An End-to-End LTE Testbed in Three Clicks

From LTE PHY to full E2E in 30m

Andre Puschmann

SRS
SOFTWARE RADIO SYSTEMS

Free Software Radio devroom @ FOSDEM 2019
Feburary 3, 2019, Brussels

Company At a Glance

Paul Sutton
Director

Ismael Gomez
Director

Andre Puschmann
Senior Engineer

Linda Doyle
Director

Justin Tallon
Senior Engineer

Xavier Arteaga
Senior Engineer

Francisco Paisana
Senior Engineer

Pedro Alvarez
Senior Engineer

Oriol Font-Bach
Senior Engineer

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SRS' FOSDEM History

2014 2015 2016 2017 2018

? ?

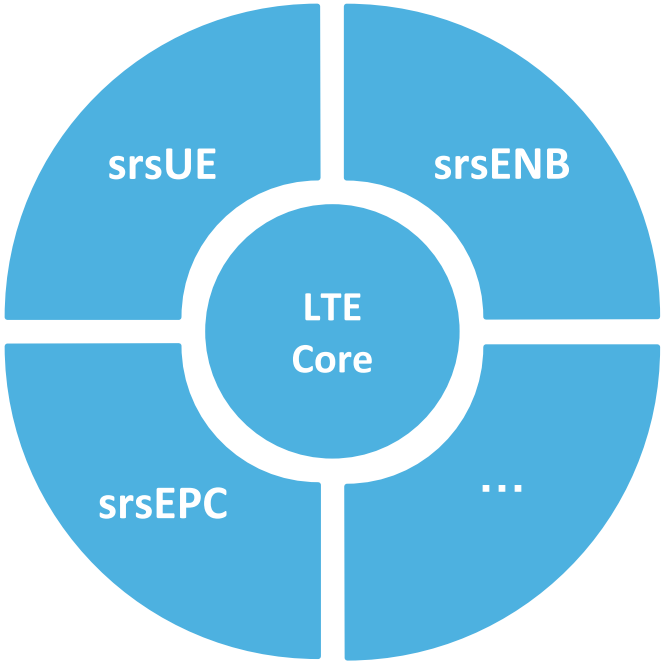
Ismael's talk:
"libLTE An Open Source LTE Library"

Paul's talk:
"Open Source LTE EPCs + eNodeBs + UEs oh my"

Ismael's talk:
"srsUE: A high-performance software radio LTE UE"

The srsLTE Ecosystem

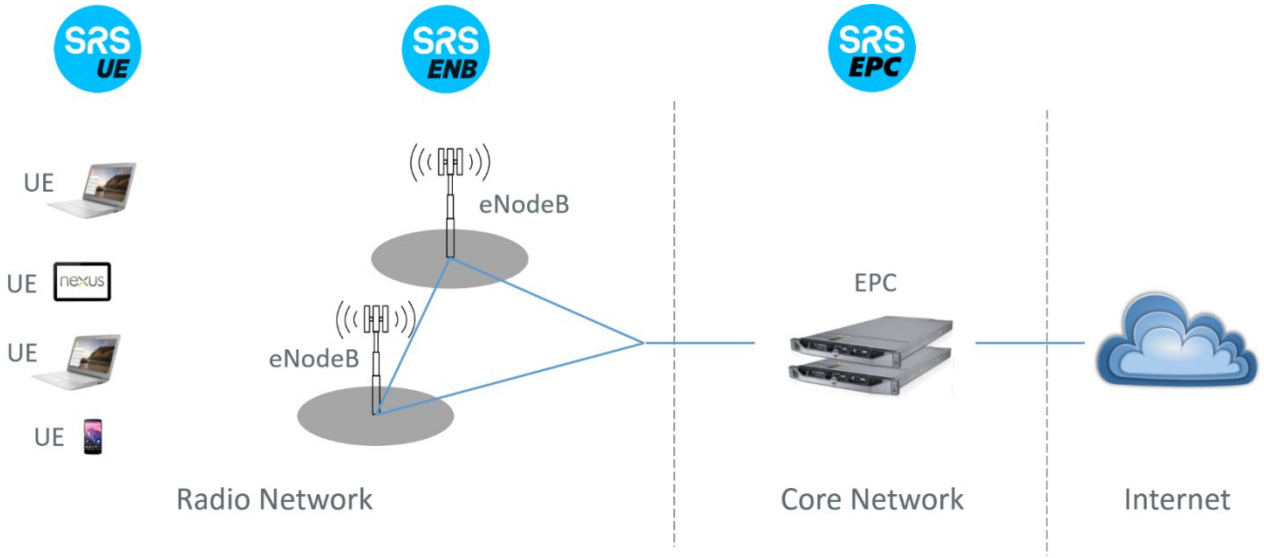
- Core LTE library
  - Modular and portable, high-performance library for LTE PHY, MAC, RLC, PDCP, RRC, NAS, S1AP and GW
  - All LTE bandwidths up to 20 MHz, TM1-4
  - Highly optimized Turbo decoder for Intel SSE4.1/AVX (150Mbps in TM3/4)
- Applications
  - srsUE: First open-source SDR LTE UE
  - srsENB: A complete SDR LTE eNodeB application
  - srsEPC: A light-weight LTE core network



