NPR
New Packet Radio on 70cm band

Introduction :
What is it?
&
Quick start guide
v3.6

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NPR – What is it? (1/4)

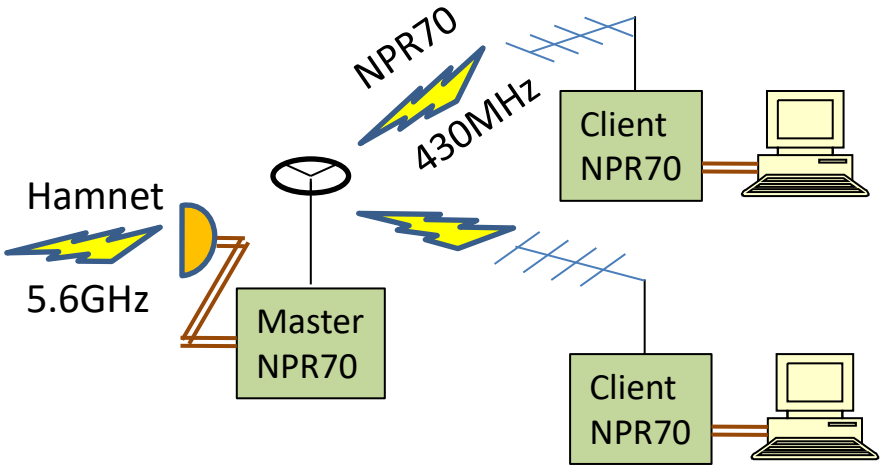
- Bi directional IP over radio link
  (no AX.25 despite the name “packet radio”)
- Intermediate data rate between Packet and HSMM-WiFi
- Frequency band 420-450MHz much easier to use than 2.4GHz or 5.6GHz (HSMM-WiFi-Hamnet).
- Designed by a HAM for HAMs
- 100% Open-Source : PCB + firmware

	Datarate	Frequencies
Packet radio	Raw : <9600bps Useful : several kbps	ALL (mainly 144MHz and 430MHz)
NPR **New Packet Radio**	Raw : 110kbps to 1Mbps Useful : 70 to 500kbps	420-450MHz
HSMM - Hamnet– WiFi	Raw : >10Mbps Useful : >10Mbps ?	2.4GHz, 5.6GHz

NPR – What is it ? (2/4)

Optimised for "Point To Multipoint" configurations

- 1 central repeater, called MASTER
- Several CLIENTS

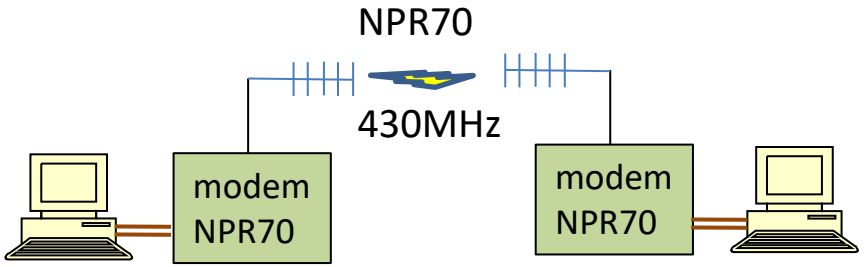


The Master only transmits when solicited by at least one Client.

Use case example :

Extension of Hamnet (2.4GHz or 5.6GHz) network

Possibility to use "Point to Point" configuration



Use case example :

Low data-rate DATV (200kbps)

Bi directionnal, single frequency.

NPR – What is it ? (3/4)

Compatibility with amateur radio rules

- Periodic transmission of callsigns
- No encryption
- The Master (repeater) only transmits when solicited
  (at least by one “client”)

Limitations:

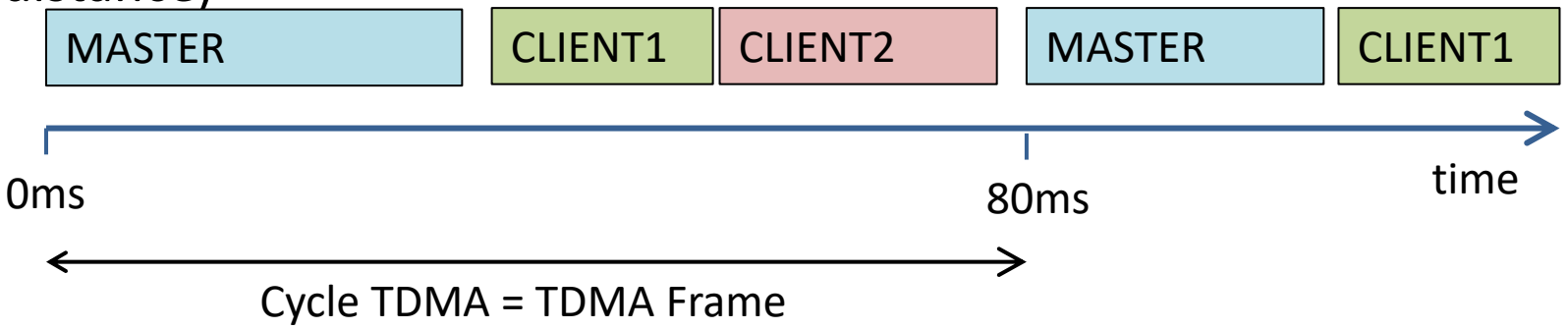
- Currently 7 simultaneous clients maximum
  (Evolution planned to upgrade to 15 clients maxi)
- 300km maxi (due to protocol)
- Limitations of 430MHz band: Not designed for 24x7 usage
- Not designed for “mobile” (only modulations 11, 20, 21)

NPR – What is it ? (4/4)
Some technical aspects

- Protocol invented & designed by me (Guillaume F4HDK)
- Use of chips initially designed for ISM 433MHz : SI4463
- Modulation 2GMSK or 4GMSK (Good spectral efficiency).
- Very simple FEC (Forward Error Correction) non tuneable
- TDD : time division duplex.

