- can't keep $N_{\text{GNU Radio projects}} \cdot N_{\text{Distros}}$ binary packages up-to-date
- Good luck getting current Thrift e.g. on Ubuntu 14.04LTS
- Heck, this is a **Developers'** Meeting – you're here to build and mend things – **Offering a safe way to build from Source is a must**

Getting GNU Radio

PyBOMBS

Python **B**uild & **O**verlay **M**anaged **B**undle **S**ystem

- Manages Recipes &
- Installs those and their Dependencies
- Will install the recipes you asked for in a Prefix (think: VirtualEnv)
- Deals with
  - yum/dnf
  - apt
  - yaourt
  - macports . . .
- builds from source if required



Getting GNU Radio

PyBOMBS

It's really easy to install GNU Radio into ~/prefix:

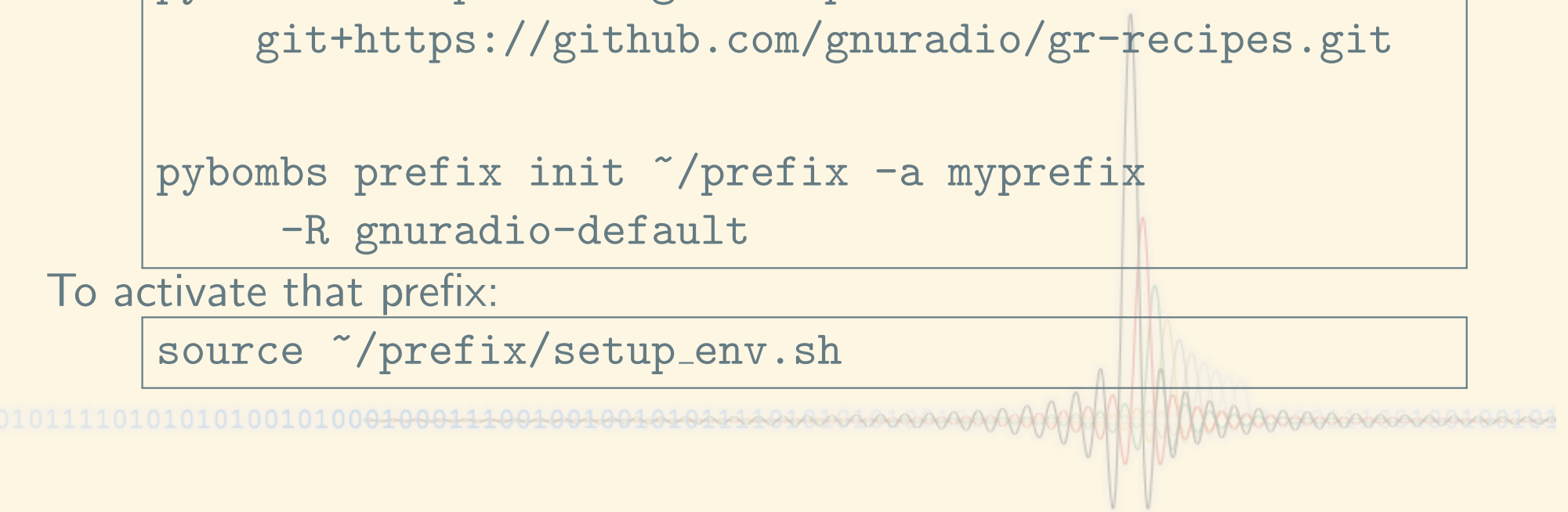
```
sudo pip install pybombs

pybombs recipes add gr-recipes
    git+https://github.com/gnuradio/gr-recipes.git

pybombs prefix init ~/prefix -a myprefix
     -R gnuradio-default
```

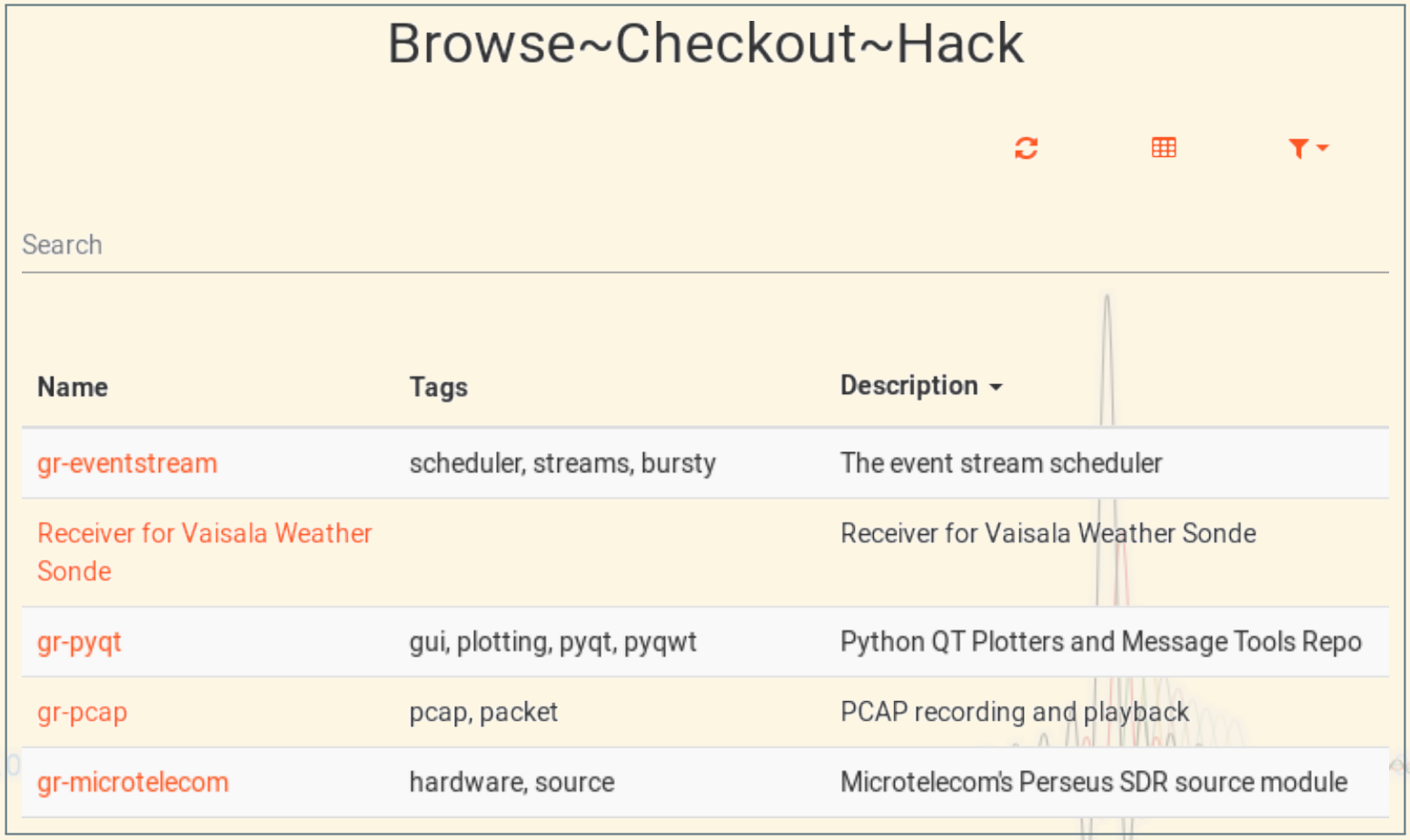
To activate that prefix:

```
source ~/prefix/setup_env.sh
```



