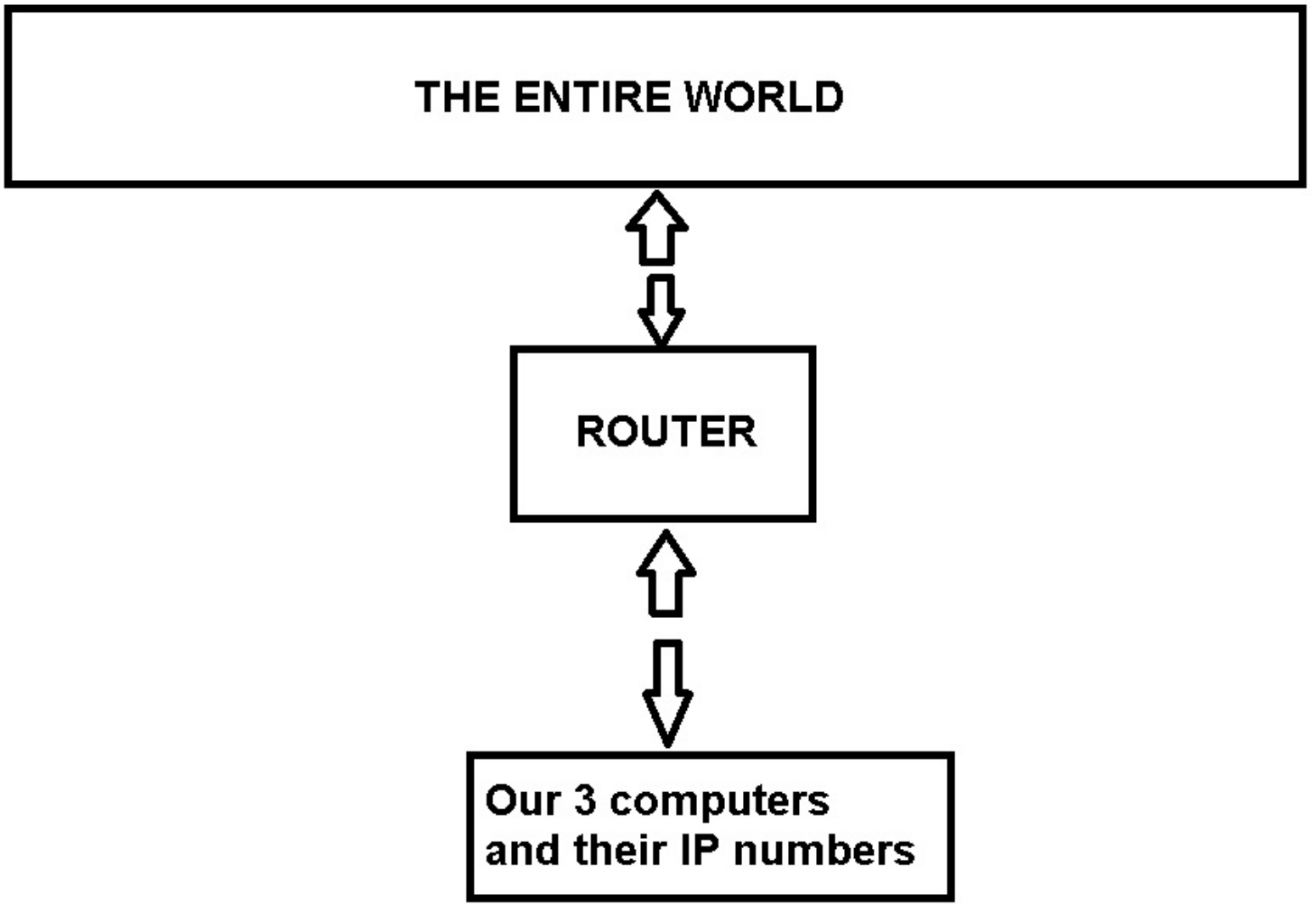
NEWBIE CORNER:
Configuring a home router
(Turns out this is very close to a solution for an entire island with no communications)

Router

- Special computer that connects two networks.
- Typically connects a smaller network (like 2, 6, 14, 30,62,126,or 254 computers) to the “rest of the world”
- Routers make packets move properly by inspecting the Internet Protocol number of the addressee and determining which direction packet should go, out or in?


