WSRD-X Workshop 2018

LTE Security, Privacy, and Assurance: Key Research Challenges and Hardware Needs

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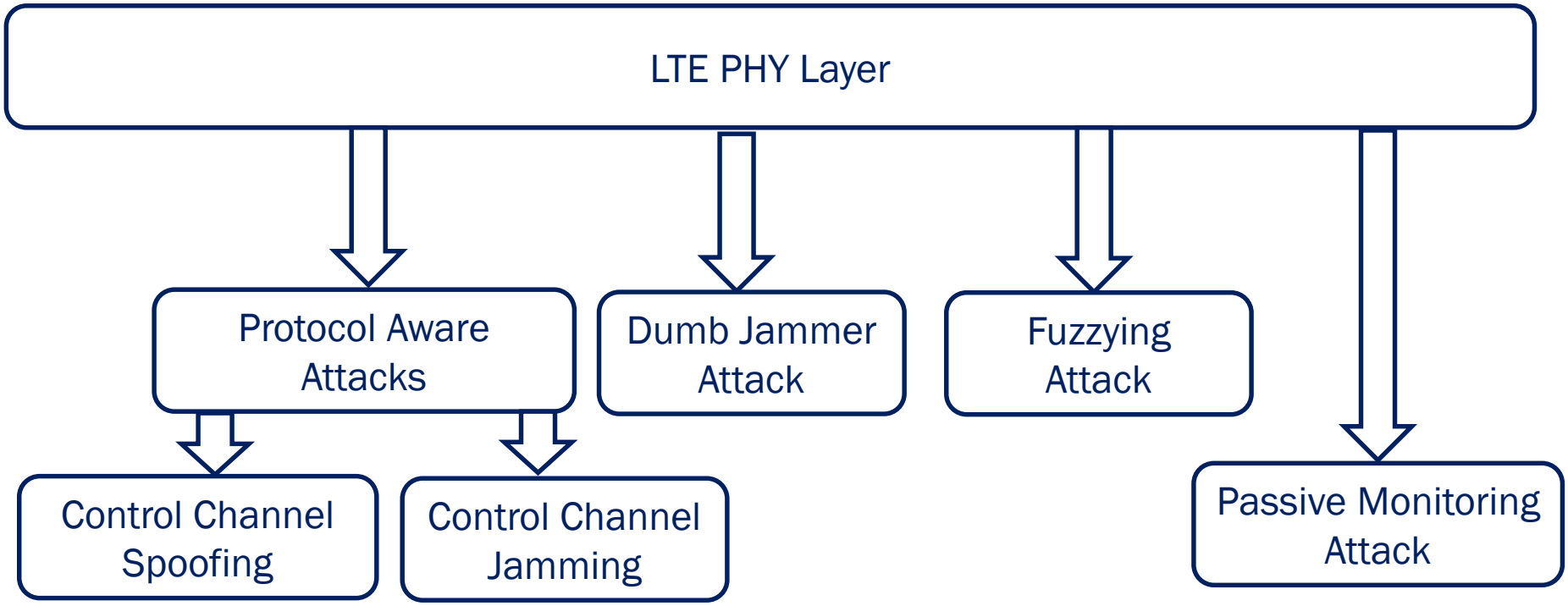
Introduction

- 4G LTE (even 5G NR) is vulnerable to attacks at all layers [1,2].
- Last year, there was evidence of “stingrays” being used in the DC area. Devices to snoop on callers.
- This presentation slides address the following:
  - Highly vulnerable 4G LTE PHY attacks and mitigation.
  - Methods to detect stingray activity
  - Challenges in performing LTE information assurance research
  - Example of Hardware Needed
  - Recommendations for a way forward in enabling research

LTE PHY Layer Security/Assurance/Privacy Attacks



Known attacks, ignored in the past, but must be addressed for mission and life critical 5G systems and FirstNet.