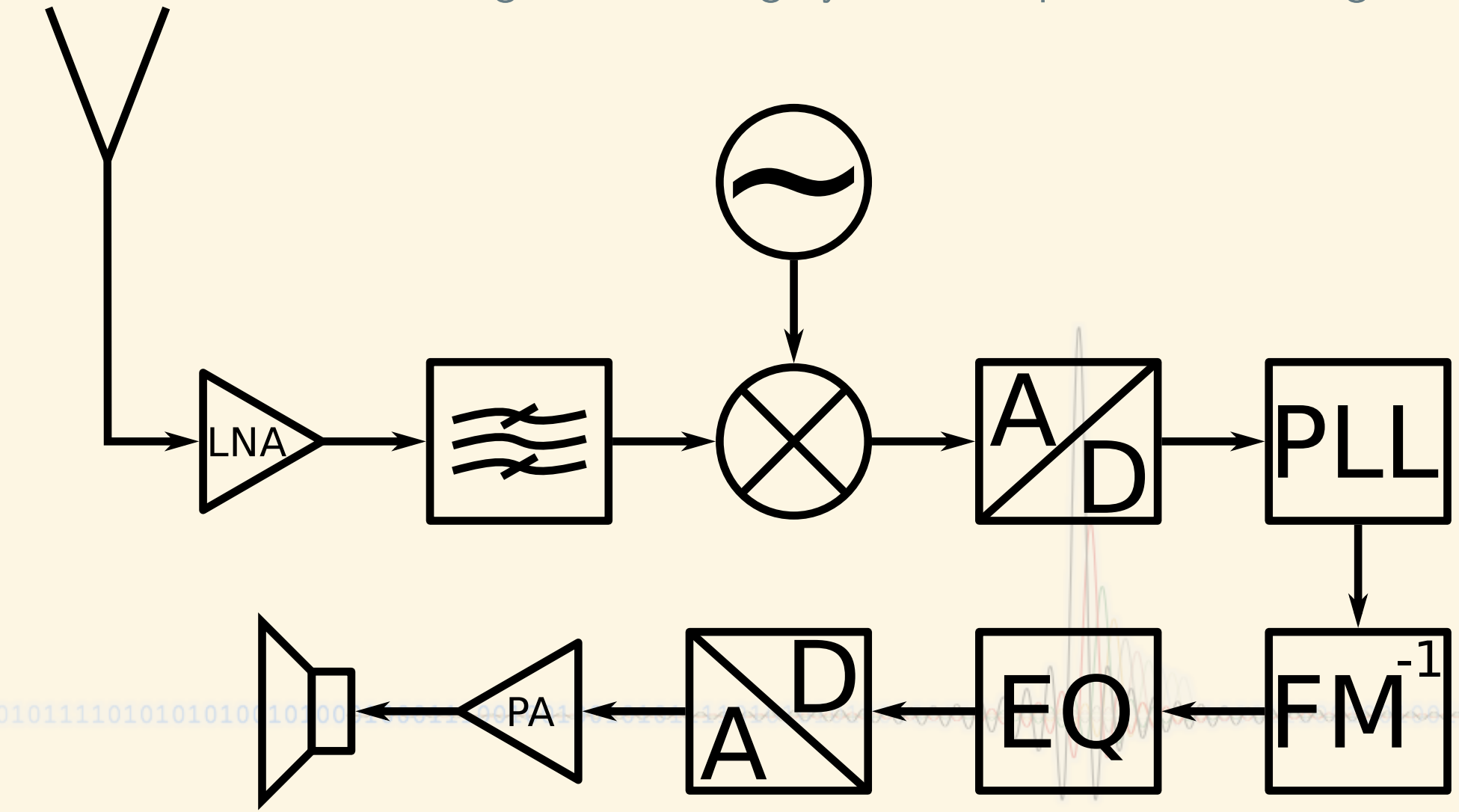
I heard **Ecosystem**?!

CGRAN (Comprehensive GNU Radio Archive Network) has lots of applications and tools other devs shared



From Idea to Implementation

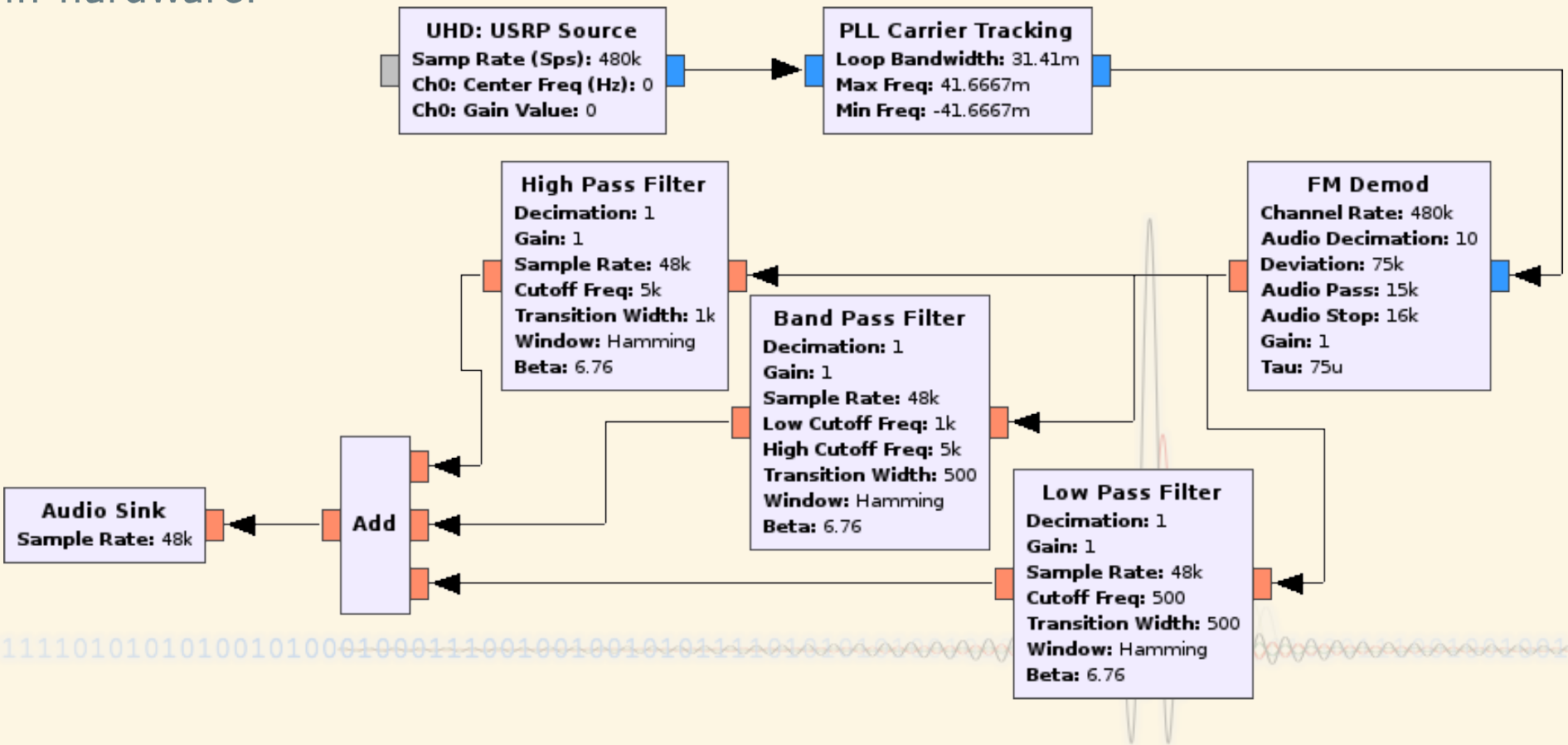
When we think about Signal Processing Systems, we picture something like:



From Idea to Implementation

GNU Radio Flow Graphs

GNU Radio Companion allows us to represent such logical block diagrams in hardware!



