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A National Instruments Company

“Ettus Research and its Research”

GRCon 2018

Martin Braun, Senior Git Wrangler

We and our Research

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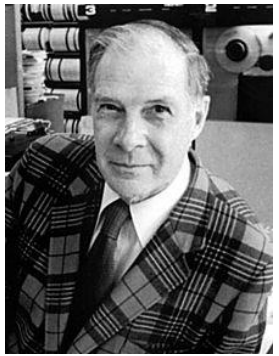
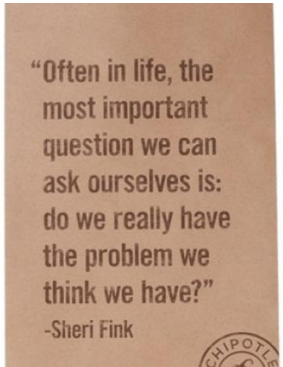
- This is not a keynote, so I'll skip the inspirational quotes
- If you want some good inspirational quotes, read/watch Hamming's talk "You and your research"
  - (Or go to a famous burrito chain)
- Hamming asks: What are the most important problems in your domain? And are you working on them?
- ….well, are we?





What *are* the SDR problems?

Martin's

Opinion

Not a National Instruments Opinion

- Do we even have any?
- Is SDR finished?
- Are SDR researchers going to be unemployed?

- ...I don't think so.

What *are* the SDR problems?

Martin's

Opinion

Not a National Instruments Opinion

- **Hardware**:
  - Which components will we use going forward?
  - Can we make hardware for all kinds of use cases?
  - How can we make hardware easy to use in various scenarios?
- **Frameworks & Software:**
  - Can frameworks keep up with the heterogeneity of hardware?
  - How do we keep up with increased bandwidth, lower latency requirements, …? Can we even have one framework to rule them all?
- **Algorithms:**
  - Are our current DSP solutions still optimal in today's SDR environment?
  - How do we optimize implementations of any given algorithm for power, latency, platform, resource utilization...
- **People:**
  - How do we train future engineers to work in the broad domain of SDR?

Example: Let's build a phone

Martin's Opinion

Not a National Instruments Opinion

- It's 2018; makers and hackers build all sorts of stuff, without having to have decades of experience
- So how would you build a pure SDR phone?
  - Which hardware do you get? You might need a lot of FPGA/RF/CPU resources. Are you OK using a rack-mountable device?
  - Would you use GNU Radio? (Spoiler: The answer is "no")
  - What about OpenBTS, Osmocom, OAI, srsUE, etc….. they're not generic frameworks!
  - Do we really know what the "best" implementation of a decoder/equalizer/synchronizer… is, given an arbitrary constraint space?
  - How many people do you intend to hire to do this?

What *are* the SDR problems?

Martin's Opinion

Not a National Instruments Opinion

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Hardware Trends

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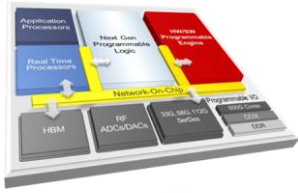
- Why can't we have a smartphone-sized device with high performance SDR capabilities?
- Many vendors are providing new chips, SoCs, and platforms. Can they solve the SDR problems?
- Hardware and Software are driving each other, too (TensorFlow, ML, ...)
- Will we be still dealing with von-Neumann architectures in the future? Are we set up to do otherwise?



(Note: This is not an Ettus product announcement slide!)