  All stations transmit on the same frequency, alternatively
- Fast TX/RX cycles : 80ms to 200ms. (similar to DMR).
- Managed-TDMA : The Master (central repeater) allocates speaking times to each station (Master and clients), according to the needs, in real time.

  ➔ No collision possible.
- Timing Advance management (transmission anticipation due to distance)

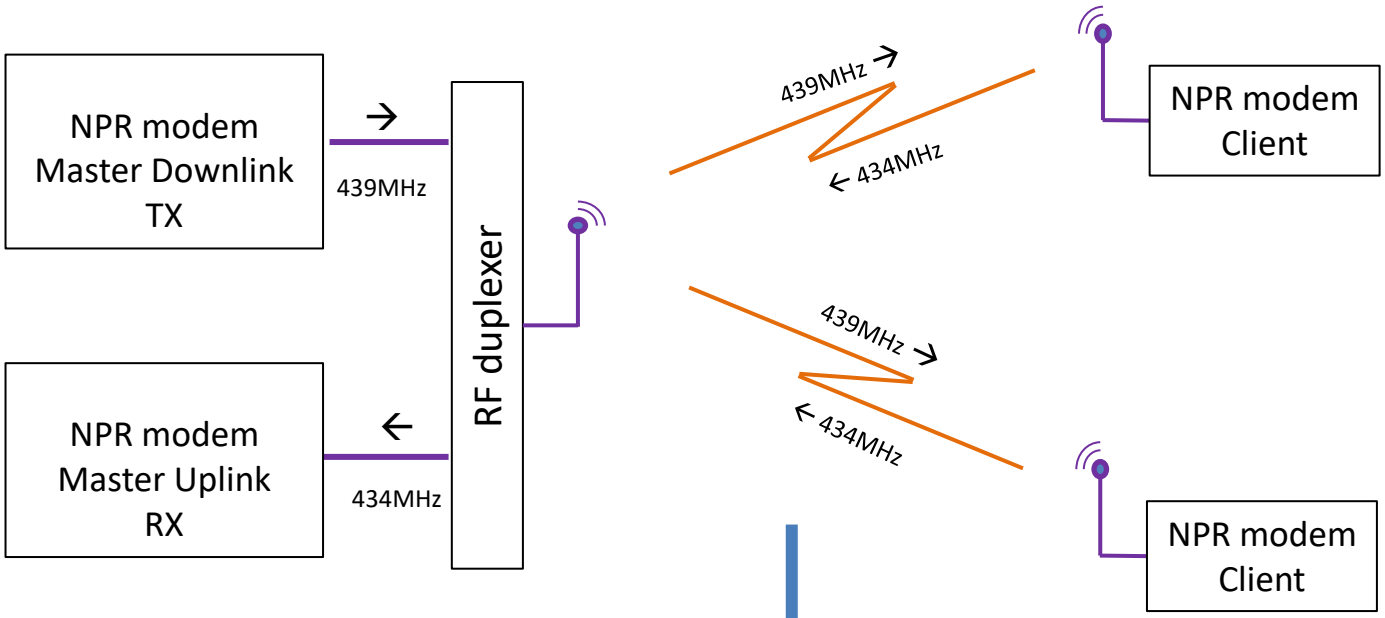


FDD mode (Frequency Division Duplex)

optional

Frequency Shift operation. 2 separated frequencies

- One frequency for uplink (from Clients to Master)
- One frequency for downlink (from Master to Clients)



Master side :

Full Duplex RF installation (with RF duplexer)

2 modems:

- One for TX – Downlink
- One for RX - Uplink

Client side :

One single modem per client.

Half duplex

Very fast shifting between TX and RX frequencies

Refer to the « advanced user guide » for more details

NPR – antennas

- You need antenna gain! It's wide band!
- ~~Horizontal polarisation is highly recommended~~
- Horizontal or vertical polarisation should be decided regarding local constraints (no IARU recommendation anymore about this topic)
- Due to multi-path issue (at such high symbol rates):
  - Client should use directional antennas (Yagi)
  - Master can use omni, but antenna should be unobstructed

Master :

– Horizontal polar omni (big wheel stack, or multiple panel antennas)

or

– Horizontal polar sectorial (1 or several panel antennas)