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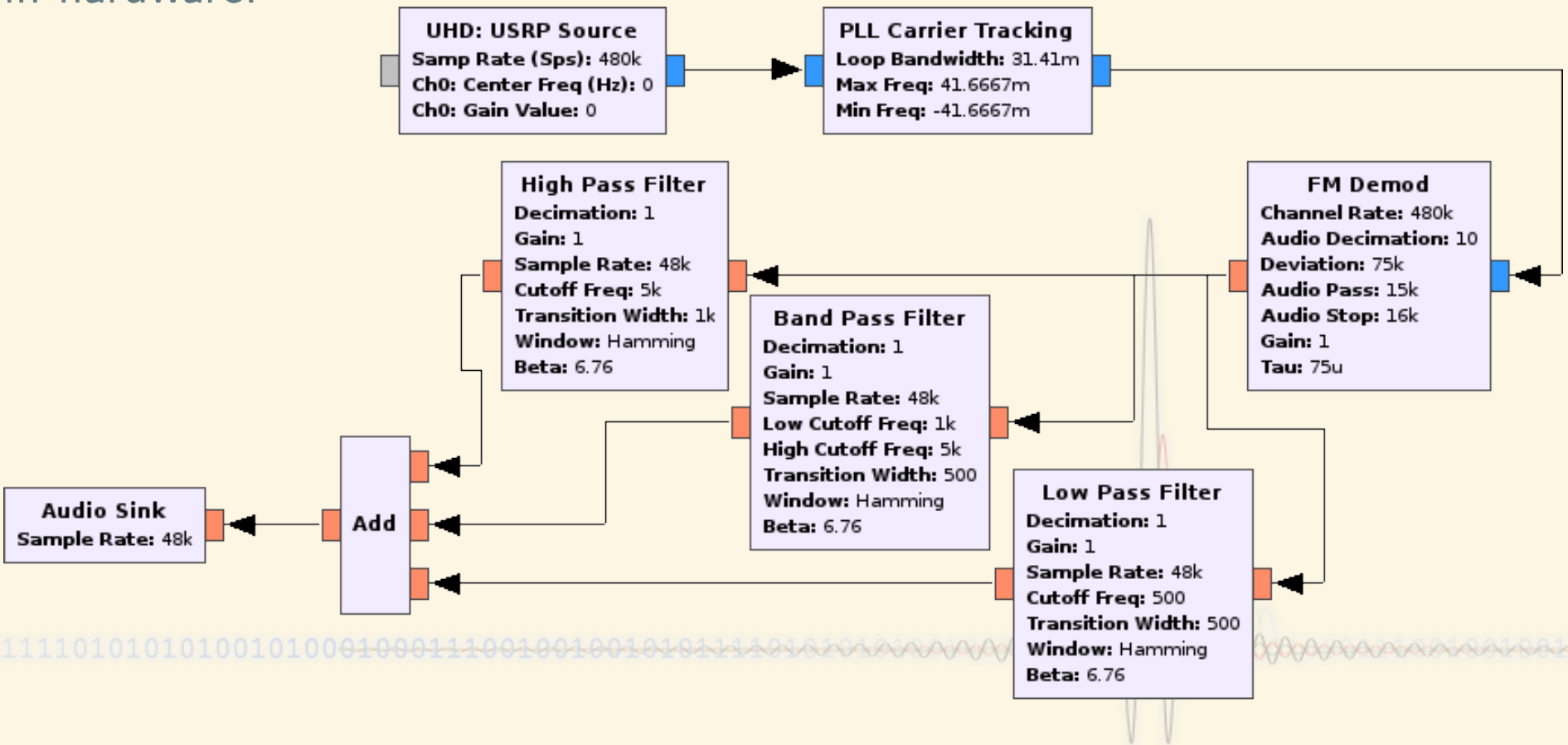


From Idea to Implementation

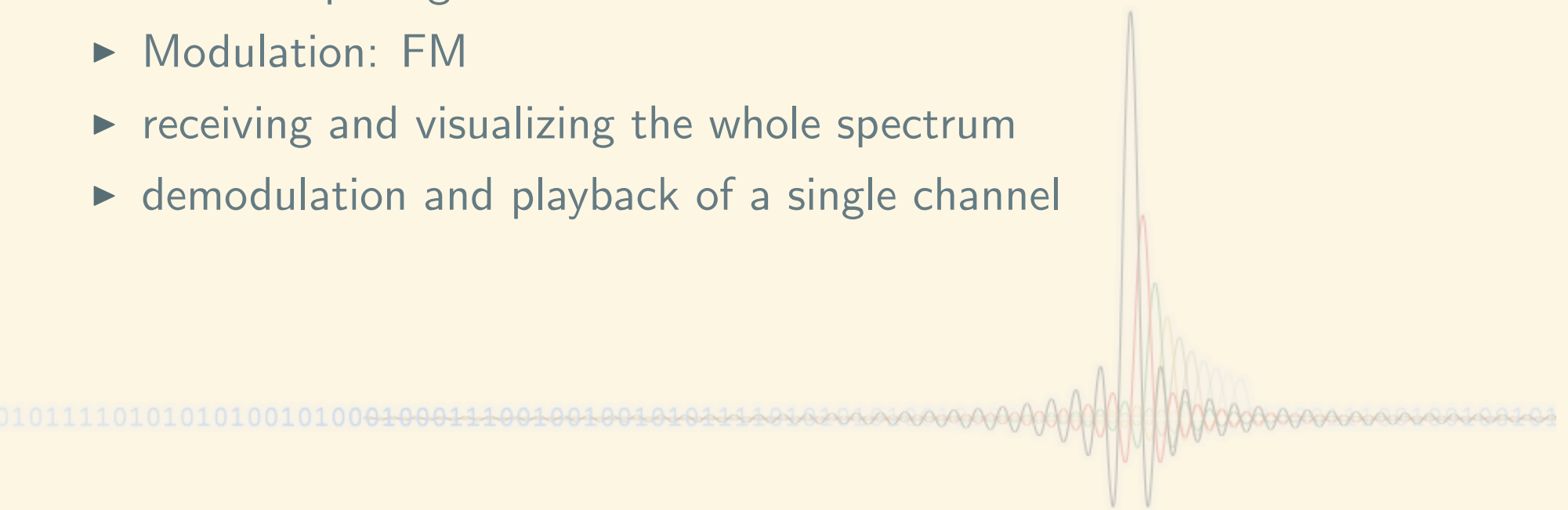
GNU Radio Flow Graphs

Demo?

