NPR
New Packet Radio on 70cm band

Introduction :
What is it?
&
Quick start guide

Guillaume F4HDK

January 2019

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 430MHz much easier to use
     than 2.4GHz or 5.6GHz (HSMM-WiFi-Hamnet).
- Designed by a HAM for HAMs
- 100% Open-Source : PCB + software

	Datarate	Frequencies
Packet radio	Raw : <9600bps Useful : several kbps	ALL (mainly 144MHz and 430MHz)
NPR **New Packet Radio**	Raw : 300kbps à 1Mbps Useful : 150 to 600kbps	430-440MHz
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
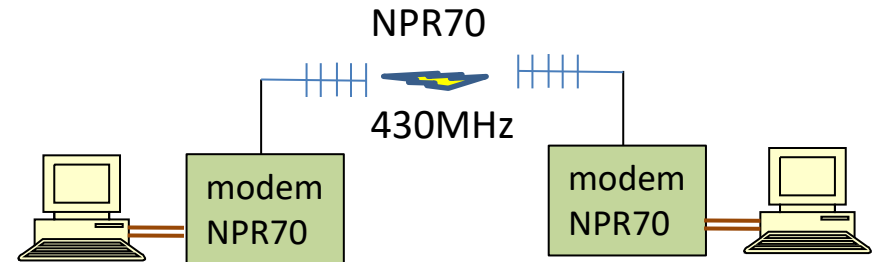- Several CLIENTS
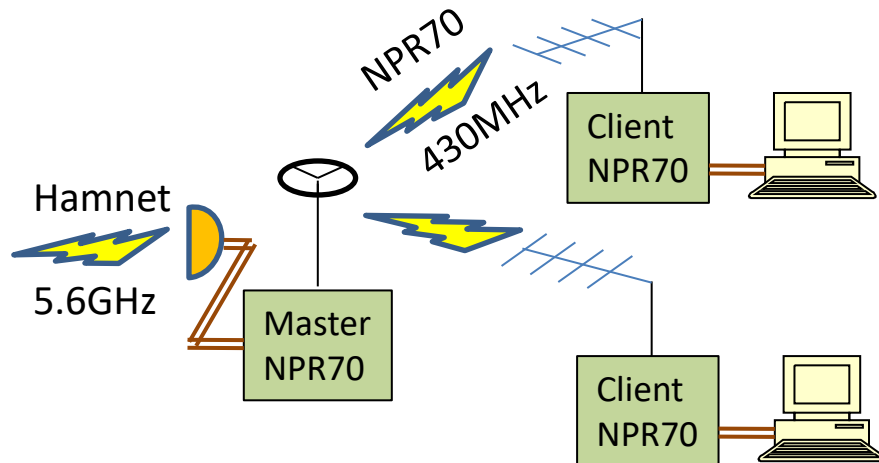
The Master only transmits when solicited by at least one Client.

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)

Limitations:

- 7 simultaneous clients maximum

- Limitations of 430MHz band:
  Not designed for 24x7 usage

  (The Master only transmits when solicited)

NPR – antennas

- Horizontal polarisation is highly recommended

Master :

(horizontal and omnidirectional):

    Big Wheel

    Or Big Wheel stack

    Or multiple panel antennas

Clients: horizontal Yagi

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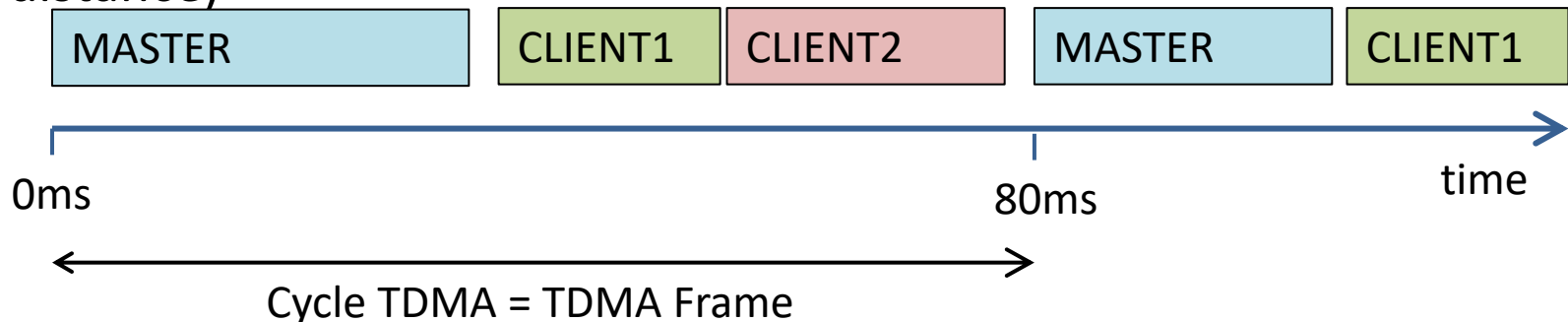# Some technical aspects