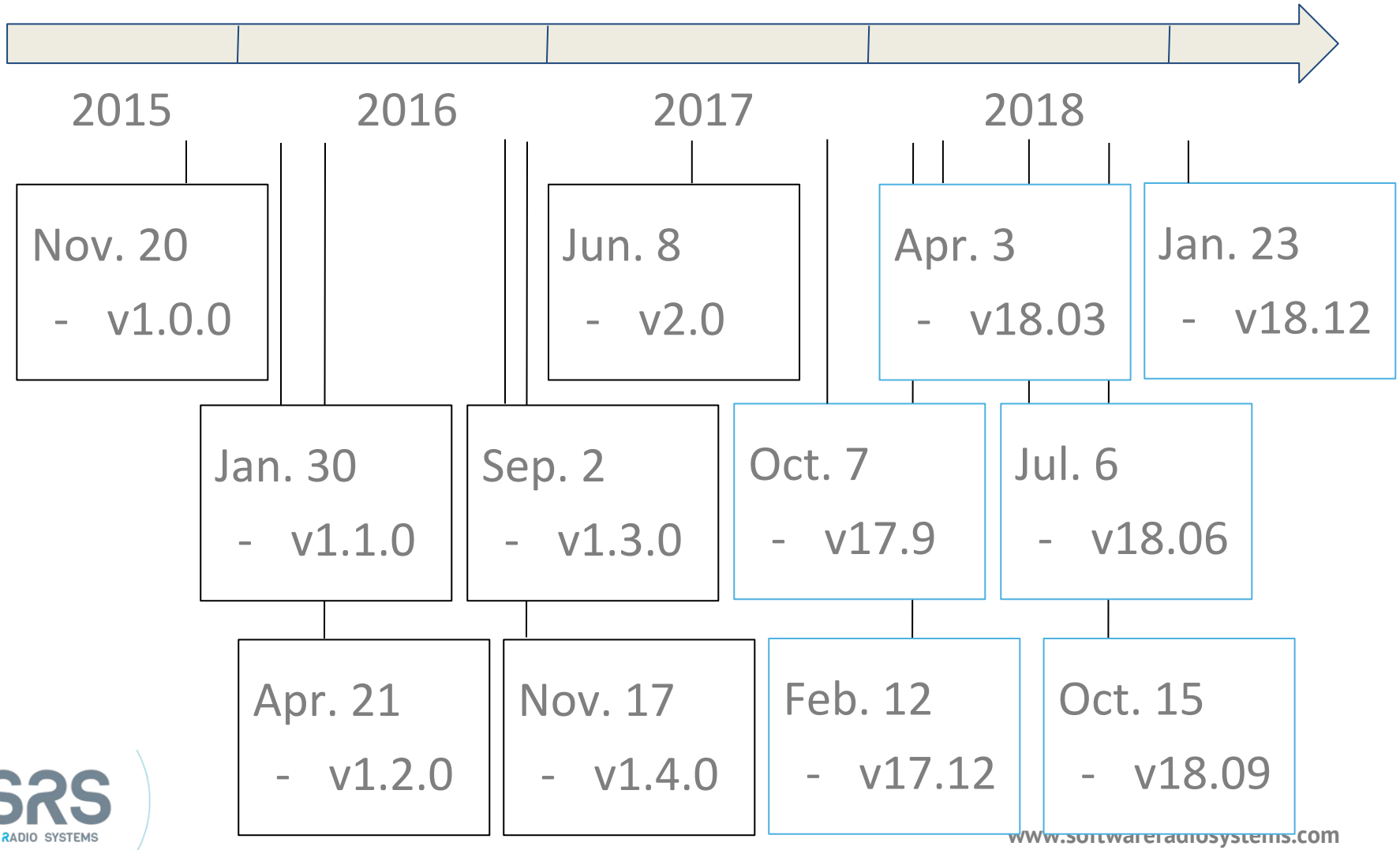
Recent Public-Funded Projects

OPENFirst

- NIST **P**ublic **S**afety **I**nnovation **A**ccelerator **P**rogram
- Fully open-source end-to-end LTE network for public safety research & development (PTT, D2D, ..)



srsLTE Release Overview



Important srsLTE Releases (1)

- srsLTE 2.0
  - Added srsENB
  - Merge srsUE code into main srsLTE repo

- srsLTE 17.09
  - 2x2 MIMO in PHY and srsUE (i.e. TM3/TM4)
  - eMBMS support in PHY

Important srsLTE Releases (2)

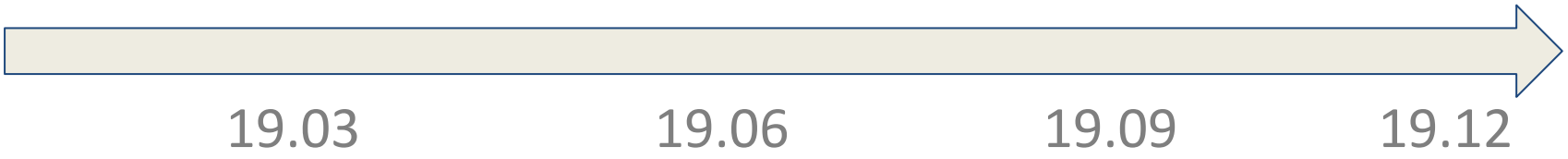
- srsLTE 17.12
  - 2x2 MIMO in srsENB
  - Added srsEPC
  - X2/S1 handover and UP encryption in srsUE

- srsLTE 18.06
  - eMBMS in srsUE/srsENB/srsEPC
  - Hard-SIM support in srsUE

Important srsLTE Releases (3)

- srsLTE 18.12
  - New ASN1 library for RRC packing/unpacking
  - Encryption for srsEPC
  - IPv6 support for srsUE

srsLTE Roadmap 2019



Early 2019:

- Closed-loop power control in srsUE
- TDD and Carrier Aggregation (CA) in srsUE

Later 2019:

- CA in srsENB
- Sidelink (D2D/V2X) in srsUE

Binary Packaging

- Ubuntu packages
  - PPA: https://launchpad.net/~srslte
  - Maintained by SRS (added in 18.06)
- (Open-)SUSE packages
  - https://build.opensuse.org/package/show/home:mnhauke:sdr-devel/srsLTE
  - Maintained by Martin Hauke
- Debian packages
  - https://packages.debian.org/sid/srslte
  - Maintained by Ruben Undheim

Supported RF Hardware

- Native support:
  - Ettus Research USRP B2xx, X3x0
  - Nuand bladeRF x40/x115, 2.0 micro
  - Epiq Solutions Sidekiq
- Through SoapySDR (tested):
  - RTL-SDR
  - LimeSDR
  - IIO
- Soon: ZMQ No-RF