Stingrays: Menacing DC

- Also known as Rogue Base stations/IMSI catchers.
- Can be easily implemented from open-source libraries such as srsLTE/OAI, while hooked to a cheap USRP.
- Detection Methods:
  - Signal Structure: Anomaly detection of spatial signature, power, and spectrum.
  - Network-level: Crowdsourcing BS behavior, deployment of “honeypot” UEs, supply fake IMSI and watch behavior.
  - Repurposing available infrastructure: Legitimate eNodeBs or crowd source UEs with collection software

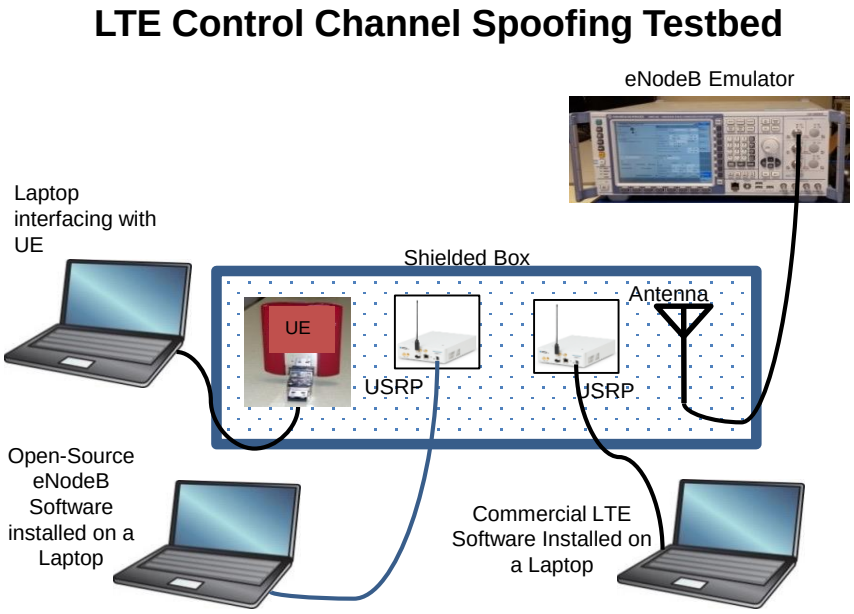
Obtaining IMSI by Software-Defined Radio (RTL-SDR) -- $32 IMSI catcher

Pictures from:

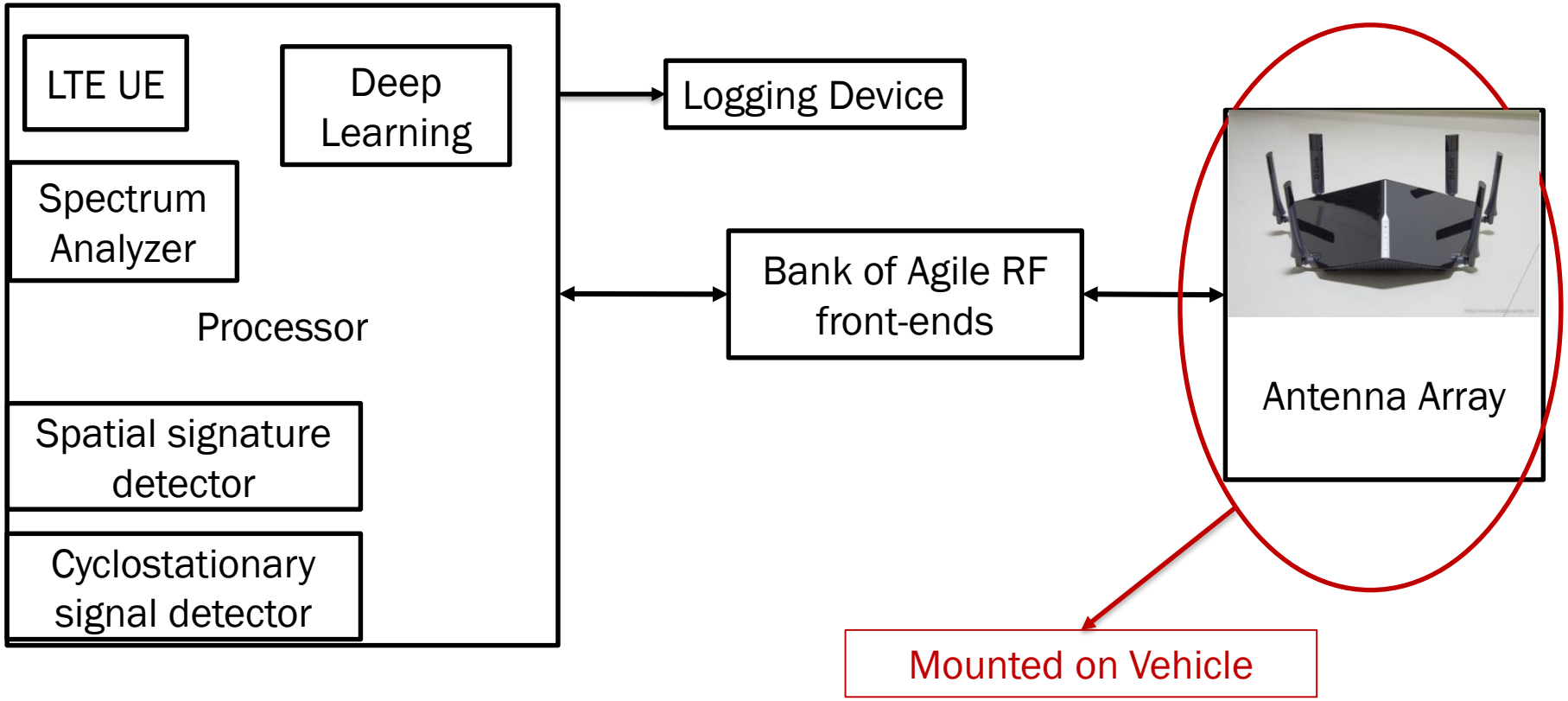
R. V. Bulychev, D. E. Goncharov and I. F. Babalova, "Obtaining IMSI by software-defined radio (RTL-SDR)," *2018 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (ElConRus)*, Moscow, 2018, pp. 21-23. doi: 10.1109/ElConRus.2018.8316859