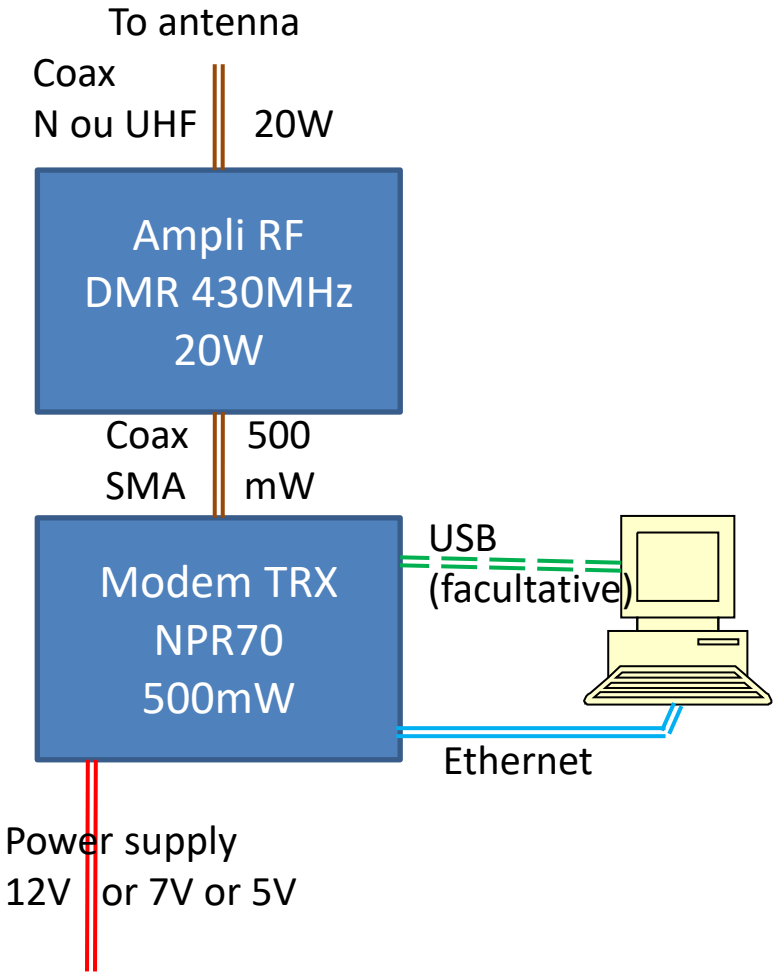
or

– Vertical (collinear)

Clients: Yagi

(Horizontal or Vertical polar)

NPR Hardware(1/6)



RF amplifier

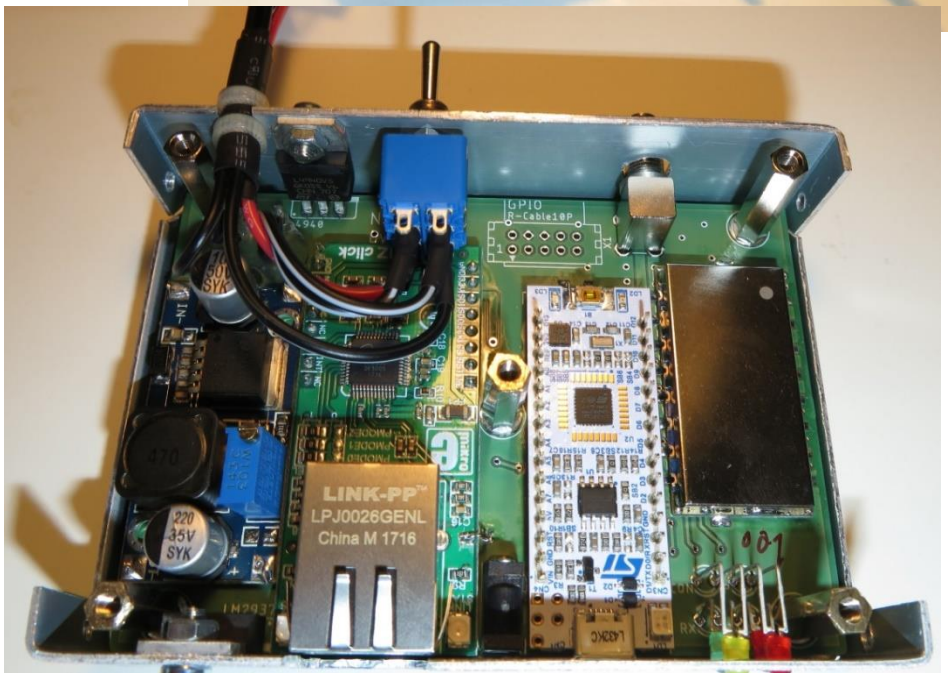
- The NPR protocol is compatible with some ‘off the shelf’ DMR amplifiers.
- Fast TX/RX commutation
- Warning : check compatibility before buying