THE ENTIRE WORLD
ROUTER
Our 3 computers
and their IP numbers

Interruption: What is a packet?

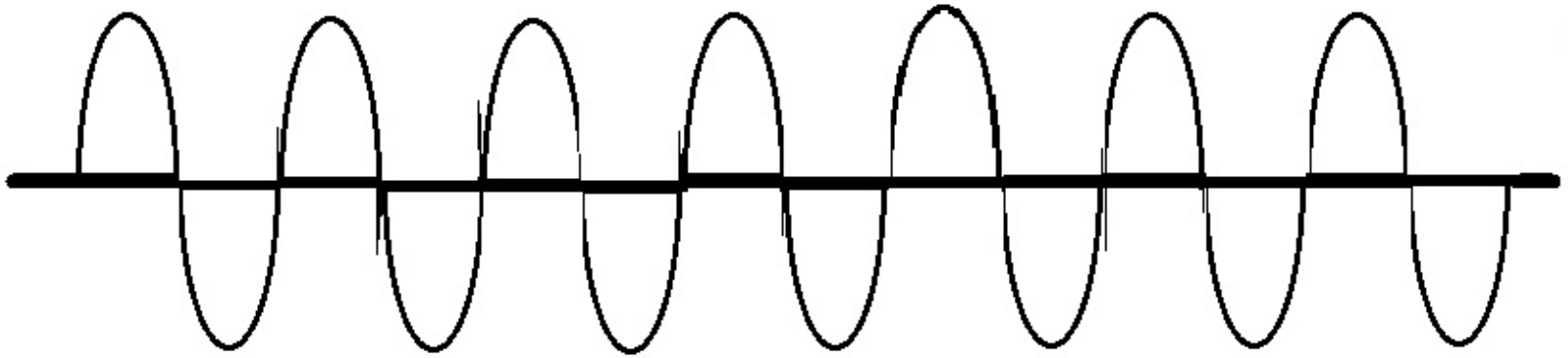
- Packet: string of 1's and 0's in a structured format that conveys not only a **bit of a sentence,** but also *source* and *destination* information (in a "header").

2nd Interruption:
How to send 1's and 0's over a microphone?

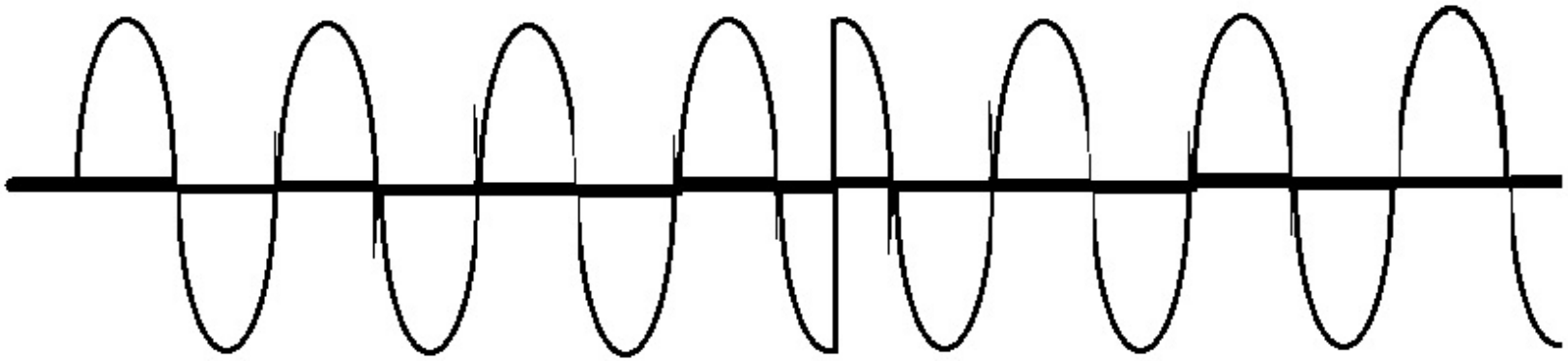
- Two major ways are PHASE SHIFT KEYING and FREQUENCY SHIFT KEYING. Basis of more complicated systems.
- FSK is easy: bounce back and forth between a couple of frequencies.
- PSK used to be more of a mystery to me. NOT ANY MORE.