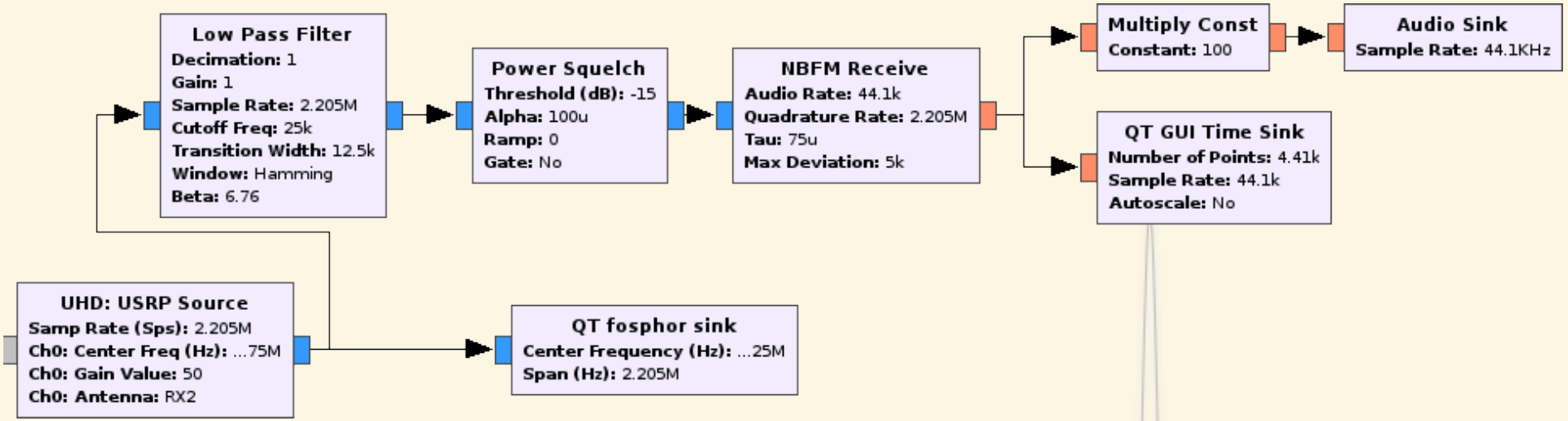
Let's build a Demo!

Observing the whole LDP433 spectrum

- 25 channels, 433.075 MHz to 434.775 MHz
- channel spacing: 25 kHz
- Modulation: FM
- receiving and visualizing the whole spectrum
- demodulation and playback of a single channel



Spectrum Visualizer



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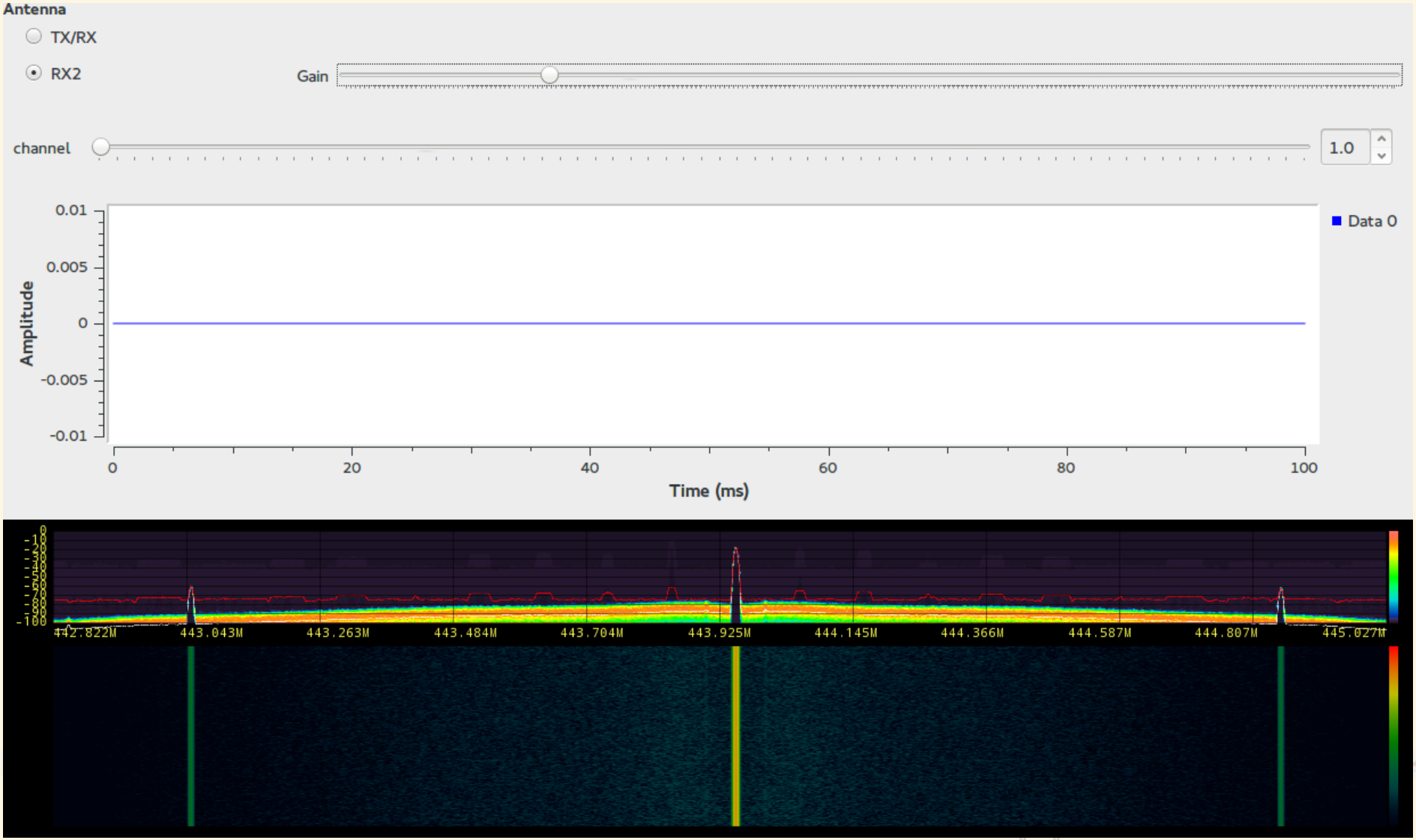
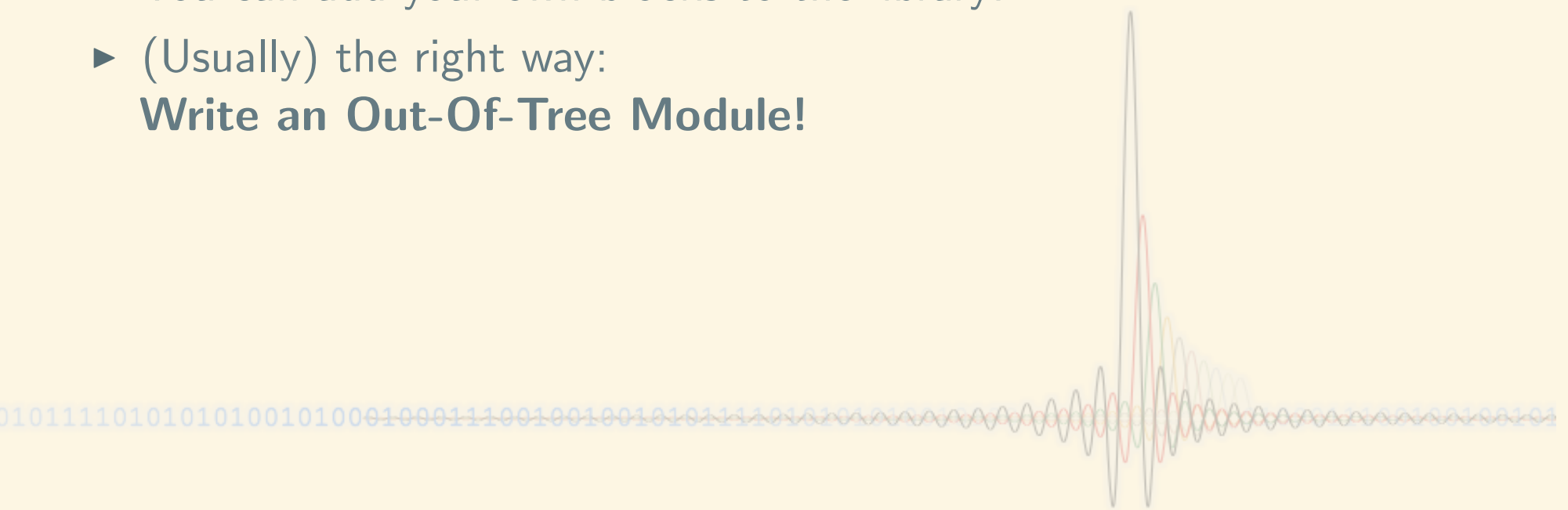


