V2X Laboratory Lesson

Corso di Tecnologie di Infrastrutture di Reti

Carlo Augusto Grazia
Tenure-Track Assistant Professor

Department of Engineering *Enzo Ferrari*
University of Modena and Reggio Emilia

Modena, 31st May 2024

How to create an 802.11p Network

Arduino-Yun based Laboratory

Laboratory: Arduino-Yun based 802.11p Network

Atheros AR9331 processor, running Linux and the OpenWrt wireless stack

ArduinoYun pros&cons

If you are interested

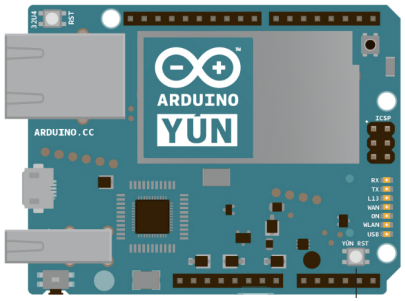
I've created a "tutorial for dummies" to configure a Yun with the right Kernel and be able to use 11p and other features (otherwise hard to deploy on a Yun)

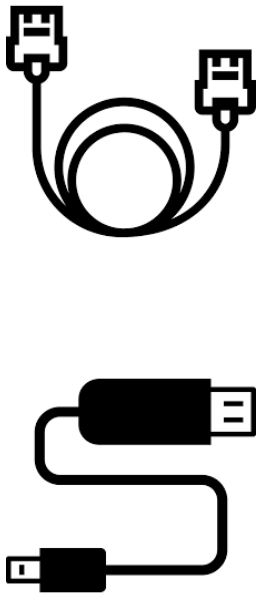
Requirements

What we need for start:

- If you don't what to "use your hands", you can simply follow as a standard lesson
  - Requirements: your own brain
- If you want to participate, each student needs:
  - One laptop
  - One Ethernet socket
  - One USB port
  - OS: Linux/OSX
  - Windows is allowed (Lab Canali: putty instead of ssh)
- We only need to connect via ssh to the Yun and we then can start

Setup

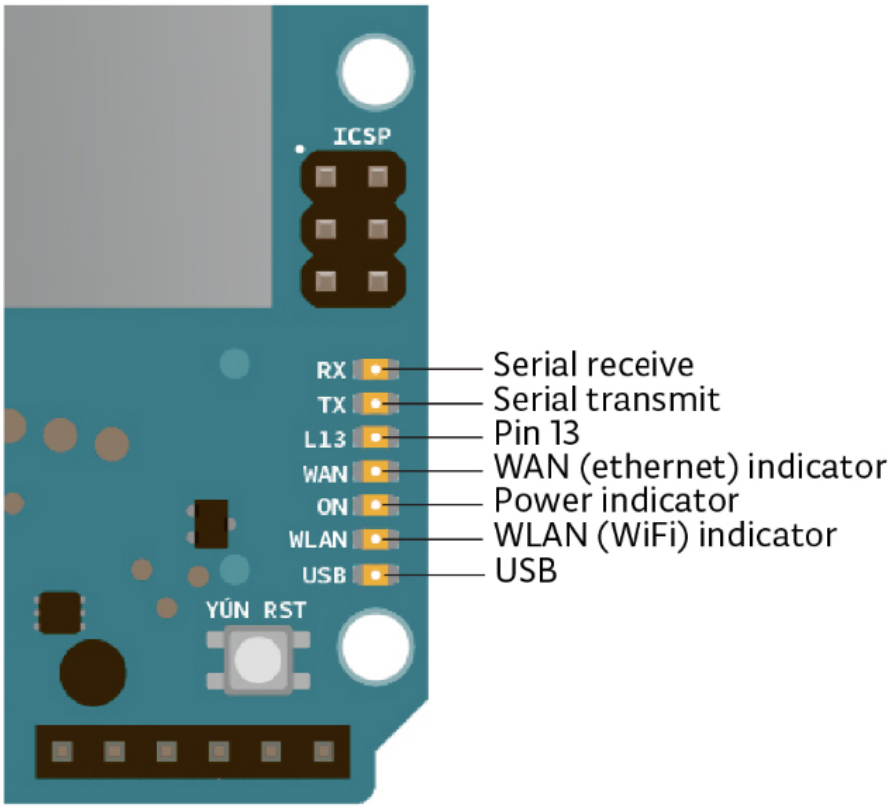




Yun <-> Eth ——— Eth <-> PC

Yun <-> MicroUSB ——— USB <-> PC

Powering the Yun



Once connected to the USB port the "power indicator" LED will switch on

Connecting to the Yun

The number in the Open Source Heart is YOUR ID, we will call it **X** during the lesson.

Remember your **X**, we will use it a lot.