Period 1

Period 2



Audio tone literally played into the mic input

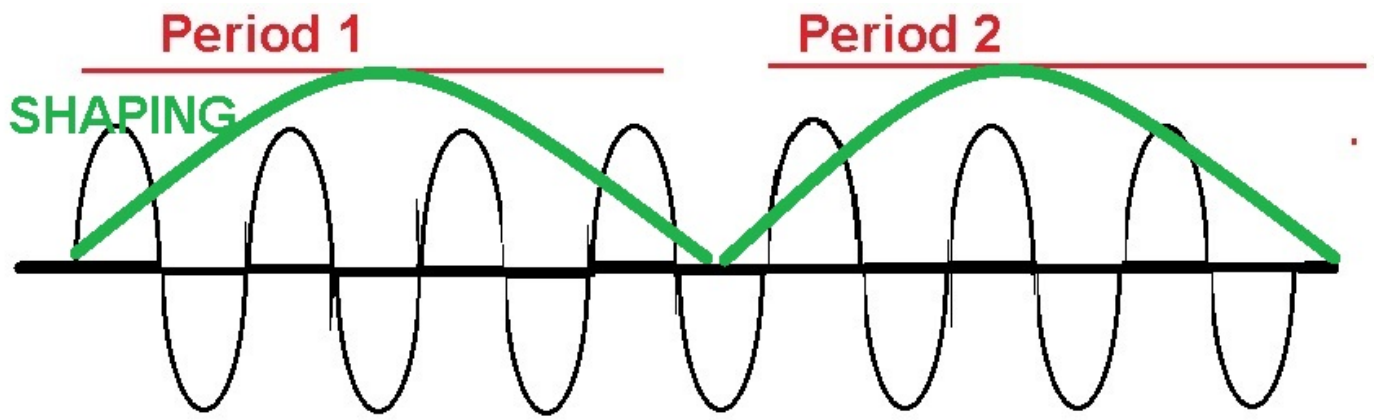


This is a ONE

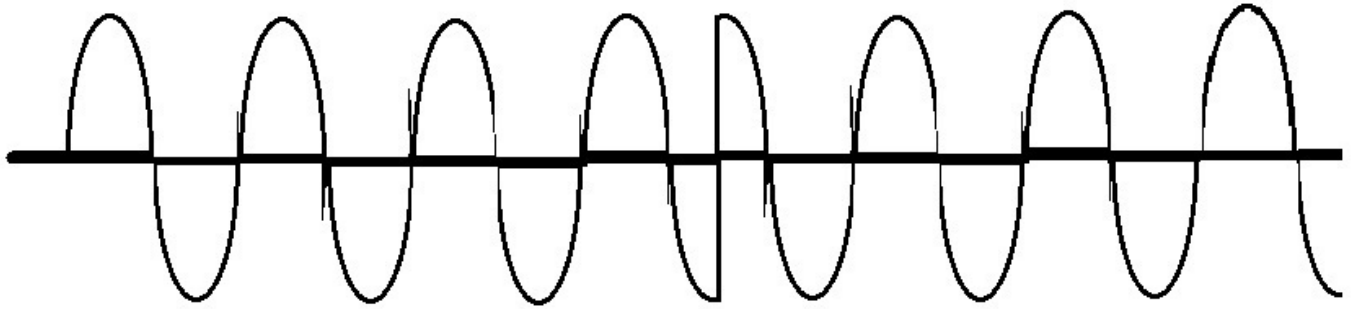
Completely reversed phase (180deg) -- this is a ZERO

- That ABRUPT phase change generates a zillion audio frequencies.....makes the signal (both audio and RF) take up a BUNCH MORE SPECTRUM.....
- bad news...