Challenges for Research

- Need the realism of a real situation.
  - Finding issues
  - Fixing issues
  - Getting/generating the data
- Need expensive equipment for observing protocol exchange and logging for forensics.
- Need to replace expensive equipment with inexpensive equipment so that many universities are enabled to do the needed research. -- Hard
- Need to be concerned with privacy issues and impacting real networks though active probing– can inadvertently become the bad guy. FCC might get mad



Hardware for Stingray Detection



Architecture and features of “spectrum enforcement” hardware

What's Needed – A Contest on LTE Assurance, Privacy, and Security

- Common tools for researchers
  - LTE UEs and eNBs SDR-based and/or dedicated hardware.
  - LTE Protocol monitors
  - Misc. software tools
  - Reference manual for how to deal with privacy issues
- Hardware testbed – Out of the carrier's spectrum.
  - Early phase experiments in lab or via internet
  - Later phase experiments in the field (is this a role for an NSF PAWR testbed?)
- Paid competition among researchers to determine
  - Flaws and weakness identified in the standard or interpretation of the standard
  - Defensive strategies and countermeasures
  - Forensics techniques to find new attacks and understand them
- Field-based experimentation for more realism – *Could this be a role of NSF PAWR testbeds?*
- Should we consider DSRC or cV2x instead?
  - Less investigation
  - Mission critical (life-critical)
  - Early enough research to impact deployment and standards

For Further Reading

- [1] M. Lichtman, R. P. Jover, M. Labib, **R. M. Rao**, V. Marojevic, and J. H. Reed, “LTE/LTE-A Jamming, Spoofing, and Sniffing: Threat Assessment and Mitigation,” *IEEE Communications Magazine*, vol. 54, no. 4, pp. 54–61, April 2016.

- [2] M. Lichtman, R. Rao, V. Marojevic, J. Reed and R. P. Jover, "5G NR Jamming, Spoofing, and Sniffing: Threat Assessment and Mitigation," *2018 IEEE International Conference on Communications Workshops (ICC Workshops)*, Kansas City, MO, 2018, pp. 1-6.

- [3] M. Labib, V. Marojevic, J.H. Reed, A.I. Zaghloul, “Enhancing the robustness of LTE systems: analysis and evolution of the cell selection process,” *IEEE Commun. Mag.*, Vol. 55, Iss. 2, *Feb. 2017*.

- [4] R. Rao, V. Marojevic, S. Ha, J.H. Reed, “LTE PHY Layer Vulnerability Analysis and Testing Using Open-Source SDR Tools,” *Proc. IEEE MILCOM*, Baltimore, MD, 23-25 Oct. 2017, pp. 1-6.

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