Hardware: USRP Spectrum

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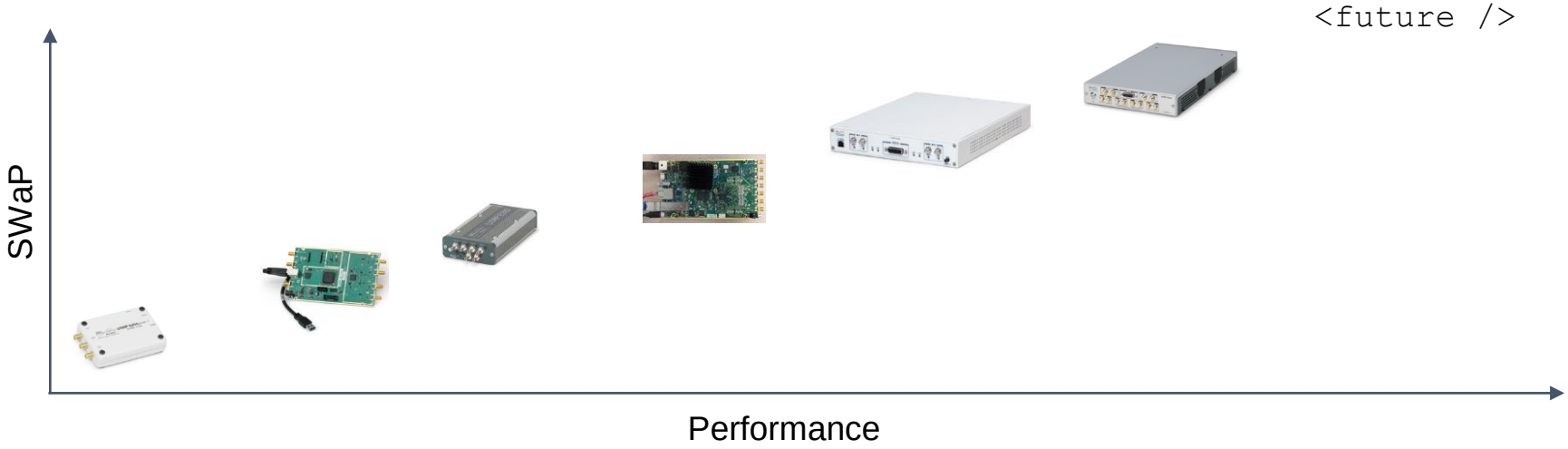
- Let's accept the fact that we have to obey the rules of physics: More powerful devices will always be bigger
- Ettus philosophy: Cover a wide range of devices in the cost/power spectrum, provide single software API



USRP N310

- A bit of E310, a bit of X310, and many other things!
- XC7Z100 FPGA for more RFNoC, AD9371 RFIC for higher channel density
- Embedded Linux for more control, RASM features
- SFP connectors for 10GigE access to FPGA, or slower streaming rates for embedded mode

USRP E320

- To improve coverage of the power/SWaP space, we introduce the E320!
- Bigger brother of the E310:
  - XC7Z045 Zynq
  - Single-board form factor for custom integration
  - 10G/1G SFP for higher streaming rates off-device
  - GPSDO

Hardware: Simplifying Control

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- More channels, more USRPs, more problems?
- Hopefully not: Let's make our USRPs smarter!
- Controlling multiple USRPs in a rack can be hard if there are no tools to help
- Let the Embedded OS do some of the heavy lifting!
- Remote updates, remote management, health monitoring, remote app deployment, ...

Hardware: White Rabbit

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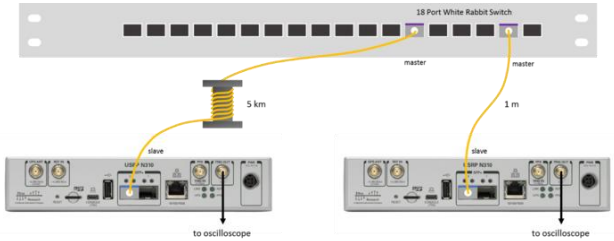
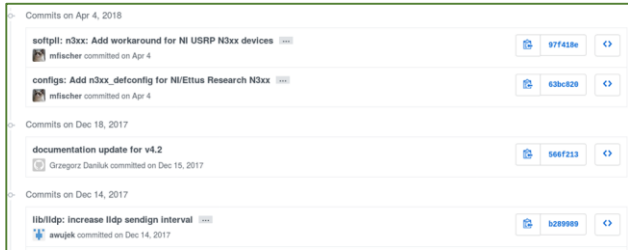
- How do you synchronize widely distributed SDRs?
- Don't reinvent the wheel: CERN gave us White Rabbit
  - Sub-nanosecond synchronization across Ethernet
  - SyncE + IEEE 1588 PTP
- Open Source, so we can modify it, even upstream
- Currently available for the USRP N310/N300