Some Yuns for you: $\mathbf{X} \in [0, 30]$

Connecting to the Yun

Critical Part

Create the wired Ethernet connection

Yun side

Nothing to do, the Yun once booted creates its own wired interface with the IPv4 192.168.**X**.1

PC side

Modify your Ethernet NIC assigning a manual IPv4 192.168.**X**.2 with NetMask 255.255.255.0

All the OS have the "Network Setting" possibility

Connecting to the Yun: Lab Canali PC

In Superadmin role, click on network icon

- Impostazioni di rete
- Modifica opzioni scheda
- Ethernet n
- Proprieta'
- Protocollo [...] TCP/IPv4
- Proprieta'

Modify IP and NetMask fields

manual IPv4 192.168.**X**.2 with NetMask 255.255.255.0

Connecting to the Yun: Verifying

Open a Terminal (console, bash, shell, ...)

```
$ ping 192.168.X.1
```

What do you see?
Only if you have the reply we can move forward

Connecting to the Yun: Finalizing

```
$ ssh root@192.168.X.1
```

Password: arduino ...(not always asked)

You are now inside!

Connecting to the Yun (Lab Canali): Finalizing

Open PUTTY application

ip: 192.168.**X**.1
username: root
port: 22

Password: arduino ...(not always asked)

You are now inside!

On the Yun: Some commands

ip & iw

- **ip**: command that replaces ifconfig on new kernels: can manage links, routing table, assign ip, enable/disable interfaces
- **iw**: command that manages the wireless interface

Try some commands by yourself

```
$ ip link
[output]
$
$ iw list
[output]
```

On the Yun: Some commands

ip & iw

- **ip**: command that replaces ifconfig on new kernels: can manage links, routing table, assign ip, enable/disable interfaces
- **iw**: command that manages the wireless interface

Try some commands by yourself

```
$ iw dev wlan0 info
[output]
$
$ iwinfo wlan0 frequency
[output]
```

On the Yun: Some commands

iw

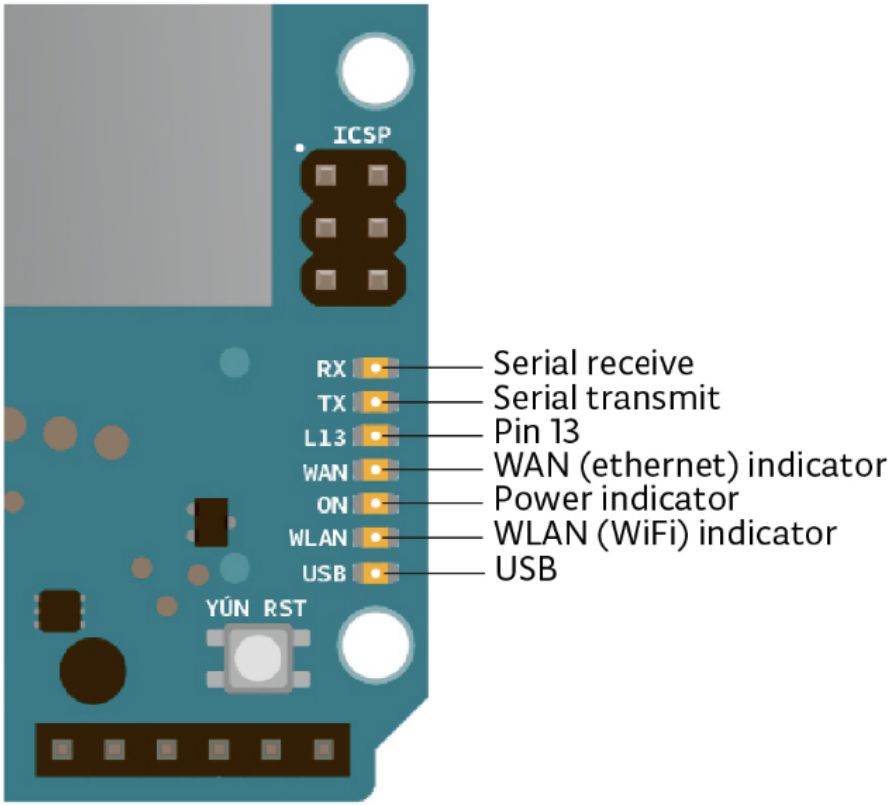
Tells us if the OCB mode is available

```
$ iw list
...
    Supported interface modes:
         * IBSS
         * managed
         * AP
         * AP/VLAN
         * monitor
         * mesh point
         * P2P-client
         * P2P-GO
         * outside context of a BSS
...
```

On the Yun: wlan0

ip

A little game to play with the WLAN LED




```
$ ip link set dev wlan0 up

% WLAN LED up %

$ ip link set dev wlan0 down

% WLAN LED down %
```

On the Yun: 802.11p Creation

ip & iw

ip to enable/disable wlan0 and **iw** to configure it

Try the commands by yourself

```
$ ip link set dev wlan0 down
$ iw dev wlan0 set type ocb
$ ip link set dev wlan0 up
$ iw dev wlan0 ocb join 2462 10mhz
```