- 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.

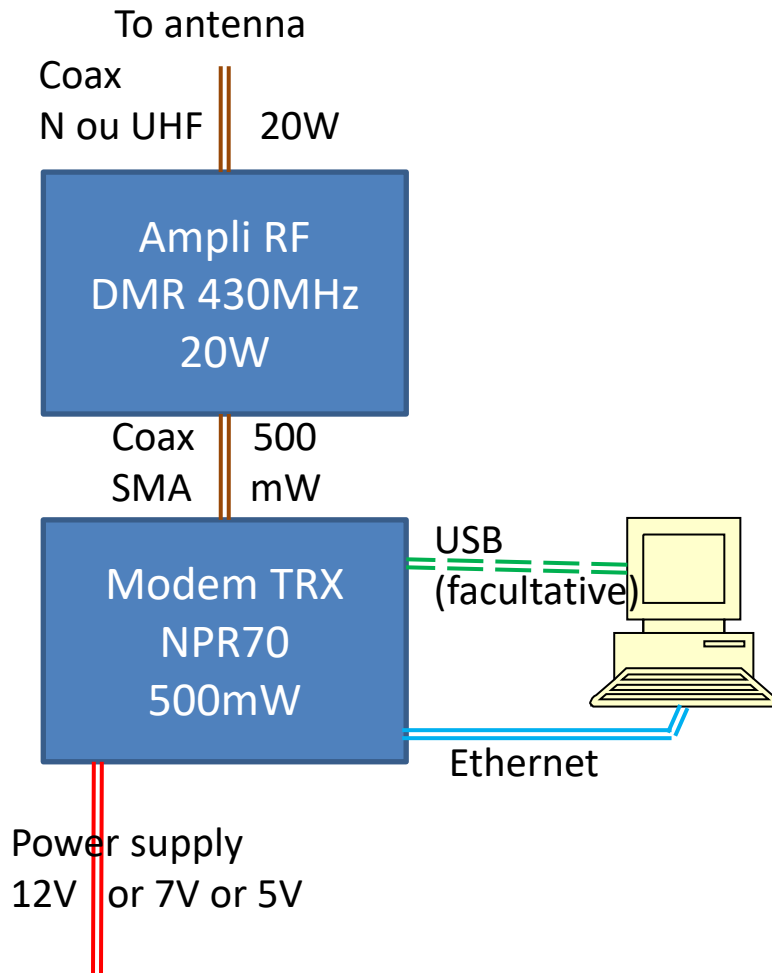	All stations transmit on the same frequency, alternatively

- Fast TX/RX cycles : 80ms à 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)

MASTER	CLIENT1	CLIENT2	MASTER	CLIENT1

0ms   80ms   time

Cycle TDMA = TDMA Frame

NPR Hardware(1/6)

To antenna

Coax
N ou UHF   20W

**Ampli RF
DMR 430MHz
20W**

Coax   500
SMA   mW

**Modem TRX
NPR70
500mW**

USB
(facultative)