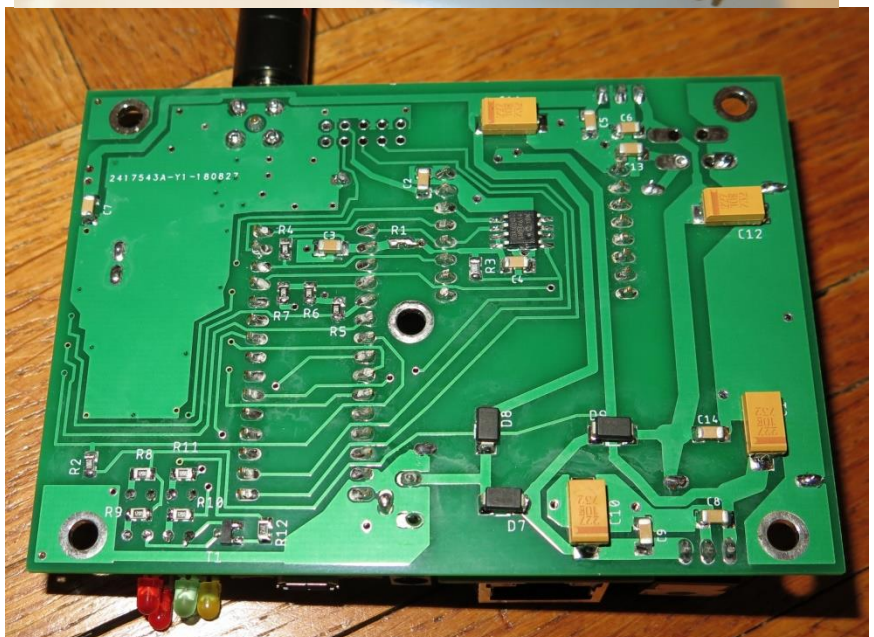
Modem-Transceiver

- Custom design (PCB + software).
- kit price (to be confirmed) : 70$ to 80$ including enclosure.
- 3 power supply sources possible
  - 12V (9V to 20V)
  - 7V (6.5V to 8V)
  - 5V regulated
    (only for tests, RX sensitivity degraded)
- Ethernet connection
- No software needed on PC!

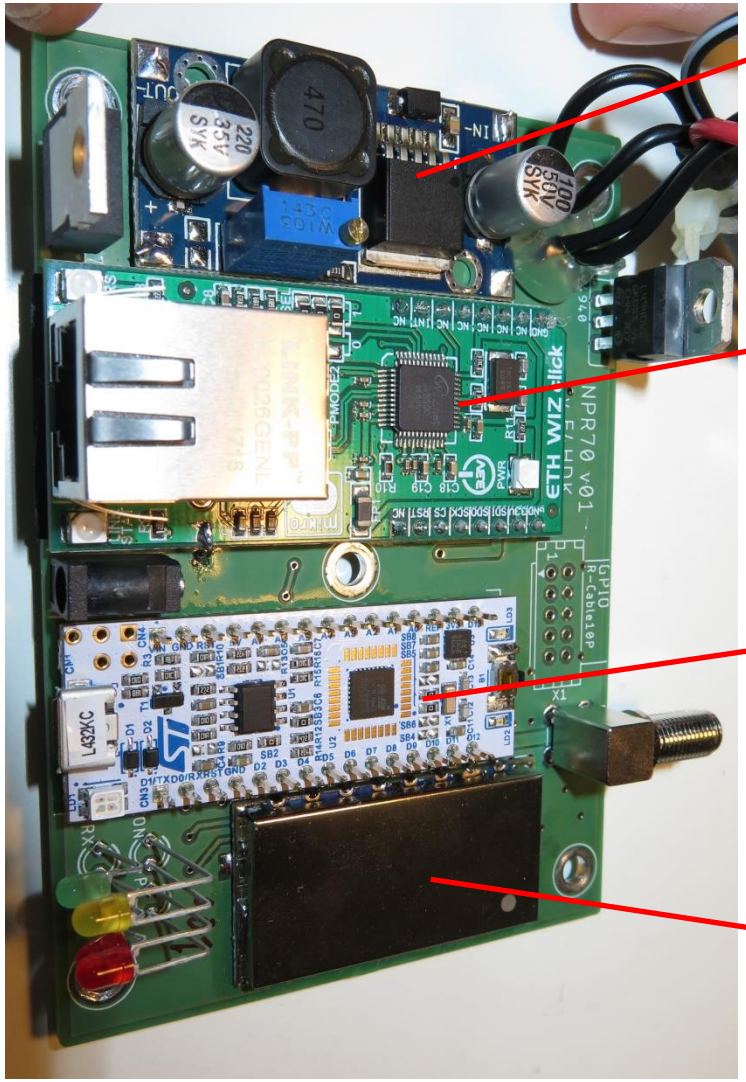
NPR Hardware (2/6)
The modem (TRX)

One single modem type for Master and Clients





NPR Hardware (3/6)
Modem PCB details



Switching Regulator

(ITEAD LM2596)

Ethernet SPI Module

(Eth-Wiz-Click Wiznet W5500)

