



# Institute for the Wireless Internet of Things

at Northeastern University

## Sounding Assignment



Platforms for Advanced  
Wireless Research



MITRE



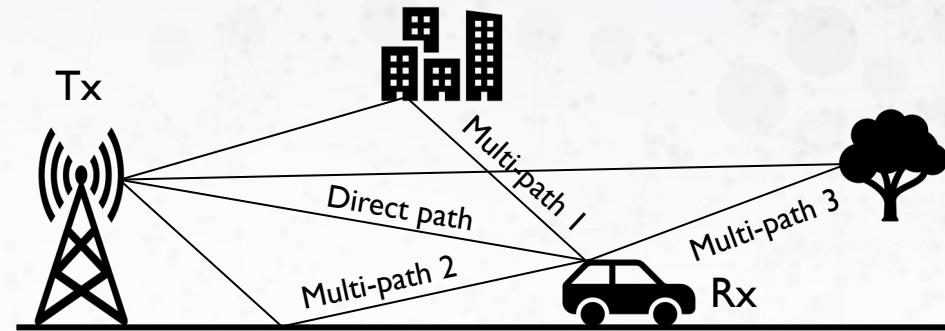
MASSACHUSETTS  
TECHNOLOGY  
COLLABORATIVE



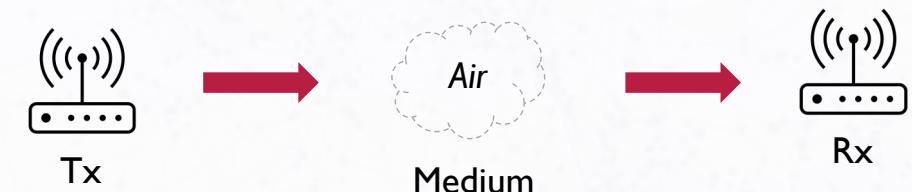
N COLOSSEUM  
at Northeastern University

# Channel Sounding in Colosseum

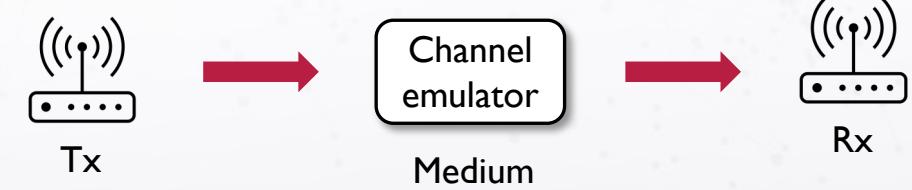
- Channel sounding goals:
  - **Evaluate** an RF channel characteristics
  - **Analyze** the environment
  - **Optimize** the design
- **No over-the-air** communication
- **Emulated** medium
- Sounding goals in emulators:
  - **Validate** original traces:
    - Channel Impulse Response (**CIR**) for Time of Arrivals (ToA)
    - Power Delay Profile (**PDP**) for Pathloss (**PL**)
  - **Understand** emulated behavior