Frameworks & Software

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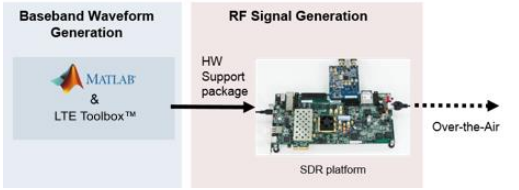
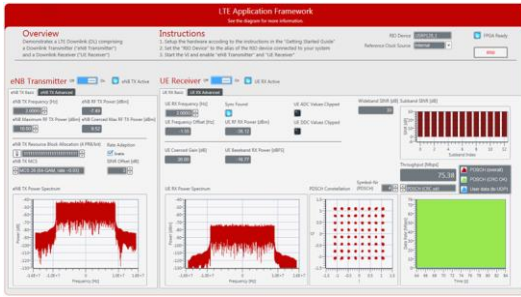
- Good frameworks & software APIs are the **key enabler to efficient SDR development**
- Many open and proprietary frameworks and development environments available
- We need a constructive and scientific approach at comparing and dissecting the various solutions
- Many areas for research! Optimum resource allocation, scheduling strategies, ...

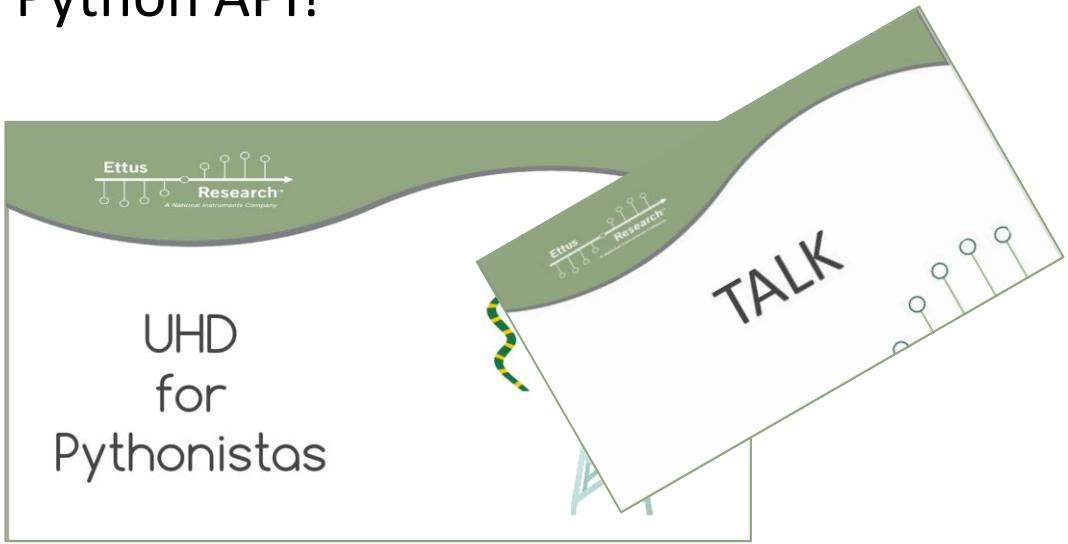
GNU Radio
THE FREE & OPEN SOFTWARE RADIO ECOSYSTEM





Frameworks: Language Support

- We don't like to tie ourselves down:
  - We have C, C++, and Python APIs for UHD
- Go to Brent's talk to find out more about the Python API!