Ethernet

Power supply
12V or 7V or 5V

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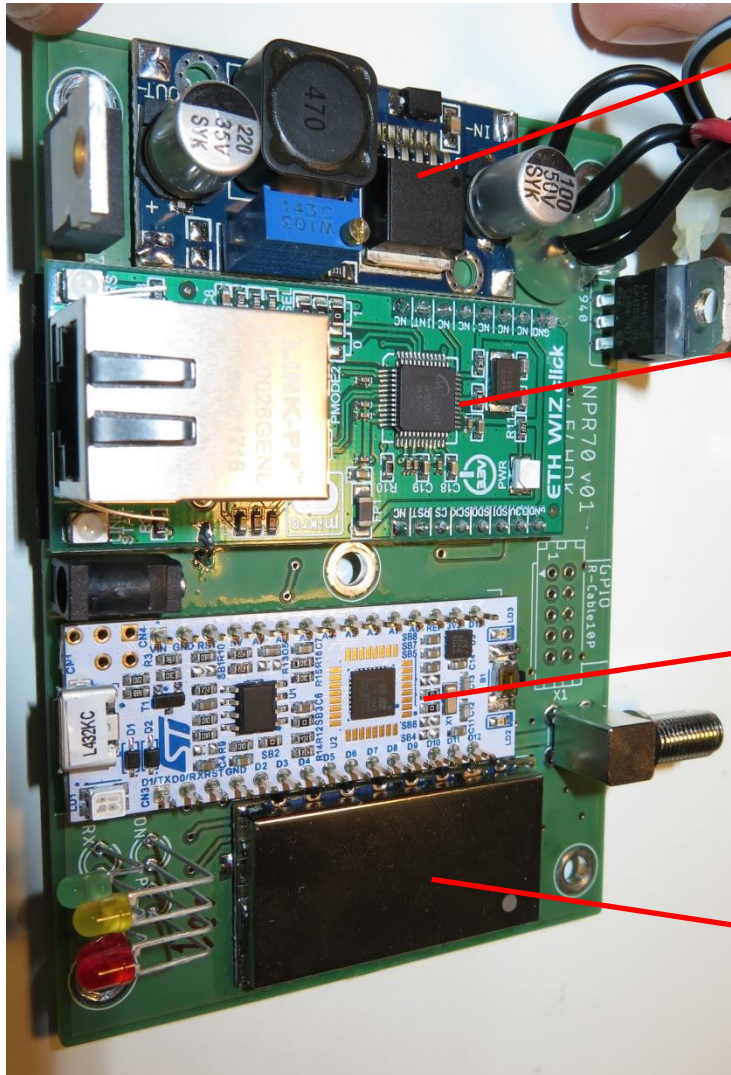
NPR Hardware (2/6)
The modem (TRX)