Communication over-the-air

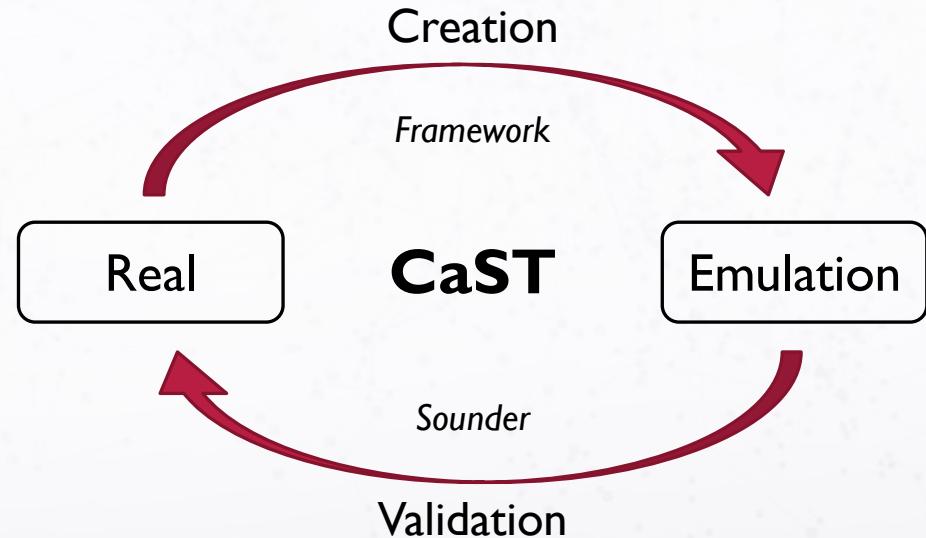


Communication in emulators

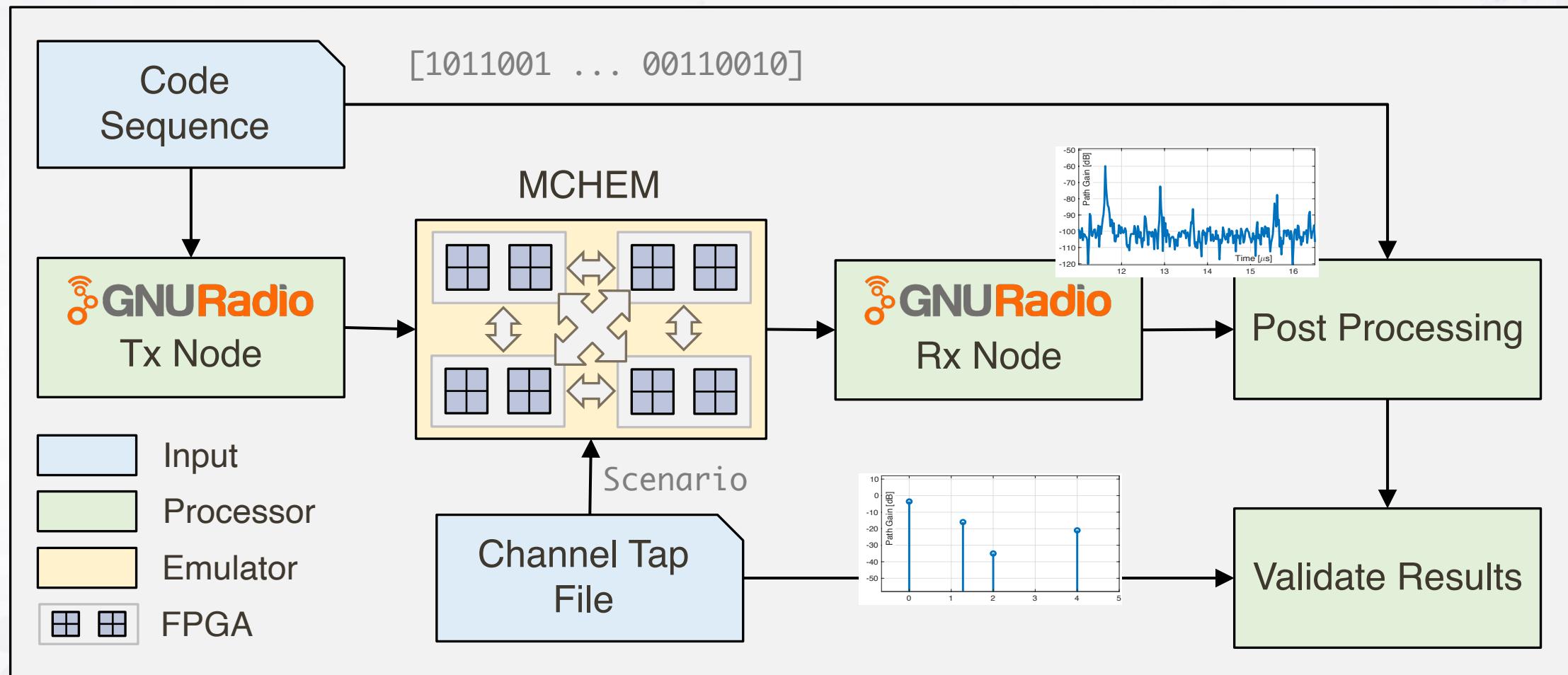


# What is CaST? Definition and contributions

- **CaST** - Channel emulation generator and Sounder Toolchain:
  - Streamlined **framework** to create realistic mobile wireless scenarios.
  - SDR-based **channel sounder** to characterize emulated RF channels.
- Contributions:
  - **Accuracy** up to 20 ns for CIR delays and 0.5 dB for tap gains.
  - Partially **automated**.
  - Fully **open-source**.
  - Validated in **Colosseum**.