Frameworks: RFNoC

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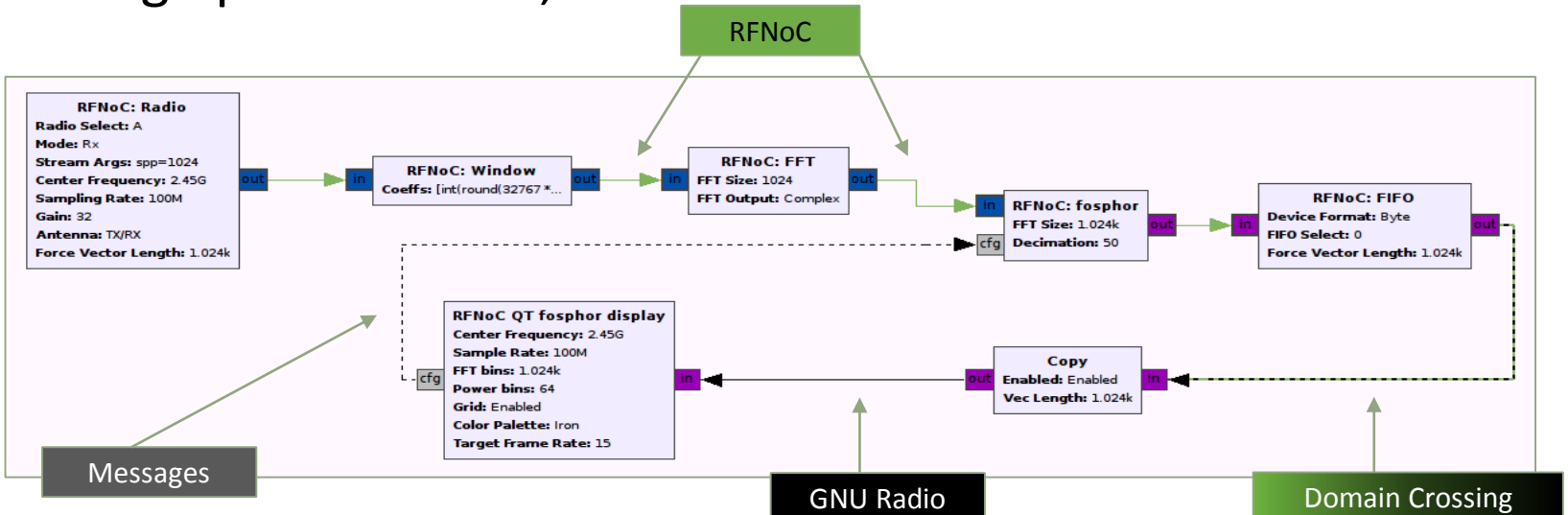
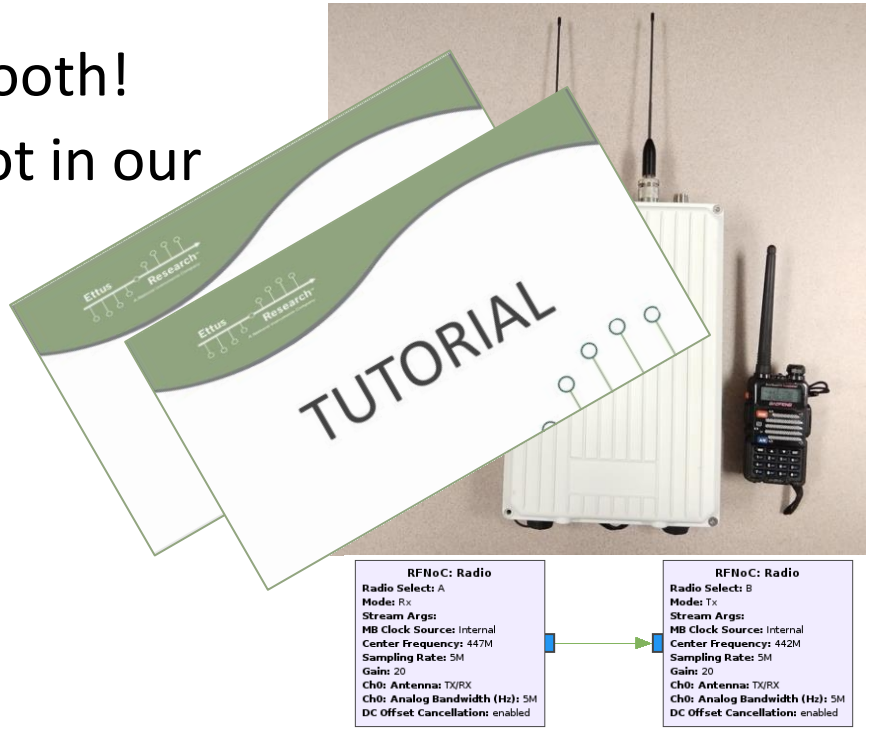
- RFNoC: Native support for FPGA acceleration within GNU Radio and other frameworks/applications
- Fully meets the framework paradigm: High flexibility and high performance, some framework overhead