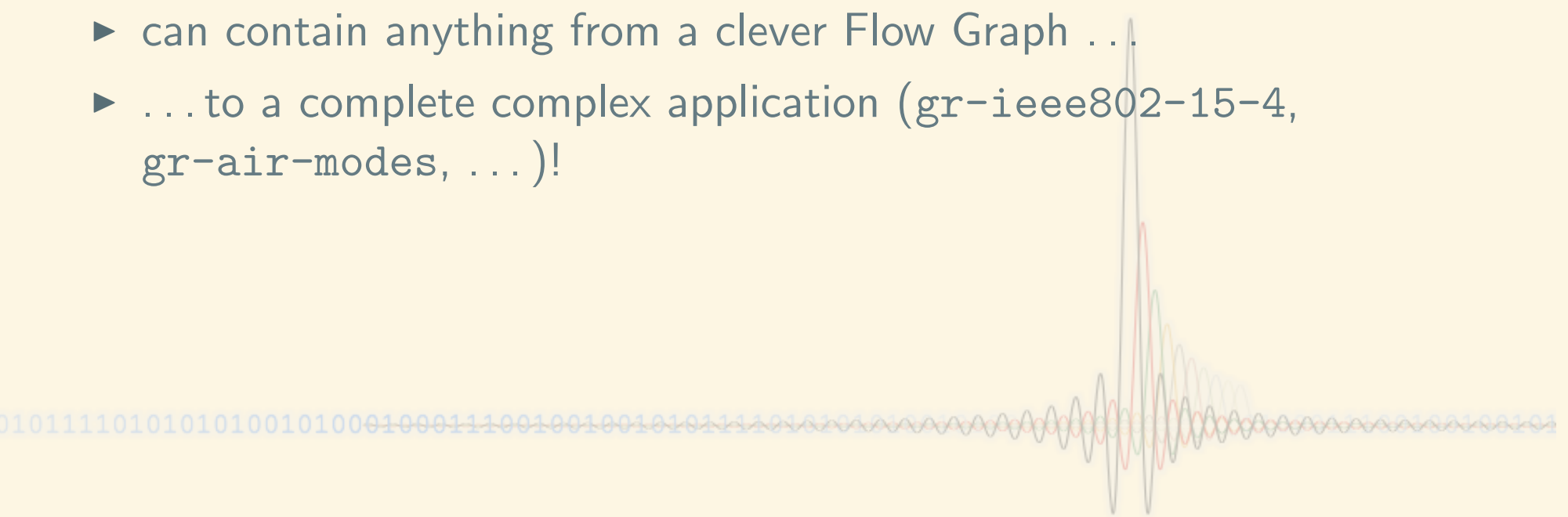
Extending the Tools

- GNU Radio's meant to be extended
- You can add your own blocks to the library!
- (Usually) the right way:
  Write an Out-Of-Tree Module!



Out-Of-Tree Modules

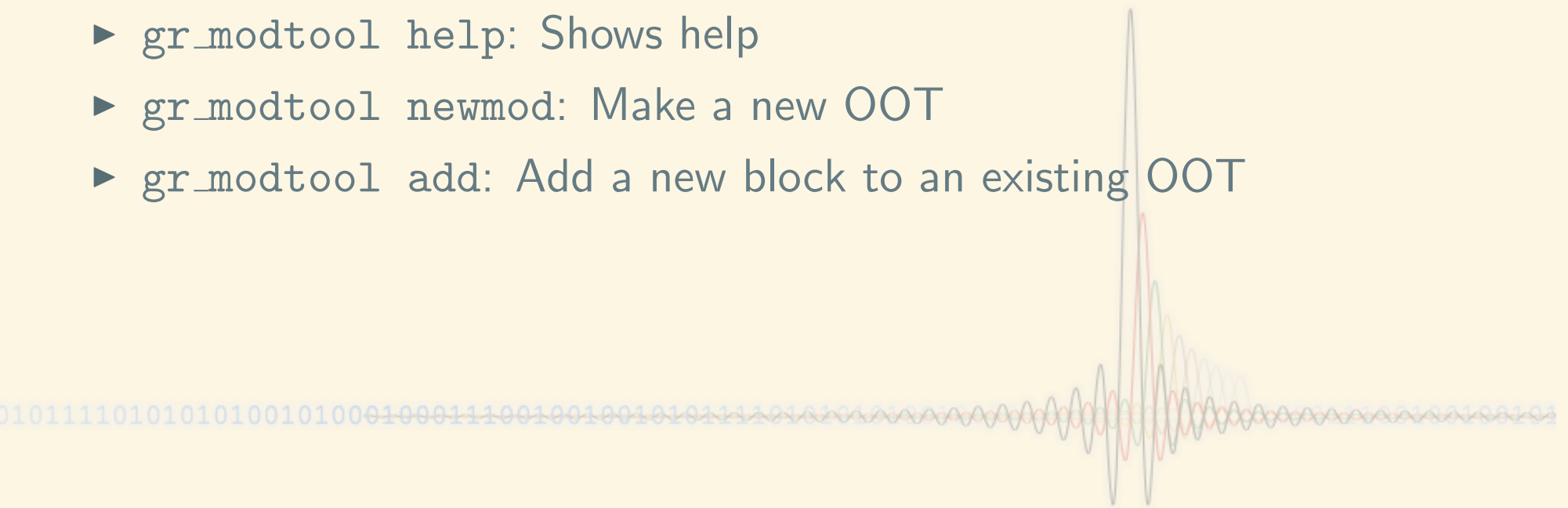
- self-contained, buildable source tree
- uses/links against GNU Radio
- can contain anything from a clever Flow Graph . . .
- . . . to a complete complex application (`gr-ieee802-15-4`, `gr-air-modes`, . . .)!