# CaST Channel Sounding Workflow



# GNU Radio Tx Node

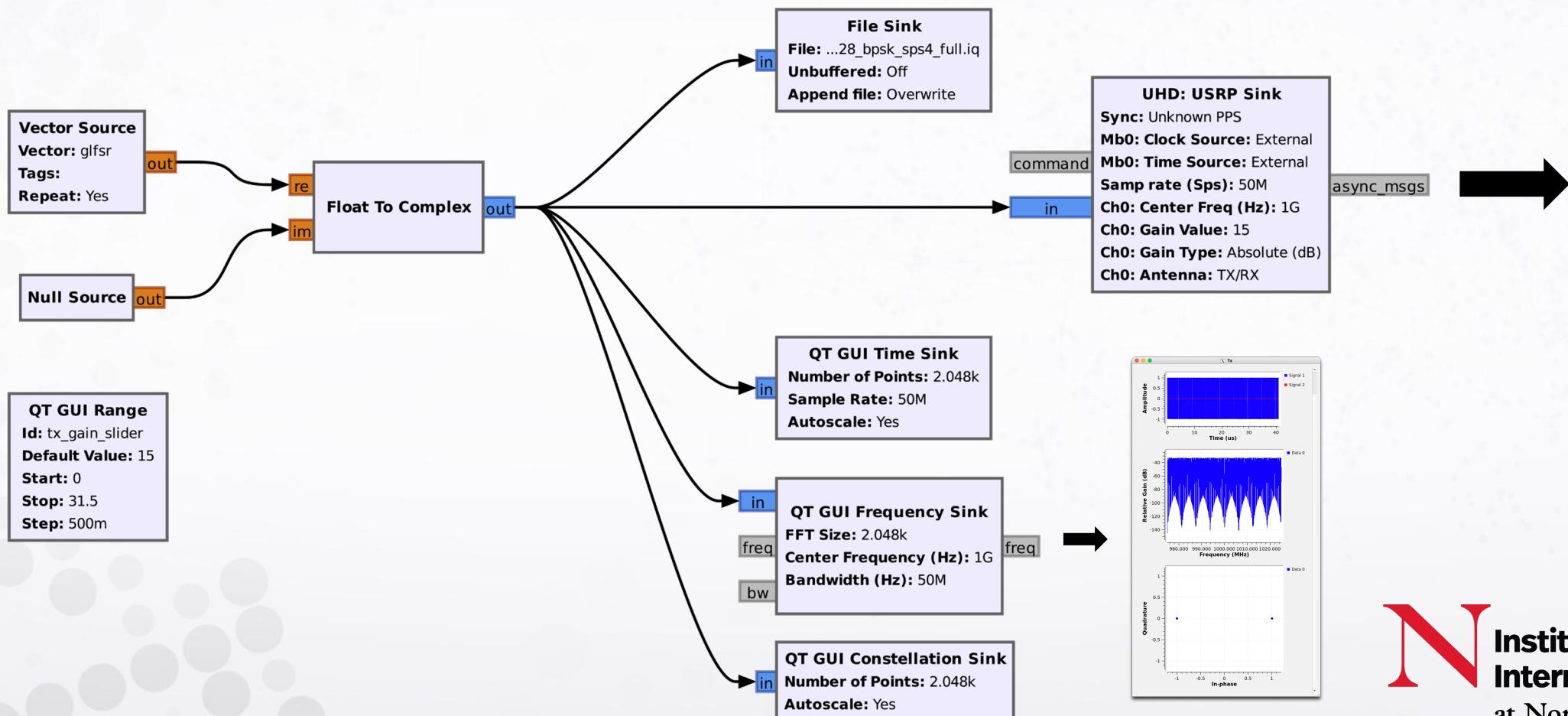
**Options**  
Title: Tx  
Author: root  
Output Language: Python  
Generate Options: QT GUI