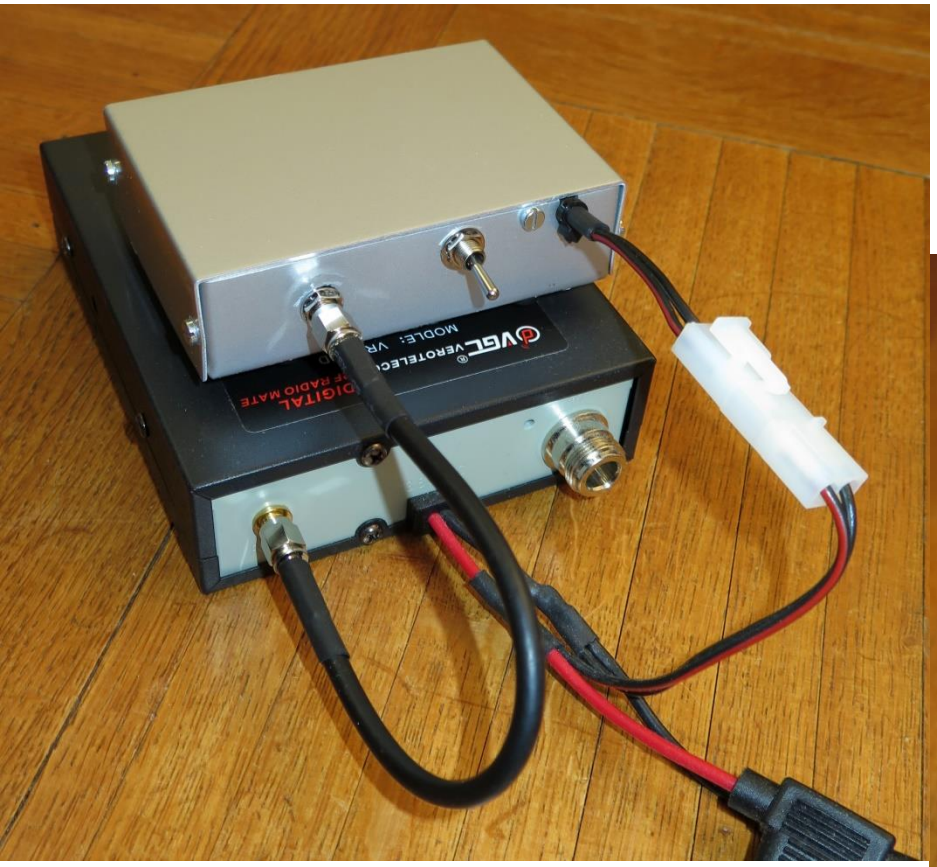
Microcontroller

Mbed Nucleo STM32 L432KC

Radio Module

RF4463 F30 (based on SI4463)

NPR Hardware (4/6)



With RF DMR amplifier

VR-P25D 20W

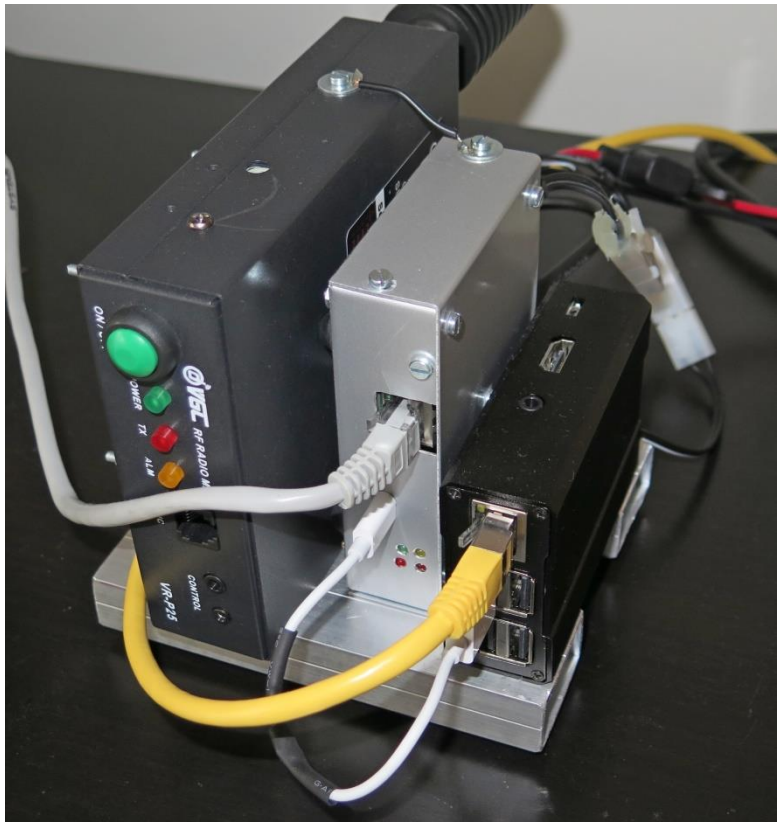
(Vero-Telecom)

NPR Hardware (5/6)

