Lessons Learned while Trying to Reproduce the OpenRF Experiment

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General Outline

1. Context and Motivation
2. OpenRF: A Case Study
3. Reproducibility Challenges
4. Lessons Learned
5. Conclusion
# Motivation

<table>
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<th>Learning</th>
<th>Extending</th>
<th>Reusing</th>
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<tbody>
<tr>
<td>Learning with a hands-on experience</td>
<td>Extending scientific work</td>
<td>Reusing tools for other scientific projects</td>
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Beamforming

- Wireless channel reciprocity assumption
- Precoding Tx from CSI measurements upon the reception of a client packet
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OpenRF\textsuperscript{[1]}: A Case Study

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<td>Learning about the implementation of Beamforming in COTS Wi-Fi chips</td>
<td>Extending cross-layer optimization by physical layer manipulation</td>
<td>Reusing Acquired knowledge of the Intel CSI tool\textsuperscript{[2]} and the Intel 5300 agn card for other related projects (Localization)</td>
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Provided Material

- Web page containing:
  - OpenRF code release
  - Link to the ISO image used during the experiments (Ubuntu 10.04.4 LTS)
  - Installation instructions
  - A sample testing scenario with description of expected results
Project Timeline

RESOURCES

- 45 Intel 533AN MMW Full / Half
- 3 x86 machines in office room
- 3 x86 machines in Anechoic chamber

INSTALLATION

- Operating Systems:
  1. Ubuntu 15.04
  2. Ubuntu 12.04 LTS
  3. Ubuntu 10.04 LTS
- Kernel : 3.5.4-csitool+ kernel

VERIFICATION

- Checking Dmesg
- Plotting SNR from CSI
- PHY layer configuration
Initial Outcome

- Matrix injection and system response:
  - Driver message comes back with positive ACK
  - SNR plot for each subcarrier shows no difference between the before and after precoding

```bash
$ dmesg
...
iwlwifi 0000:04:00.0: Setting beamforming matrix
<iwlwifi 0000:04:00.0: Set bf: Returned (0)
iwlwifi 0000:04:00.0: In iwlagn_send_rxon_assoc_wsdn
iwlwifi 0000:04:00.0: rssi: 39 40 38 noise: -90 agc: 36
```
Verification Procedure

• Double check on every step from the matrix computation to the transmission of the CSI report to the Firmware

• Driver messages comes back clean with no Firmware crashes or injection rejection

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$ dmesg
...
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iwlwifi 0000:04:00.0: rssis: 39 40 38 noise: -90 agc: 36
```
Verification Procedure

• Variation of Transmission scenarios:
  ▪ Dynamic rate adaptation
  ▪ Fixed number of space time stream (STS)
  ▪ Fixed Modulation and Coding Scheme (MCS)
Interpretation

• The Spatial mapper is always set to the default Intel’s indirect spatial mapping matrix

• Intel wireless cards vary from a manufacturer to another with some Engineering Samples (ES) still in the market
Lessons Learned

• It would preferable to:
  ▪ Provide a detailed description of their experiment scenario
  ▪ Publish the code and scripts used for their experiments
Lessons Learned

• It would be preferable to consider managing research projects as a Software development projects:
  ▪ Similar reproducibility challenges
  ▪ Source code management tools and notebooks are great for fostering a more reproducible research
Requirement Description

- System Description should focus on the critical details and particularities of their setup
- A shallow and lengthy description should be traded for a focused on critical requirements
- A system verification against multiple hardware should be conducted or at least the specific references should be mentioned
Code and Scripts

• The code should be:
  ▪ Freely accessible
  ▪ Possibly written in non propitiatory languages
  ▪ Depending on accessible and properly maintained packages
Conclusion

- Reproducibility is tied to information accessibility
- Reproducibility should be accounted as a part of the research project’s activities