One single modem type for Master and Clients
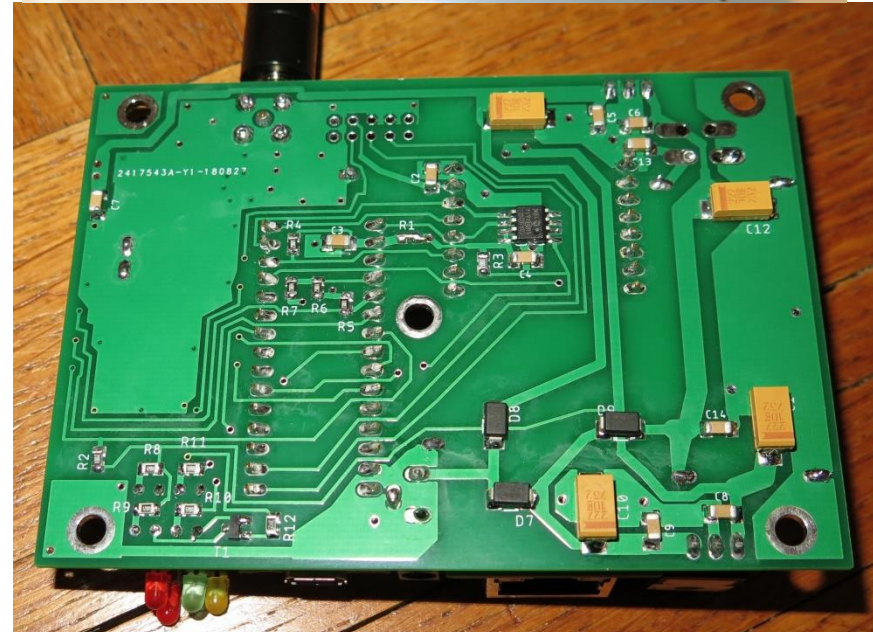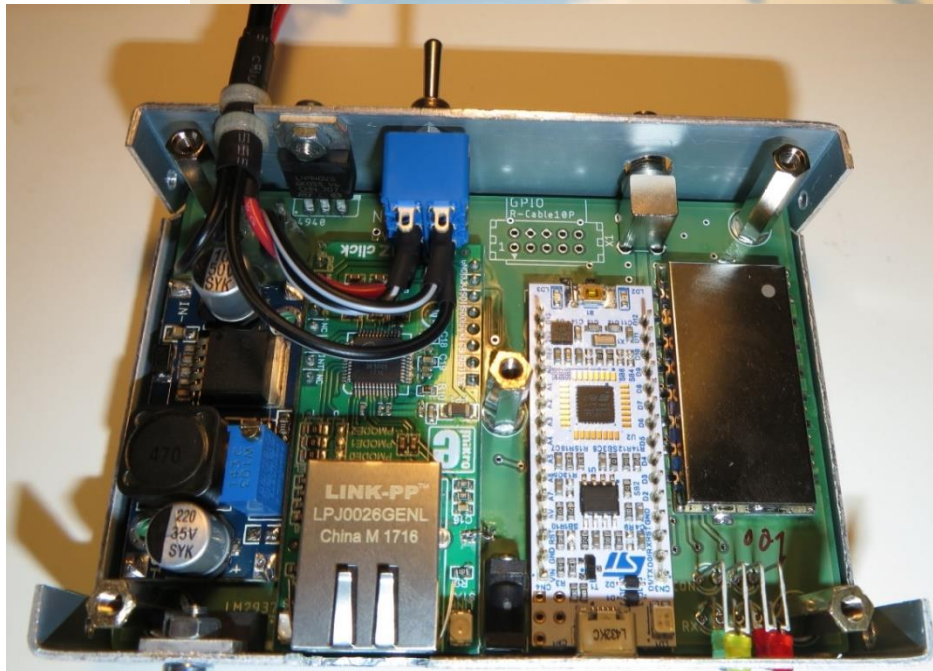