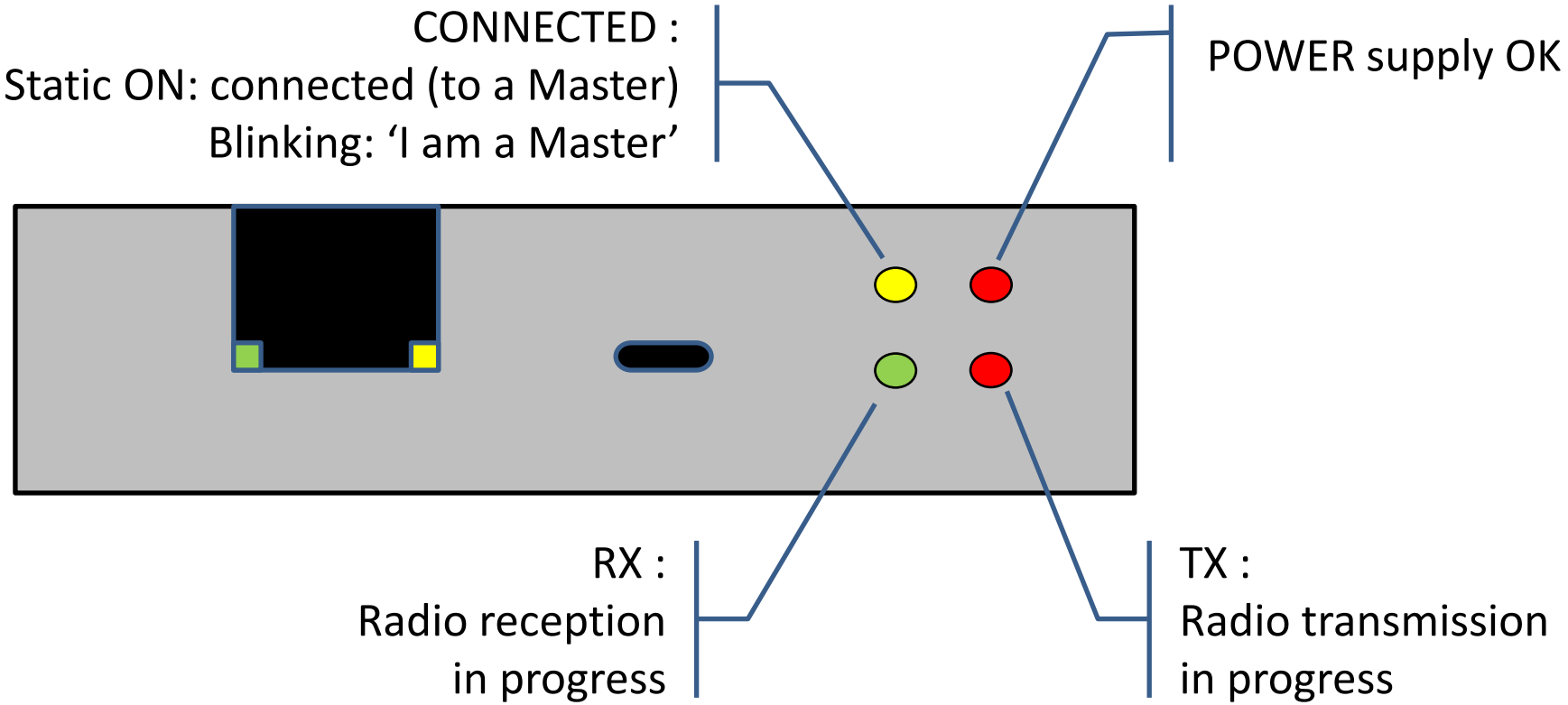
Example of autonomous NPR Master, remotely manageable (configuration and programming),

with one Raspberry-Pi.

Automatic fan on RF amplifier.



NPR – Quick start guide
The LEDs



NPR –Quick Start Guide

- The remaining is only applicable to ‘Clients’, not for Master.
- (For Master operations, refer to ‘advanced user guide)

- You should prefer direct Ethernet connection between modem and a single PC:
  no Ethernet switch.

NPR – Quick Start Guide

Configuration via command line

Either via serial over USB

- Use whatever serial terminal
- Port configuration:
  - 921 600 bps
  - 8 bits
  - flow control : NO

- USB driver could be necessary on Windows (up to Win 7): https://os.mbed.com/docs/v5.9/tutorials/windows-serial-driver.html

- Press ‘enter’ to obtain a prompt

Or via Telnet: (To the IP of modem)

```
C:\Users\moi> telnet 192.168.0.253
```

No password.

Warning: this IP can change during radio link connection.

You need to find modem IP address.

It corresponds to DHCP server IP address.

- Windows :

```
C:\Users\moi> ipconfig /all
[...]
Carte Ethernet Principal_PCIe :
   [...]
   Adresse IPv4. . . . . .: 192.168.0.102
   Masque de sous-réseau. : 255.255.255.0
   Bail obtenu. . . . . . : 22:25:21
   Bail expirant. . . . . : 22:31:22
   Passerelle par défaut. : 192.168.0.1
   Serveur DHCP . . . . . . 192.168.0.253
```

- Linux : Refer to last ‘lease’ inside `/var/lib/NetworkManager/`

NPR – Quick Start Guide

Command line: exemples

```
moi@ubuntu:~$ telnet 192.168.0.253
Connected to 192.168.0.253.
NPR modem
ready>
ready> display config
CONFIG:
  callsign: 'client_1'
  is_master: no
  MAC: 4E:46:50:52:C7:5C
  frequency: 439.000MHz
  RF_power: 6
  modulation: 24
  radio_netw_ID: 0
  radio_on_at_start: yes
  DHCP_active: yes
  client_req_size: 1
  client_static_IP: no
  telnet active: yes
  telnet routed: yes
  modem_IP: 192.168.0.253
  subnet: 255.255.255.0
  IP_begin: 192.168.0.60
  master_IP_size: 32 (Last IP: 192.168.0.91)
  def_route_active: yes
  def_route_val: 192.168.0.1
  DNS_active: yes
  DNS_value: 9.9.9.9
ready>
```

```
ready>
ready> status
   57 status: connected TA:0.0km Temp:23degC
   RX_Eth_IPv4 2863 ;TX_radio_IPv4 2788 ;
RX_radio_IPv4 5738
   DOWNLINK - bandwidth:46.7 RSSI:137 ERR:0.00%
   UPLINK -   bandwidth:38.1 RSSI:106 ERR:33.31%
CTRL+c to exit...
ready>

ready> who
1 Master: ID:127 Callsign:Master
ME: Callsign:client_02 ID:2 modem IP:192.168.0.253
Clients:
  ID:0 Callsign:client_1 IP start:192.168.0.100 IP
  end:192.168.0.100
  ID:2 Callsign:client_02 IP start:192.168.0.102 IP
  end:192.168.0.102
CTRL+c to exit...
ready>
```