No-RF Radio module

Motivation:

- Full stack testing without radio hardware

Advantages:

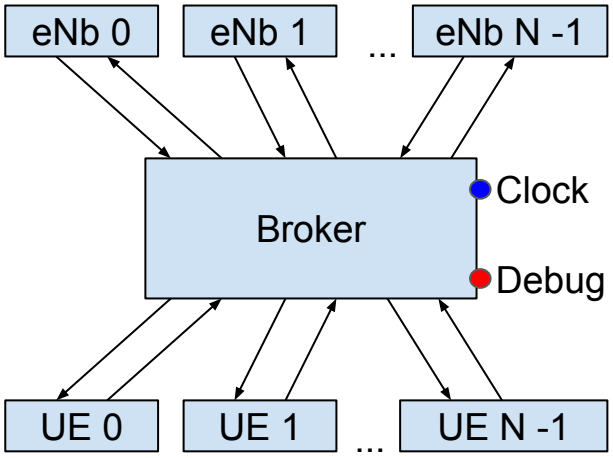
- Use tools like Valgrind, ASAN, gdb, etc.
- Run faster, slower, pause
- Model complex environments (N eNBs, M UEs, channel matrix)
- Signal visualization

Challenges:

- NO! eNB/UE changes (unless they make sense)
- Only new RF module
  - Convert btw. async and sync tx/rx model
  - Rate changes

rf_zmq_impl Prototype

- No-RF radio module (using srsLTE RF API)
- Transport IQ samples over ZMQ sockets
  - REQ/REP model for Rx/Tx
  - Blocking Rx
  - Different transports
- Timestamp synchronization
- Buffering/padding of IQ samples
- Resampling



No-RF Example (1)

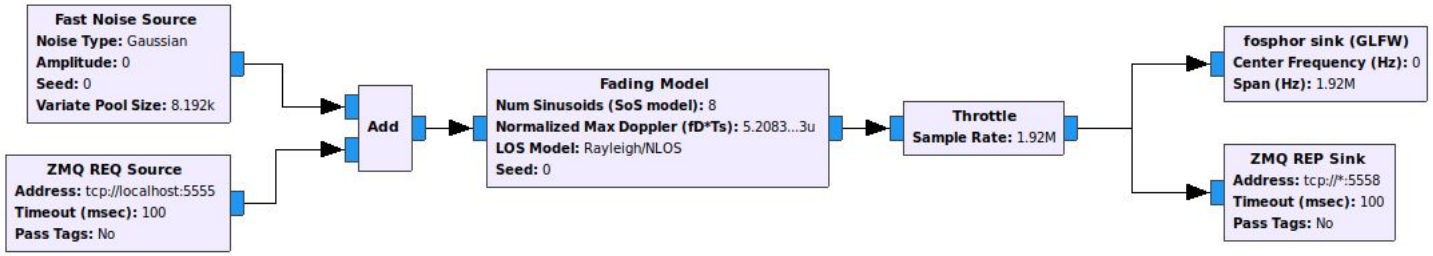
- srsENB using rf_zmq radio as Tx

```
$ ./srsenb/src/srsenb ../srsenb/enb_zmq.conf
```