NPR Hardware (3/6)
Modem PCB details

Switching Regulator
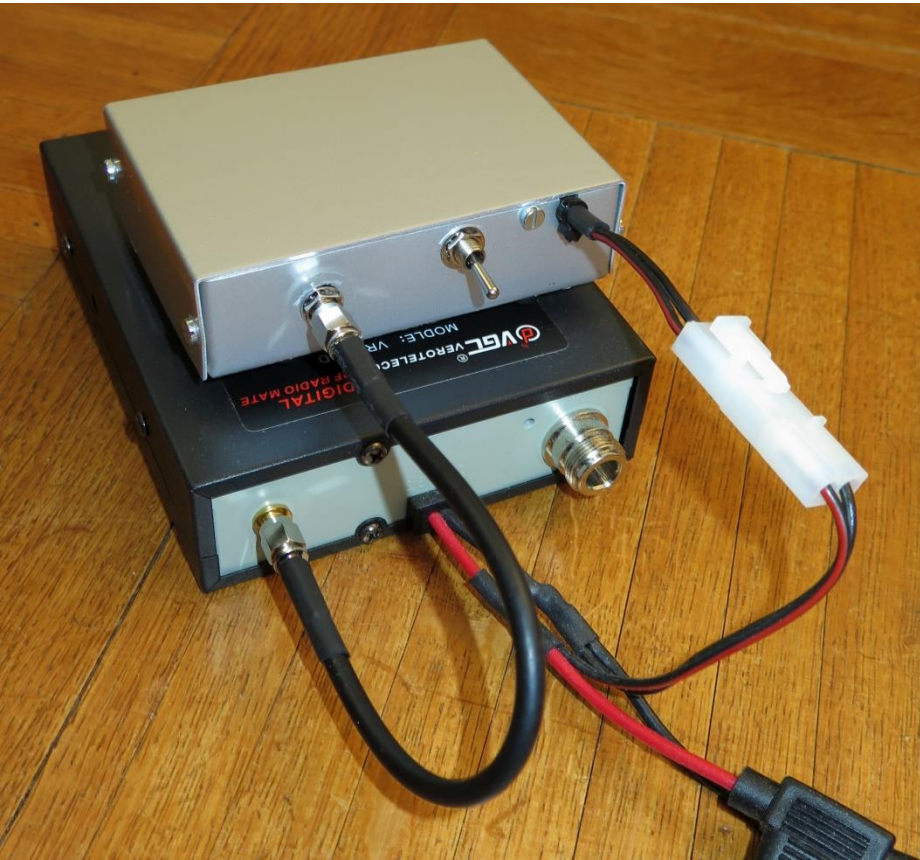
(ITEAD LM2596)