NPR – Quick Start Guide
Initial configuration (1/2)

- Command: **`set [parameter] [value]`**
- Get current configuration : **`display config`**
- Refer to parameter list at the annex
- The following parameters must match with the Master (central repeater)
  - **`frequency`**
  - **`freq_shift`**
  - **`modulation`** (refer to next page)
  - **`radio_netw_ID`** = Radio Network ID (equivalent to CTCSS)
- Other useful parameters
  - **`callsign`** (compulsory)
  - **`is_master`** : set to "**`no`**" for a client
  - **`DHCP_active`** : set to "**`yes`**" for a client (except for advanced config)
  - **`RF_power`** : warning, non linear
  - **`radio_on_at_start`** : according to your needs
  - **`client_req_size`** : depending on number of IP needed, default is '1'

NPR – Quick Start Guide
Initial configuration (2/2)

- Then **`save`** and **`reboot`** once everything is set properly

- Don’t forget to switch on the radio part
  - Either with command **`radio on`**
  - Or by setting **`radio_on_at_start`**
    to the value **`yes`** in the previous step
    (then **`save`** and **`reboot`** obviously)

NPR – Quick Start Guide
5 modulations

- Meaning of 2 digits
  - 1ier digit: 2GFSK or 4GFSK
  - 2ième digit: Symbol Rate

	Modulation name 2nd digit	**x0**	**x1**	**x2**	**x3**	**x4**	
	Symbol Rate	50	100	180	300	500	kS/s
	Radio bandwidth	100	200	360	600	1000	kHz
2GFSK (1st digit of name : 1x)	**Modulation name**		**11** (*)	**12** (*)	**13**	**14**	
	Raw data rate		100	180	300	500	kbps
	Usable data rate		71	120	190	300	kbps
4GFSK (1st digit of name : 2x)	**Modulation name**	**20** (*)	**21** (*)	**22**	**23**	**24**	
	Raw data rate	100	200	360	600	1000	kbps
	Usable data rate	68	130	220	330	470	kbps

(*) Available for firmware ≥ 2019_06_08

NPR – Quick Start Guide
During usage… (1/3)

- Initial radio connection of a Client to a Sleeping Master
  - It’s slow, please be patient
  - ~15 seconds for the Master to wake up
  - Plus 1 connection attempt by Client every 5 sec
  - Often triggers an IP configuration change at Client side (client IP, modem IP, etc…)
- Slow mode (once connected)
  - If a Client modem requires only few data at uplink, then it is placed to « slow mode », and only transmits once every 8 TDMA cycles (600ms instead of 80ms for modulation 24)
  - This mechanisms frees radio resource for other modems (Client or Master)

NPR – Quick Start Guide
During usage… (2/3)