Bootstrapping Out-Of-Tree Modules

Out-Of-Tree Modules (short: OOTs) follow a typical folder structure
There's a tool to provide you with that structure: `gr_modtool`!
Most important subcommands:

- `gr_modtool help`: Shows help
- `gr_modtool newmod`: Make a new OOT
- `gr_modtool add`: Add a new block to an existing OOT

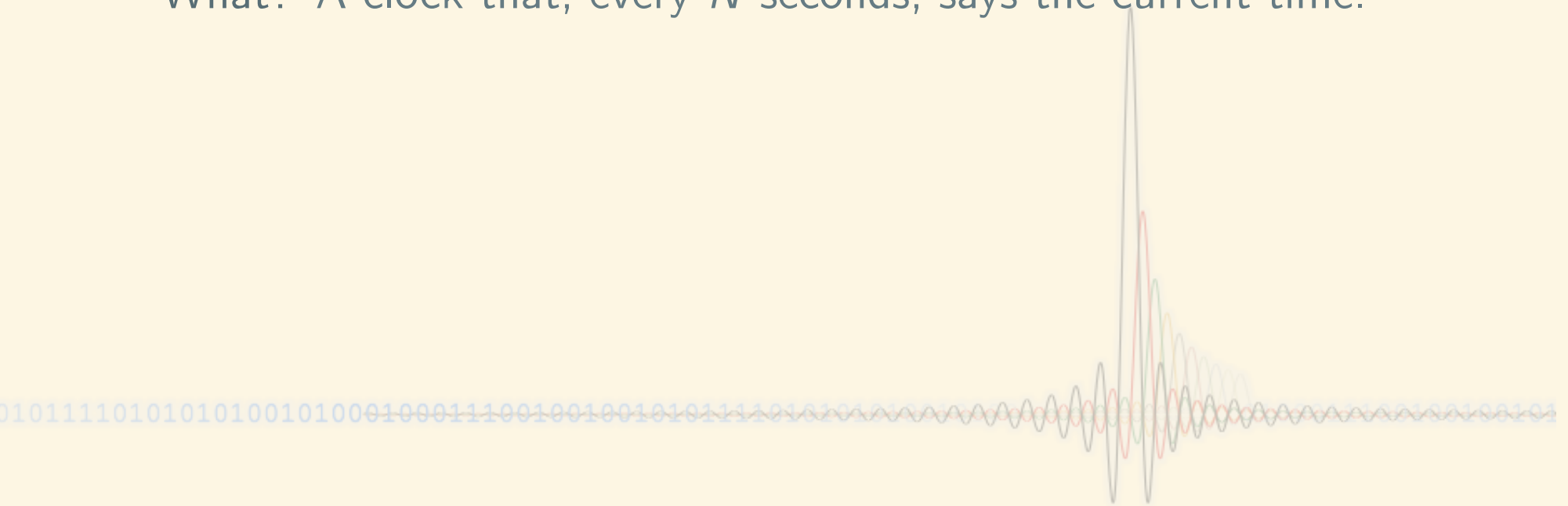


How do we apply this?

Let's go for another hands-on!

A speaking clock

What? A clock that, every N seconds, says the current time.



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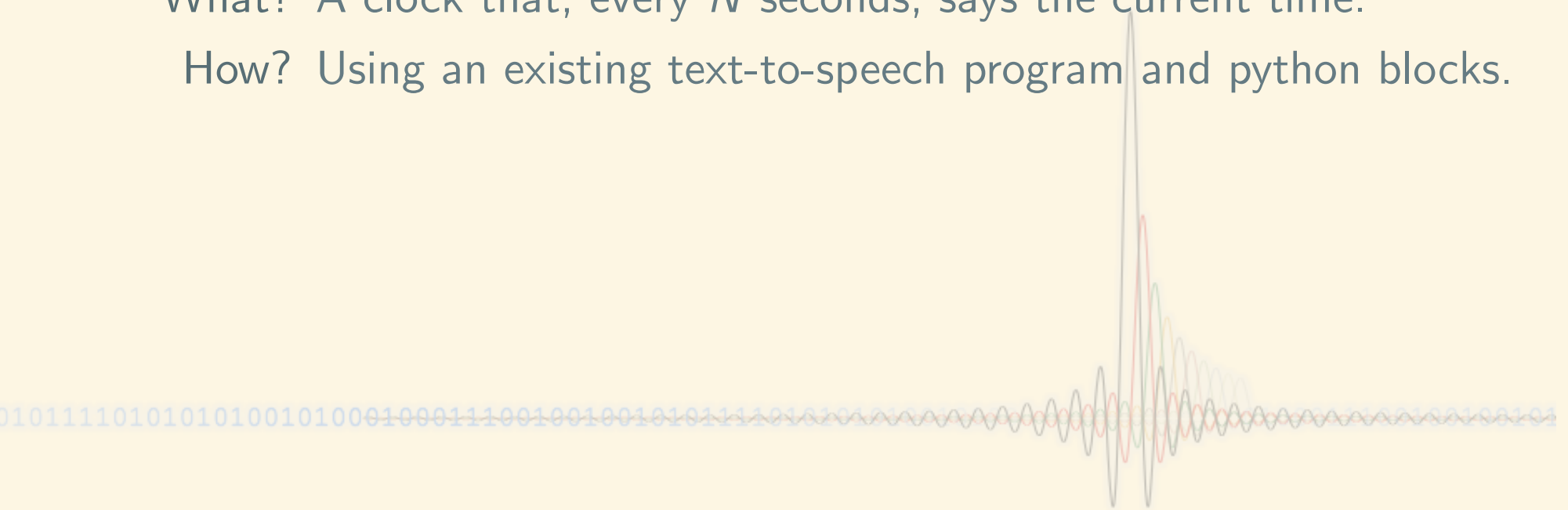
What? A clock that, every N seconds, says the current time.

How? Using an existing text-to-speech program and python blocks.