Ethernet SPI Module

(Eth-Wiz-Click Wiznet W5500)

Microcontroller

Mbed Nucleo STM32 L432KC

Radio Module

RF4463 F30 (based on SI4463)

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

CONNECTED :
Static ON: connected (to a Master)
Blinking: 'I am a Master'

POWER supply OK

RX :
Radio reception
in progress
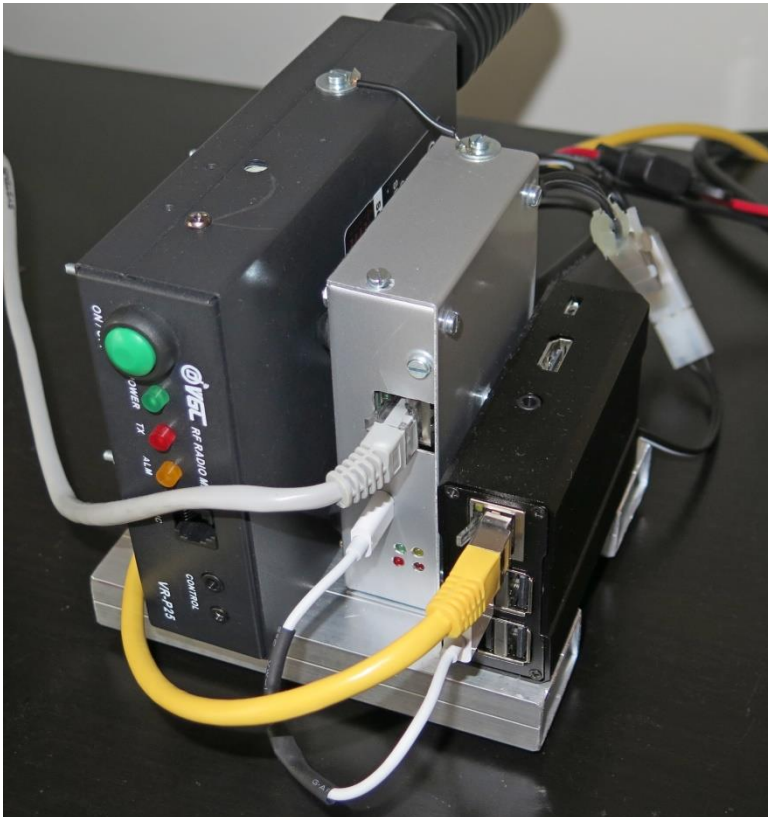
TX :
Radio transmission
in progress
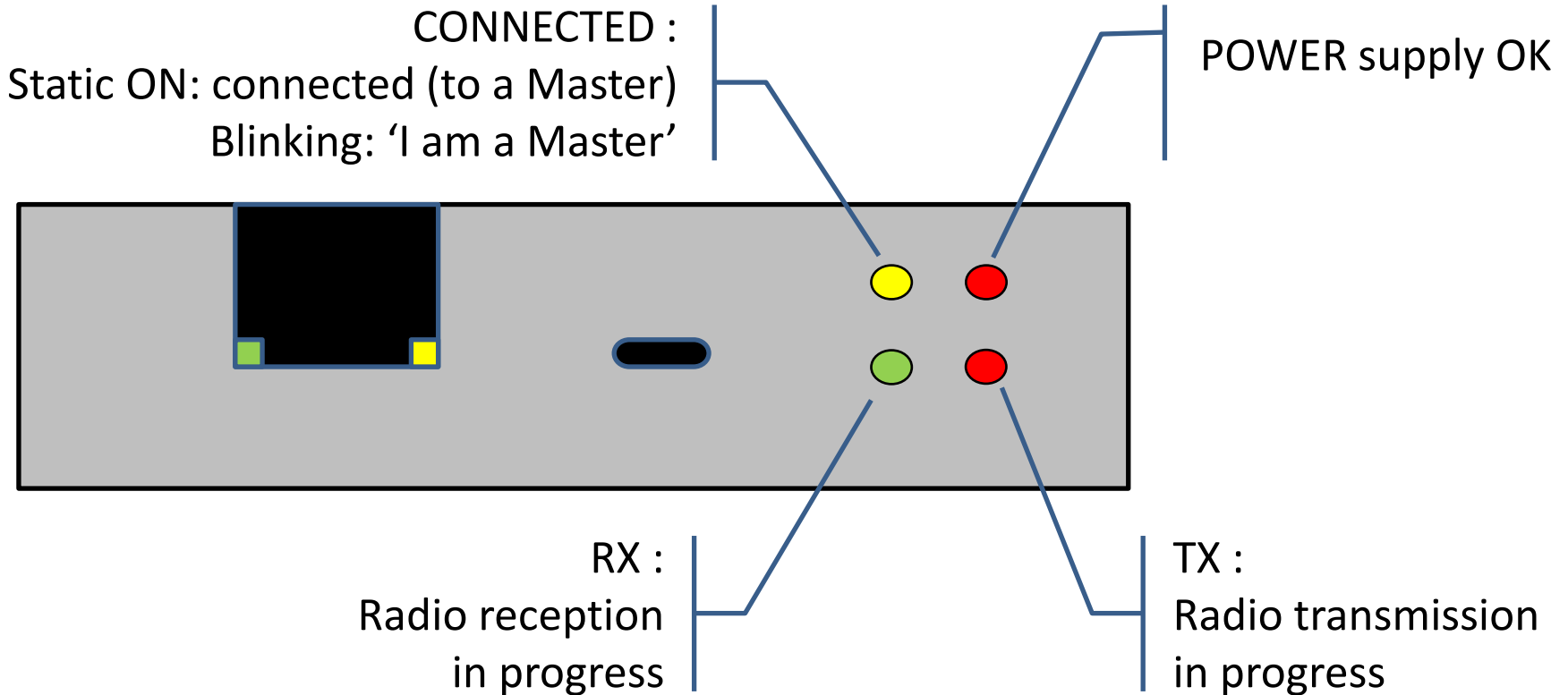
NPR –Quick Start Guide