**Variable**  
**Id:** freq  
**Value:** 1G

**Variable**  
**Id:** samp\_rate  
**Value:** 50M

**Variable**  
**Id:** num\_disp\_points  
**Value:** 2.048k

**Variable**  
**Id:** full\_signal\_len  
**Value:** 255



# GNU Radio Rx Node

MCHEM



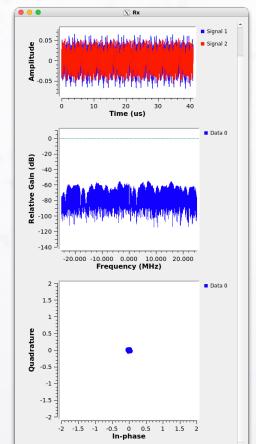
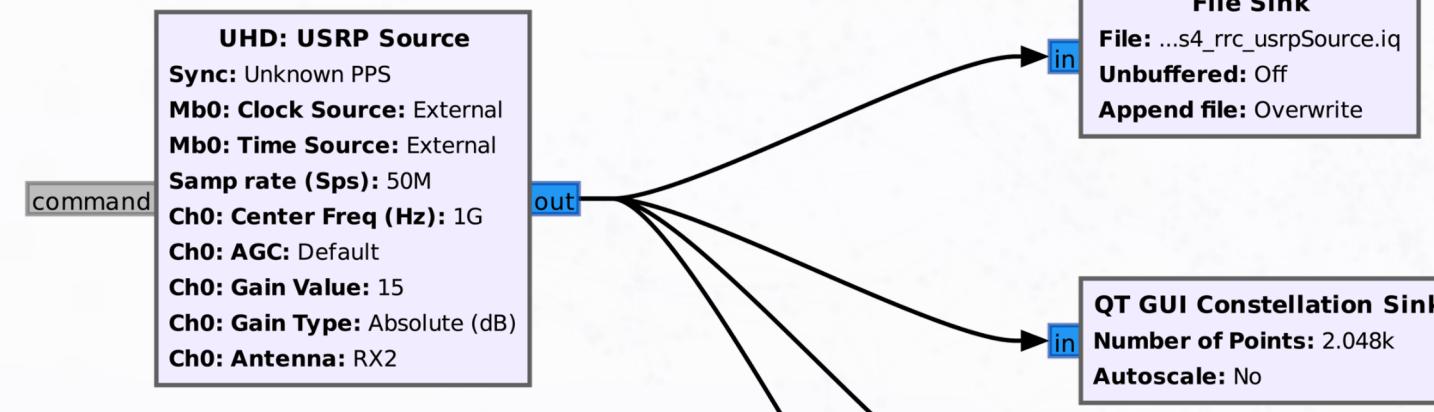
command

**Options**  
Title: Rx  
Output Language: Python  
Generate Options: QT GUI

**Variable**  
**Id:** freq  
**Value:** 1G

**Variable**  
**Id:** samp\_rate  
**Value:** 50M

**Variable**  
**Id:** num\_disp\_points  
**Value:** 2.048k



# CaST Data Post-processing

- The **received data** are post-processed to obtain:
  - **CIR**  $h(t)$  for the Time of Arrivals (ToA)
  - **PL**  $p(t)$  for the path gains  $G_p(t)$ .
- Let  $c(t)$  the known **code sequence** with  $N$  bits.
- Let  $S^{iq}(t)$  and  $R^{iq}(t)$  the modulated transmitted and received **IQ signals**.
- $$h^I(t) = (r^I(t) \otimes s^I(t)) / (s^{I^T}(t) * s^I(t))$$
- $$h^Q(t) = (r^Q(t) \otimes s^Q(t)) / (s^{Q^T}(t) * s^Q(t))$$
- $$|h(t)| = \sqrt{(h^I(t))^2 + (h^Q(t))^2}$$
- $$G_p(t)[dB] = 20 \log_{10}(|h(t)|) - P_t - G_t - G_r$$

$\otimes$  = Cross-correlation

$G_p$  = Path gain

$P_t$  = Power transmitted sequence

$G_t$  = Antenna gain at the transmitter

$G_r$  = Antenna gain at the receiver

# Let's get started...

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<https://github.com/colosseum-wiot/colosseum-school-2023/tree/main/sounding-assignment>





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Thank You!



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