Frameworks: RFNoC

- RFNoC remains the core architecture for all our USRPs going forward
- See RF loopback demo at the booth!
- Also, see if you can still get a slot in our tutorials!
- Next steps:
  - Stabilize the APIs
  - Flesh out software controls



Higher Bandwidths: DPDK

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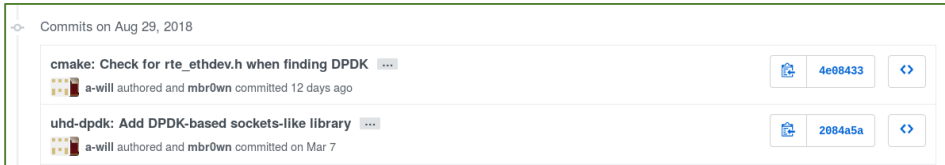
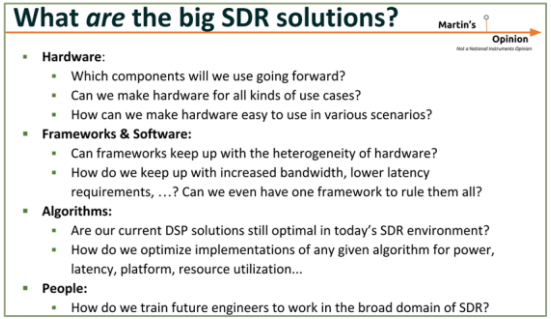
- In order to increase streaming bandwidth, there's multiple angles of attack
- One is to improve the host-side load of the actual Ethernet transport handling
- DPDK will pull more network-driver tasks into userland to allow higher optimization
- Stable device support and Benchmark results to come!

DATA PLANE DEVELOPMENT KIT



Loose Ends

- Who will train the next generation of SDR engineers?
- Who will create the perfect algorithms, the optimal frameworks (or prove that we already have them)?
- Who will design the chips that drive future SDRs?



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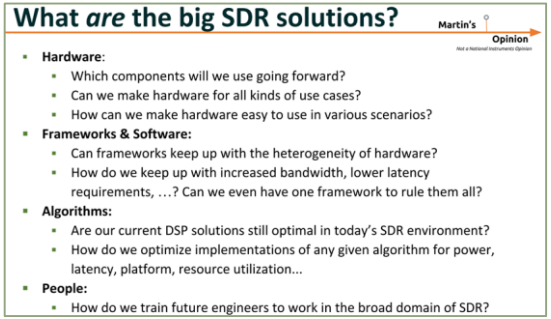
Conclusion

- There are many interesting problems left in the SDR domain
- Ettus Research is committed to doing our part by providing the best hardware and software we can
- If the GRCon community can't solve the rest, who can?



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