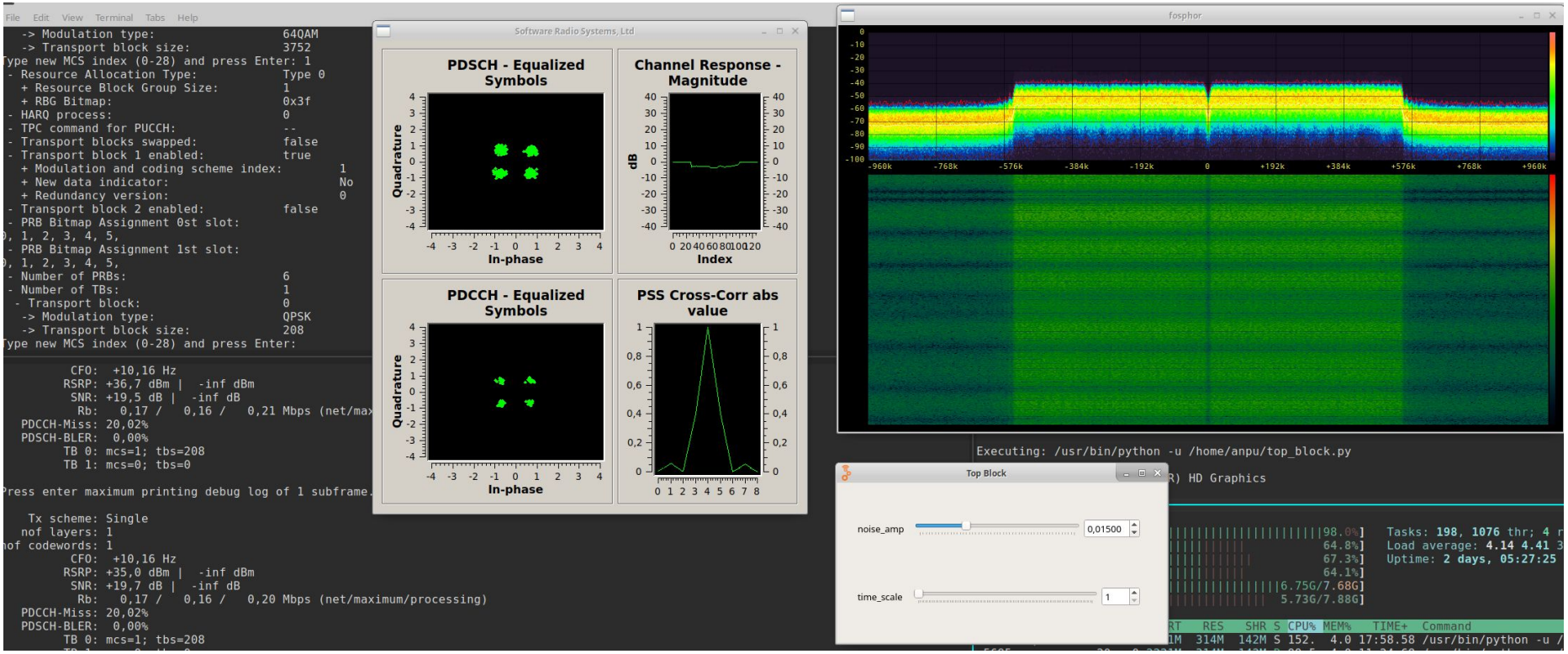
- pdsch_ue as Rx

```
$ ./lib/examples/pdsch_ue -I zmq -a rx_port=5558 -r 0x1234
```

- GNU Radio as broker adding noise and fading



No-RF Example (2)



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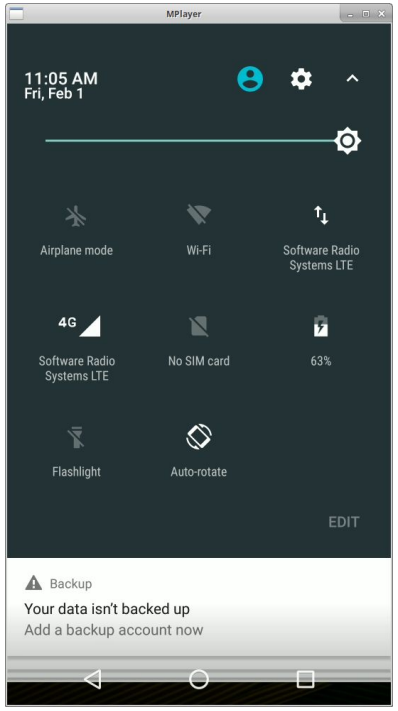
What's the Three Clicks Thing?

```
$ sudo add-apt-repository ppa:srslte/releases
$ sudo apt-get update
$ sudo apt-get install srslte -y
$ srsepc_if_masq.sh <ethX>
$ sudo srsepc
$ sudo srsenb
```



Thanks!

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We're hiring!