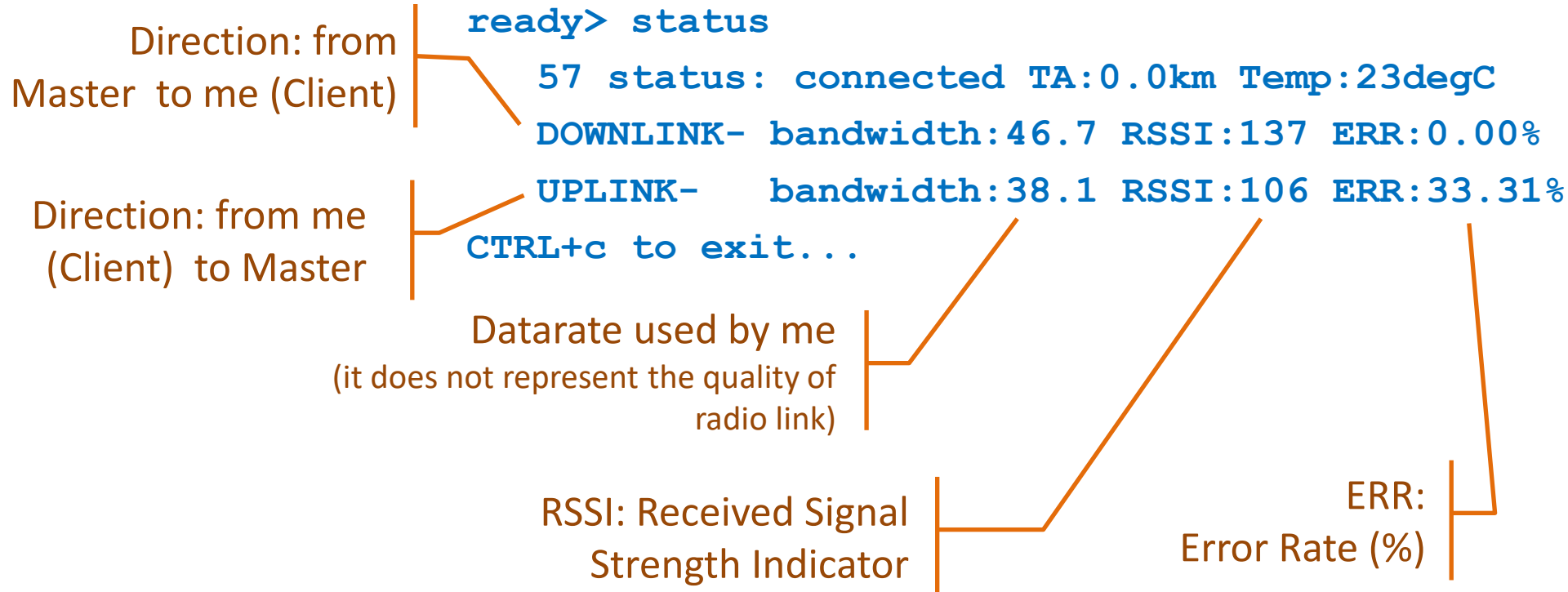
`status`

Displays radio link quality, for tuning:

- Antenna orientation
- Radio power of the modem

The status is automatically updated every 2 seconds.

You should try to obtain BER <2%.



NPR – Quick Start Guide
During usage… (3/3)

who

- Who is connected? Client and Master.
- Displays callsigns and IP range of each modem
  (The Master does not have IP range).
- Automatically updated every 2 seconds

```
ready> who
1 Master: ID:127 Callsign:Master
ME: Callsign:client_02 ID:2 modem IP:192.168.0.253
Clients:
  ID:0 Callsign:client_1 IP start:192.168.0.100 IP end:192.168.0.100
  ID:2 Callsign:client_02 IP start:192.168.0.102 IP end:192.168.0.102
CTRL+c to exit...
```

NPR – Quick Start Guide
List of commands (1/3)

command	Parameter (if applicable)	Value format	Valid for..		comment
			master	client	
version	-	-	-	-	Displays the version of the firmware
radio	on	-	X	X	Turns radio on. (currently bugged if executed after 'radio off', use 'reboot' instead)
	off	-	X	X	Turns radio off
status	-	-			Display radio status
who	-	-	X	X	Displays who is currently connected to the master.
display	config	-	X	X	Display configuration
	DHCP_ARP	-	X	X	Display DHCP or ARP entries
TX_test	-	seconds (duration)	X	X	Triggers a (quasi) continuous transmission of xx seconds, for test.
save	-	-	X	X	Save the current configuration to EEPROM.
reboot	-	-	X	X	Reboot the whole board.
reset_to_default		-	X	X	Erases the entire previous EEPROM stored configuration.
exit	-	-	X	X	Exit from telnet session.

NPR – Quick Start Guide
List of commands (2/3)

command	Parameter (if applicable)	Value format	Valid for..		comment
			master	client	
set	callsign	text	X	X	Warning : each modem must have its own callsign. 13 char maxi. No 'space' char, use '_' instead
	is_master	yes / no	X	X	Yes : set to master mode No : set to client mode
	master_FDD	no/up/down	X		No: standard Master Up/down : refer to FDD paragraph
	Eth_mode	Integer	X	X	Value from 0 to 7, refer to dedicated §
	modem_IP	IP value	X	(*)	(*) For client : temporary value
	netmask	IP value	X	(*)	(*) For client : temporary value
	telnet_active	yes / no	X	X	
	DNS_active	yes / no	X		
	DNS_value	IP value	X		
	def_route_active	yes / no	X		
	def_route_val	IP value	X		
	IP_begin	IP value	X	(*)	(*) For client : temporary value
	master_IP_size	Integer	X		
	client_req_size	Integer		X	
	master_IP_down	IP value	X		Only relevant for Master FDD uplink. IP of the Master downlink modem.
	DHCP_active	yes / no		X	Only impacts a client.

NPR – Quick Start Guide
List of commands (3/3)

command	Parameter (if applicable)	Value format	Valid for..		comment
			master	client	
set	radio_on_at_start	yes/no	X	X	
	frequency	Refer to comment	X	X	Decimal value in MHz. Range 420 to 450. Dot for decimal. Rounded in 0.001MHz steps.
	freq_shift	Refer to comment	X	X	Decimal value in MHz. Range -10 to +10. Dot for decimal. Rounded in 0.001MHz steps. Default value is 0. Refer to FDD §
	RF_power	Integer	X	X	From 0 to 127. Warning, not linear. Refer to 'annex 3'.
	modulation	Refer to comment	X	X	9 possible values : [11 to 14] or [20 to 24]. Refer to 'annex 2'.
	radio_netw_ID	Refer to comment	X	X	Radio network ID. From 0 to 15 (equivalent of CTCSS)

NPR

END
(of this presentation only)

It’s your turn!
Turn on your soldering irons,
and your PCs,
and set your antennas!