OPENWIFI INTRO & USAGE IN W-ILAB.T
WEI LIU, XIANJUN JIAO
OPENWIFI INTRO

- What
- Why
- How
WHAT IS OPENWIFI?
Q: What is openwifi?

Open-source IEEE802.11/Wi-Fi baseband chip/FPGA design. (AGPLv3)
Just google “openwifi”, you will find it on github: github.com/open-sdr/openwifi
IS OPEN WIFI BETTER THAN COMMERCIAL WIFI CHIP?
Q: Is the openwifi “chip” better than commercial Wi-Fi chip?

Yes & No!

note: not joke
IF IT IS WORSE, WHY USE IT?
Q: If it is worse, why use it?

**SPECIAL DESIGN** OF OPENWIFI MAKES IT IN SOME ASPECTS SUPERIOR TO COTS WIFI
The echo speed is faster because of SoC: Linux and Wi-Fi card on the same chip.
## OPENWIFI VS COTS WIFI

<table>
<thead>
<tr>
<th>NIC-processor interface</th>
<th>Openwifi</th>
<th>COTS WiFi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dedicated high-speed on-chip bus: Ping RTT: 300μs</td>
<td>Shared USB/PCIe bus Ping RTT: ~1ms</td>
</tr>
<tr>
<td>Processing offloading</td>
<td>Beyond the COTS:</td>
<td></td>
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<tr>
<td>Software --&gt; Hardware</td>
<td>• TSN processing (timestamping, sync, sheduling, etc)</td>
<td>• WPA encryption</td>
</tr>
<tr>
<td></td>
<td>• Etc. (Application specific)</td>
<td>• Packet filtering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Focus on consumer market</td>
</tr>
<tr>
<td>Integration level</td>
<td>One chip: Audio/Video/graphic/AI/... + Network</td>
<td>Multiple chips</td>
</tr>
<tr>
<td>Upgrade in the field</td>
<td>YES: FPGA</td>
<td>NO: Hardened silicon and BLOB (Binary Large Object – firmware)</td>
</tr>
<tr>
<td></td>
<td>New feature; bug fix; optimization</td>
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NEW FEATURE / BUG FIXES IN 2020

- FPGA-ARM interface -> more accurate
- Channel estimation -> more accurate
- Build SD card -> use script
- Debug Verilog -> use macro
- Scattered IP -> grouped
- Low MAC -> improved
- Beacon -> higher priority
- QoS -> supported
- Driver panic -> fixed

- Different boards -> single SD card
- Build -> more easy
- Frequency offset -> bug fixed
- PHY TX -> less clock
- Collision -> less happen
- Ref design 2018 R1 -> 2019 R1
- Vivado 2017.4.1 -> 2018.3
- Task -> use script
- FPGA queue 2 -> 4
- Linux 4.9.0 -> 4.14.0
- Side channel -> built
- Back off -> more compliant
HOW COULD OPENWIFI SERVE YOUR PRODUCT/RESEARCH/APPLICATIONS?
**Hug openness:** under AGPLv3 to build your unique open product and ecosystem for free!

**Secrete competence:** early access to advanced/unique openwifi features or propose your unique customization needs

**FEEL FREE TO COME AND DISCUSS FURTHER!**
Q: If openwifi is worse, why should I use openwifi?

You want in depth “know-how”

- You use Wi-Fi daily, but do you know how exactly a Wi-Fi chip is implemented: **Full stack from user program to antenna!**

You have ideas to improve Wi-Fi or customize Wi-Fi for your scenario, but …

- The Wi-Fi driver is so complicated, don’t know which part you need to modify.
- The Wi-Fi card has full MAC, you can not control it from driver.
- You want to modify some part of the Wi-Fi chip, but it is not possible.
- You want to see how will your new antenna/RF/PA/LNA/algorithm/idea improve actual Wi-Fi network performance.
UGent, CUHK (Honkong), CUHK (Shenzhen), Northeastern university, Stony Brook university, Michigan State university, Trinity College Dublin, University of Massachusetts, Danang University (Vietnam), Tsinghua University, Nanjing University, Wuhan university, BUPT (China), UST Korea, University of Dortmund, unibs (Italy), Loughborough University, University of Liverpool, etc.