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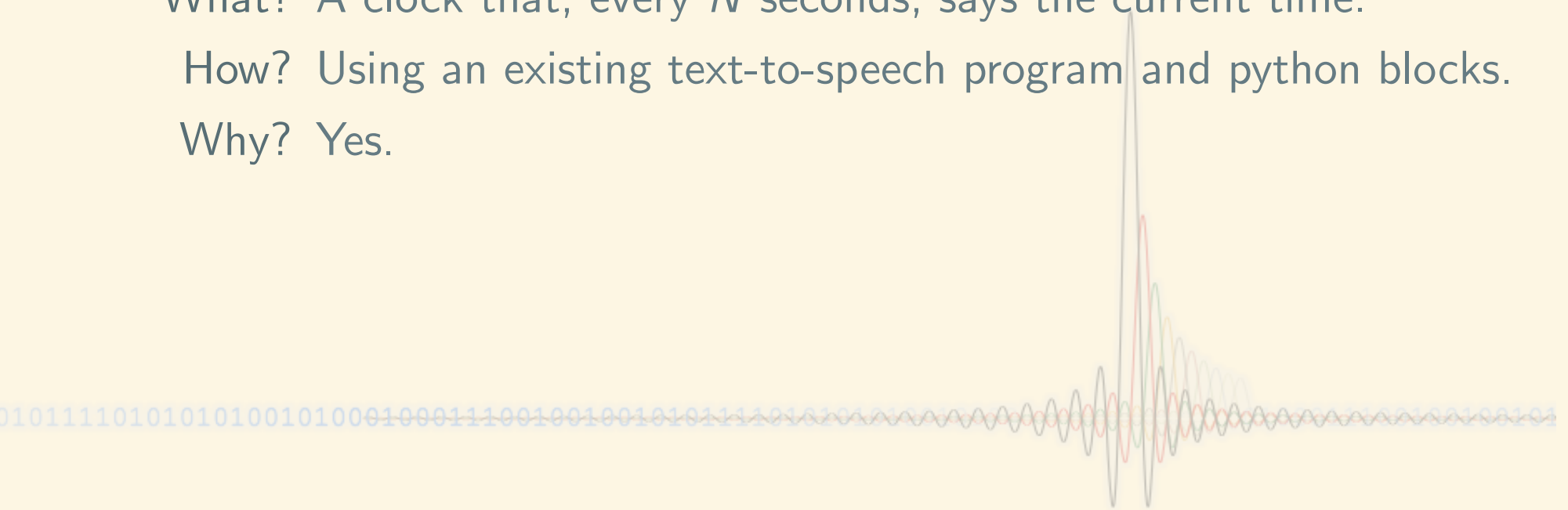
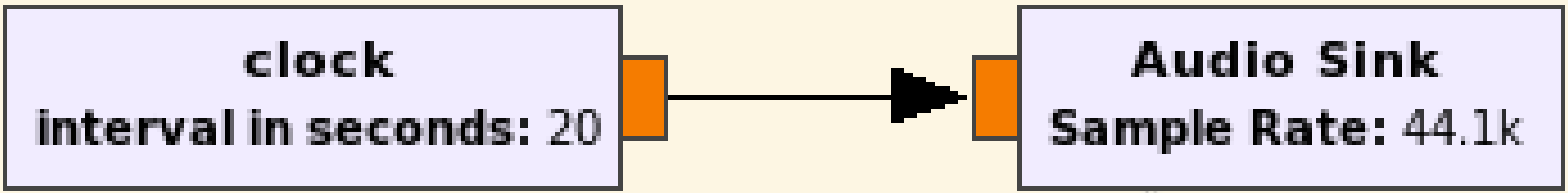
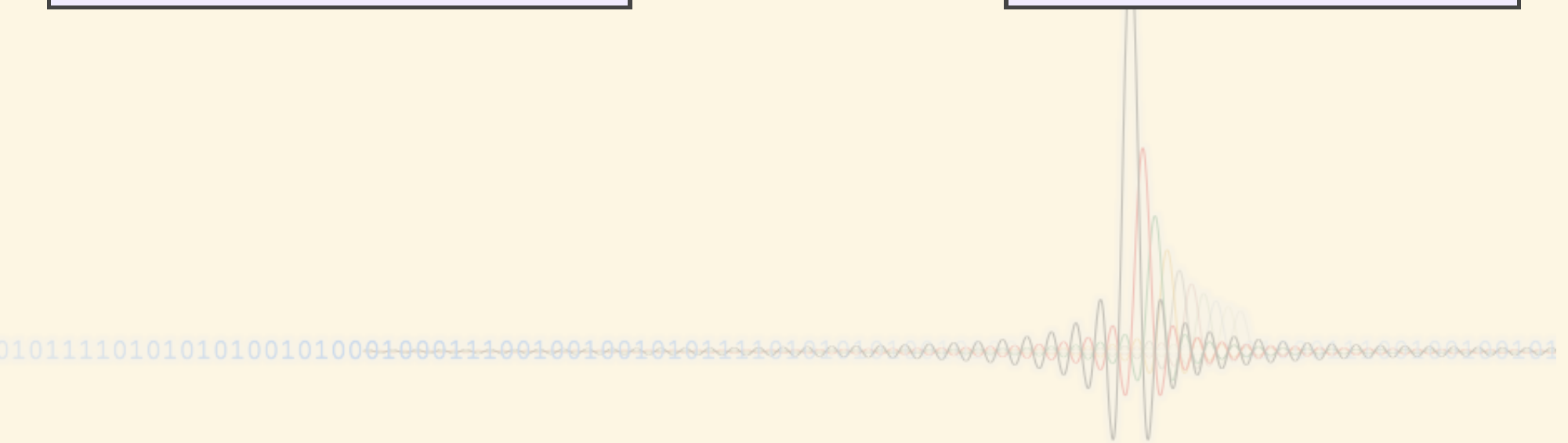
Why? Yes.



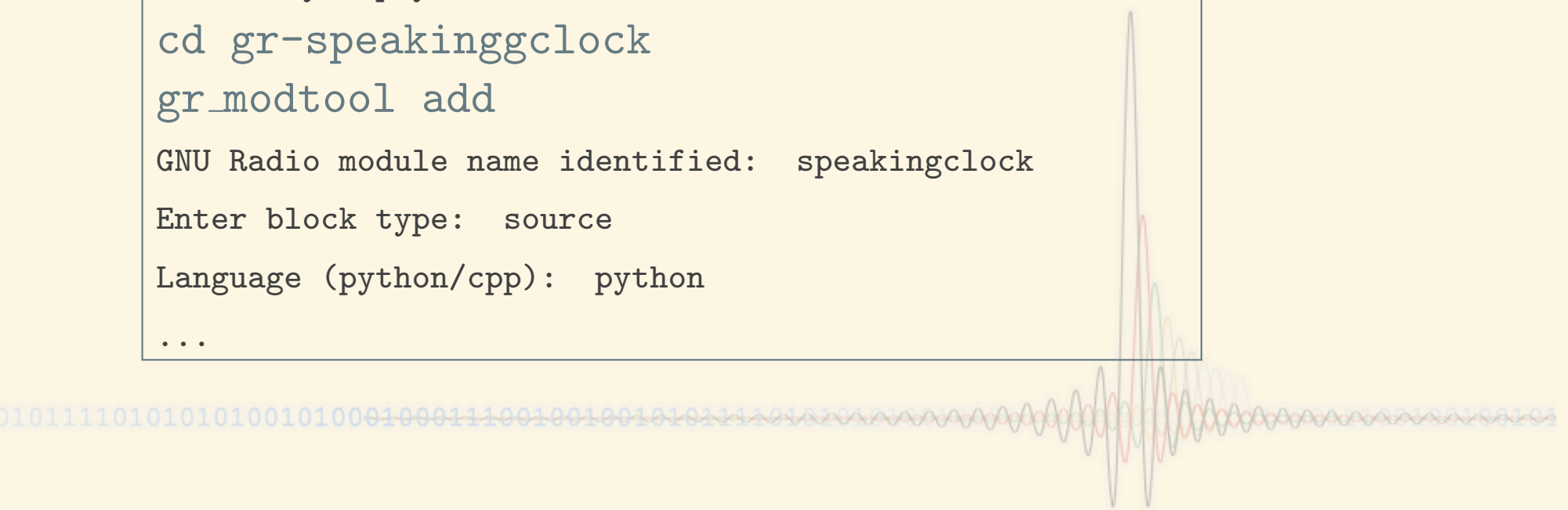
How should it look like?