- 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: 437.000MHz
  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)

- Easier via 'serial over USB' the first time.
- 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`
  - `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'
- Then `save` and `reboot` once everything is set properly

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
  - 1^{ier} digit: 2GFSK or 4GFSK
  - 2ième digit: Symbol Rate

Symbol Rate (k Symbols per second)	2GFSK (1 bit per symbol)	4GFSK (2 bits per symbol)	Occupied RF bandwidth
180 kS/s	Not available	ID : 22 Raw datarate: 360 kbps Useful datarate: 220 kbps	270 kHz
300 kS/s	ID : 13 Raw datarate: 300 kbps Useful datarate: 190 kbps	ID : 23 Raw datarate: 600 kbps Useful datarate: 330 kbps	450 kHz
500 kS/s	ID : 14 Raw datarate: 500 kbps Useful datarate: 300 kbps	ID : 24 Raw datarate: 1 Mbps Useful datarate: 500 kbps	750 kHz

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%.

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

Direction: from Master to me (Client)

Direction: from me (Client) to Master

Datarate used by me
(it does not represent the quality of radio link)

RSSI: Received Signal Strength Indicator

ERR: Error Rate (%)
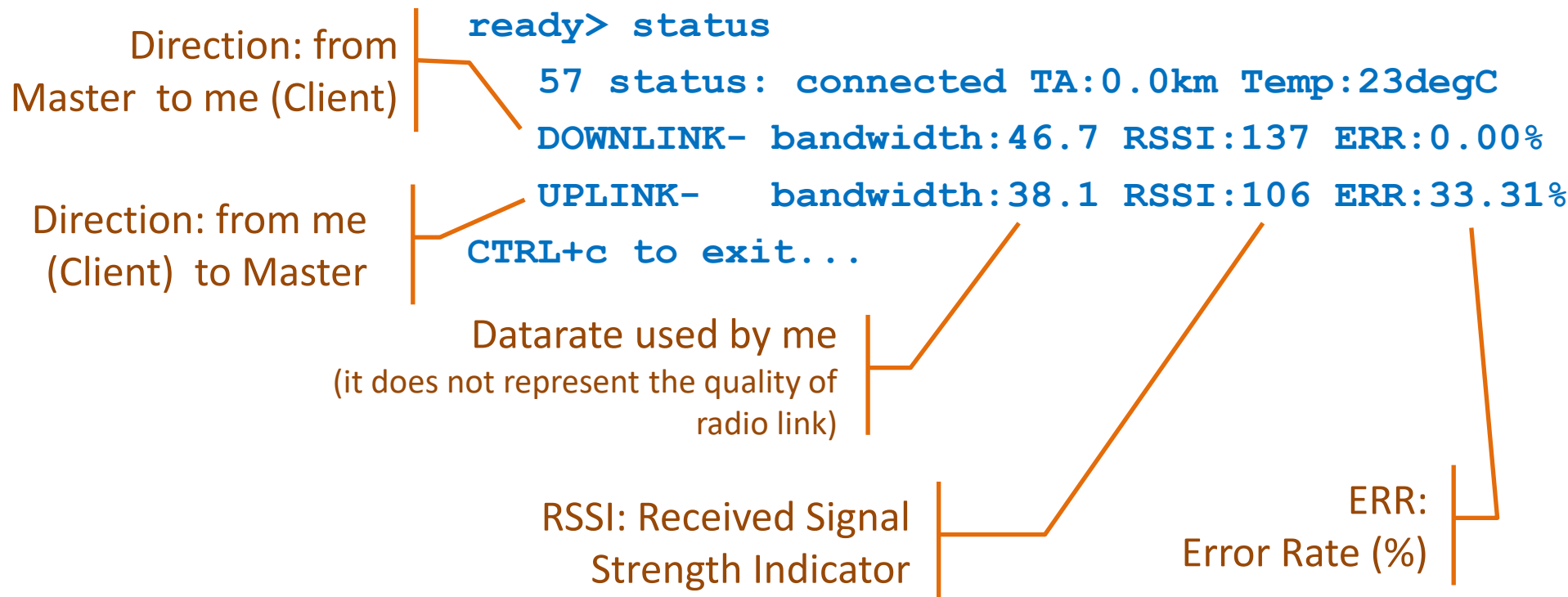
NPR – Quick Start Guide
During usage... (3/3)

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	
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	-			Display DHCP or ARP entries
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 title	format	master	client	Comment
set	callsign	text	X	X	Warning : each modem must have its own callsign. No 'space' char, use '_' instead
	is_master	yes / no	X	X	Yes : set to master mode No : set to client mode
	modem_IP	IP value	X	(*)	(*) For client : temporary value before connection to master
	netmask	IP value	X	(*)	(*) For client : temporary value before connection to master
	telnet_active	yes / no	X	X	
	~~telnet_routed~~	~~yes / no~~	~~X~~		Not implemented yet
	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 before connection to master
	master_IP_size	Integer	X		
	~~client_static_IP~~	~~yes / no~~		X	Not implemented yet
	client_req_size	Integer		X	

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

command	Parameter title	format	master	client	Comment
set	radio_on_at_start	yes/no	X	X	
	frequency		X	X	Decimal value in MHz. Dot for decimal. Rounded in 0.040MHz steps.
	RF_power	Integer	X	X	From 0 to 127
	modulation	cf comment	X	X	Possible values 13, 14, 22, 23 or 24
	radio_netw_ID		X	X	From 0 to 15 (equivalent of CTSS)

NPR

END
(of this presentation only)

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