Also many industrial companies.

On github (27/04/2021)
SW+HW repositories
• 2K stars
• 334 forks
• 120 watch
• 59 issues closed

Rank 3 of Verilog topic on github:
https://github.com/topics/verilog
DON’T BLINK
OPENWIFI INTRO

- **What**
- **Why**
- **How**
OPENWIFI INTRO

If you have a board, follow github!

- What
- Why
- How

Quick start

- Burn openwifi board specific img file (from the table) into a SD card ("Open With Disk Image Writer". Or "dd" command after unzip). The SD card has two partitions: BOOT and rootfs. You need to config the correct files in the BOOT partition according to the board you have by operation on your computer:
  - Copy files in openwifi/board_name to the base directory of BOOT partition.
  - Copy openwifi/zyqmp-common/Image (zcu102 board) or openwifi/zyq-common/image (other boards) to the base directory of BOOT partition.

- Connect two antennas to RXA/TXA ports. Config the board to SD card boot mode (check the board manual). Insert the SD card to the board. Power on.

- Login to the board from your PC (PC Ethernet should have IP 192.168.10.1) with password openwifi.

```bash
ssh root@192.168.10.128
```
OPENWIFI INTRO

- What
- Why
- How  If not, try it on w-iLab.t testbed
OPENWIFI USAGE ON W-ILAB.T
OPENWIFI USAGE IN W-ILAB.T

- Tutorial webpage
- Where are the SDR boards? Which types are installed?
- Reservation and JFED experiment
- How to boot an SDR with Openwifi Image?
- Use Openwifi to communicate with other Wi-Fi nodes in testbed
- Miscellaneous
WHICH TYPE OF SDR BOARDS ARE INSTALLED?

https://doc.ilabt.imec.be/ilabt/wilab/hardware.html#zynq-family

- SDR boards
  - zc706zynqSDR (3x)
  - zcu102zynqSDR (4x), currently for internal usage only
  - zedzynqSDR (2x)
WHERE ARE THE SDR BOARDS

https://inventory.wilab2.ilabt.iminds.be/?viewMode=inventory#

- Bird view of SDR boards (black circle) in the w-iLab.t testbed
BOARD CONNECTIONS

Host node: DSS/APU/Server

- UART
- JTAG
- Exp switch
- Eth
- PDU, remote controlled
RESERVATION AND JFED EXPERIMENT

- Reserve an SDR and its host node on inventory
- Define a JFED experiment
  - No image specified
  - Define a link between SDR and host node (for ssh later on)
- Activate experiment
DEMO OUTLINE

- Boot Openwifi Image
  - Setup UART connection
  - Setup Vivado environment for FPGA configuration
  - Download booting files: FPGA bitstream, devicetree and ulmage
  - Interact with the bootloader via UART and boot Linux

- Use openwifi to communicate with COTS Wi-Fi
  - Setup openwifi AP
  - Configure commercial Wi-Fi as a client
  - Ping from commercial Wi-Fi to openwifi
MISCELLANEOUS
 YOU CAN ADD A SUBTITLE IF YOU WANT.

- Antenna selection
  - Check each SDR’s antenna at https://doc.ilabt.imec.be/ilabt/wilab/hardware.html#hardware-zynq-sdr
  - Some SDR has omi directional, some has directional antennas pointing at specific nodes
- Take care to match configuration files
  - FPGA, driver, and Linux kernel modules
- Restore rootfs
  - If no valid rootfs on the board, follow
    https://doc.ilabt.imec.be/ilabt/wilab/tutorials/openwifi.html#restore-rootfs-if-sd-card-is-corrupted
embracing a better life