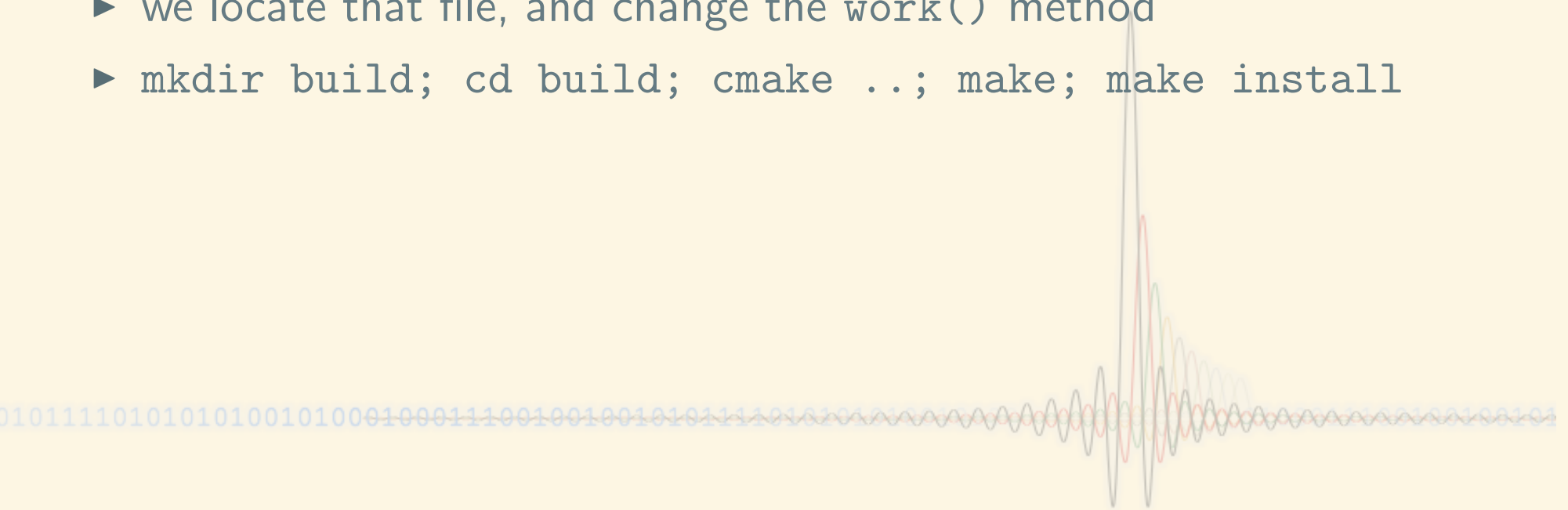
Using gr_modtool

```
gr_modtool newmod speakingclock
Creating out-of-tree module in
./gr-speakingclock...Done.
>Use 'gr_modtool add' to add a new block to this
currently empty module.
cd gr-speakinggclock
gr_modtool add
GNU Radio module name identified:  speakingclock
Enter block type:  source
Language (python/cpp):  python
...
```



Putting in the functional code

- We've added a python block, so the code is in `python/`
- we locate that file, and change the `work()` method
- `mkdir build; cd build; cmake ..; make; make install`



Writing a PyBOMBS recipe

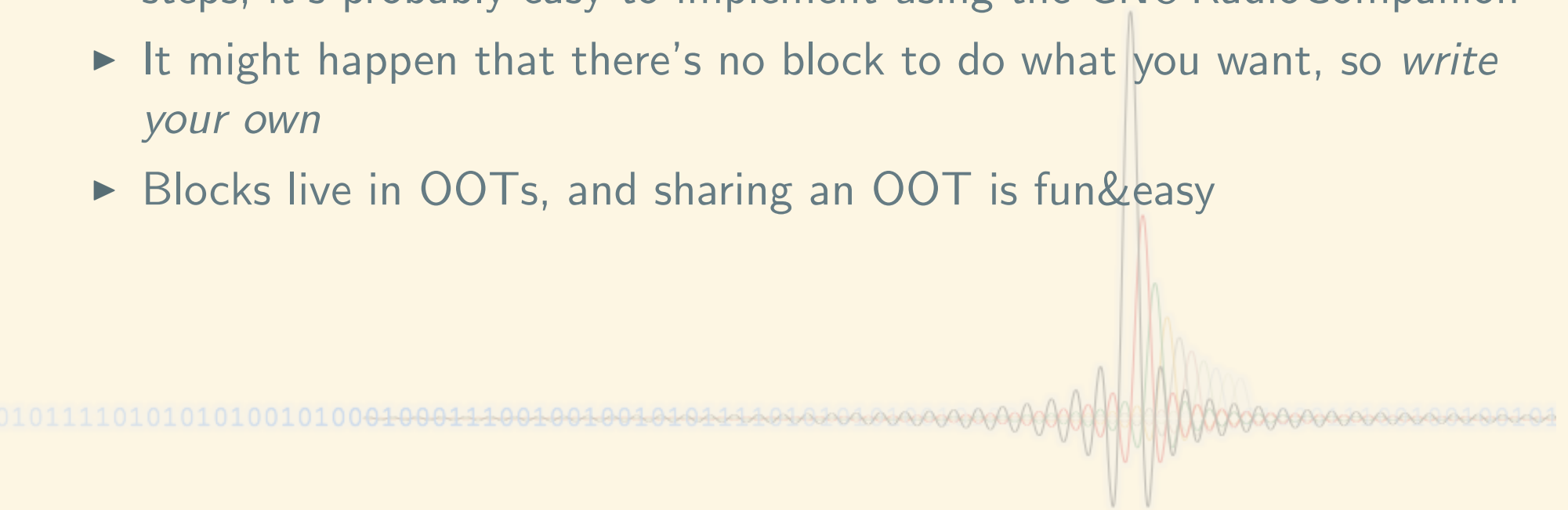
Easy:

```
category:  common
depends:
- gnuradio
description:  This is my OOT
gitbranch:  master
inherit:  cmake
source:  git+https://github.com/myuser/myrepo.git
```

Make a Pull Request against gr-etcetera/gr-recipes, done!

Wrapping things up

- GNU Radio can be a beast to set up, but PyBOMBS eases the pain
- If your problem is easy to visualize as concatenation of signal processing steps, it's probably easy to implement using the GNU RadioCompanion
- It might happen that there's no block to do what you want, so *write your own*
- Blocks live in OOTs, and sharing an OOT is fun&easy



Useful Links

GNU Radio project `http://gnuradio.org`

Guided Tutorials `http://tutorials.gnuradio.org`

CGRAN `http://cgran.org`

PyBOMBS `http://github.com/gnuradio/pybombs`

GNU Radio mailing list discuss-gnuradio@gnu.org

Registration & Archive: `https://lists.gnu.org/mailman/listinfo/discuss-gnuradio`