On the Yun: Actually use 802.11p

ip

ip to assign the address and route the traffic

Try the commands by yourself

```
$ ip addr add 192.168.100.1X/24 dev wlan0
$ route add default gw 192.168.100.1X wlan0
```

Please, remember to change **X** with your Yun number

On the Yun: Ping an 802.11p colleague

ping

ping command does not need any description at all

Try to ping another device **Y**

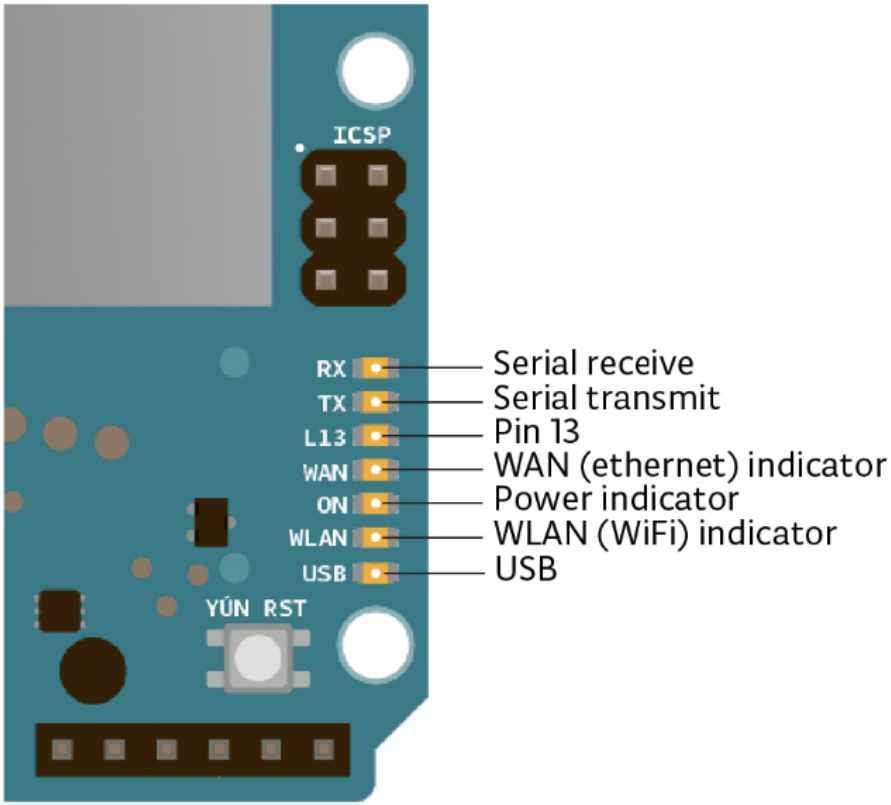
```
$ ping 192.168.100.1Y
```

Please, remember to change **Y** with someone-else Yun number

On the Yun: Ping an 802.11p colleague

ping

ping command does not need any description at all




```
$ ping 192.168.100.1Y
```

While pinging, the WLAN LED flashes (also the receiver one!)

On the Yun: Detect an 802.11p ping

tcpdump

tcpdump is a powerful command-line packet analyzer

Try to capture ping packets (better for the receivers)

```
$ tcpdump -n -i wlan0
```

On the Yun: 802.11p bandwidth

iperf

iperf is the perfect tool to create TCP/UDP client/server applications

Start with 1 volunteer **X** that would be the server and one volunteer **Y** that would be the client

SERVER: X

```
$ iperf -s
```

CLIENT: Y

```
$ iperf -c 192.168.100.1X -t 3
```

On the Yun: 802.11p shared bandwidth

Continuing with 1 volunteer **X** that would be the server and more volunteers **Y**, **Z**, ... that would be the clients

SERVER: X

```
$ iperf -s
```

CLIENT: Y

```
$ iperf -c 192.168.100.1X -t 10
```

CLIENT: Z

```
$ iperf -c 192.168.100.1X -t 10
```

Please, sync in order to actually share the spectrum

On the Yun: 802.11p message passing

ncat

ncat is a feature-packed networking utility which reads and writes data across networks from the command line

Pairs of 1 volunteer **X** that would be the server and one volunteer **Y** that would be the client

SERVER: X

```
$ ncat -l -k 8080
```

CLIENT: Y

```
$ ncat 192.168.100.1X 8080
```

You can also simply try

```
$ echo "message" | ncat SERVER_IP 8080
```

On the Yun: 802.11p **broadcast** message passing

EVERYONE: enable broadcast

```
$ echo "0" > /proc/sys/net/ipv4/icmp_echo_ignore_broadcasts
```

HOW TO RECEIVE MESS

```
$ ncat -k -l -u -p 8080 –sh-exec "cat > /proc/$$/fd/1"
```

SEND IN BROADCAST

```
$ echo "message" | ncat -u 192.168.100.255 8080
```