Add shaping to each period



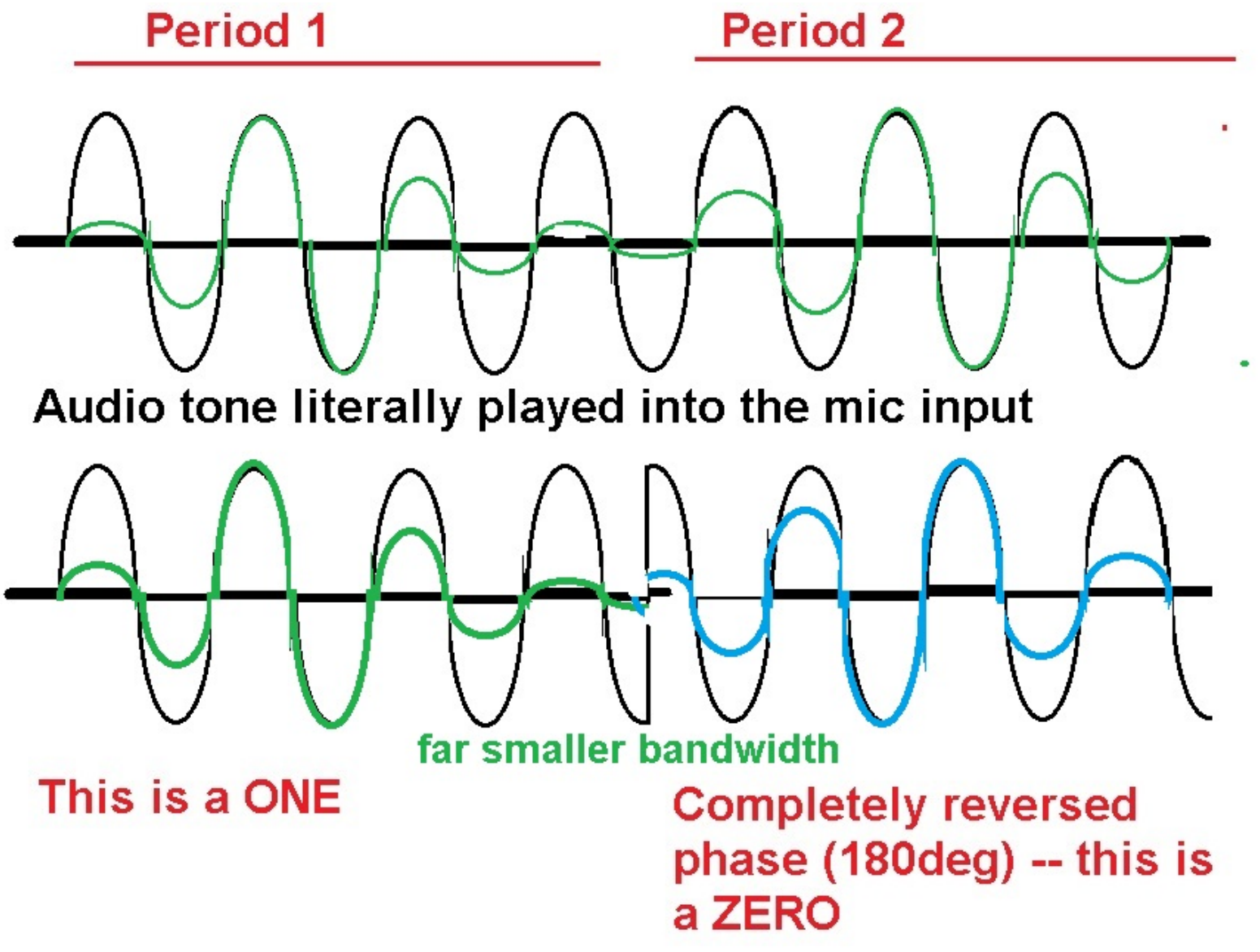
Audio tone literally played into the mic input

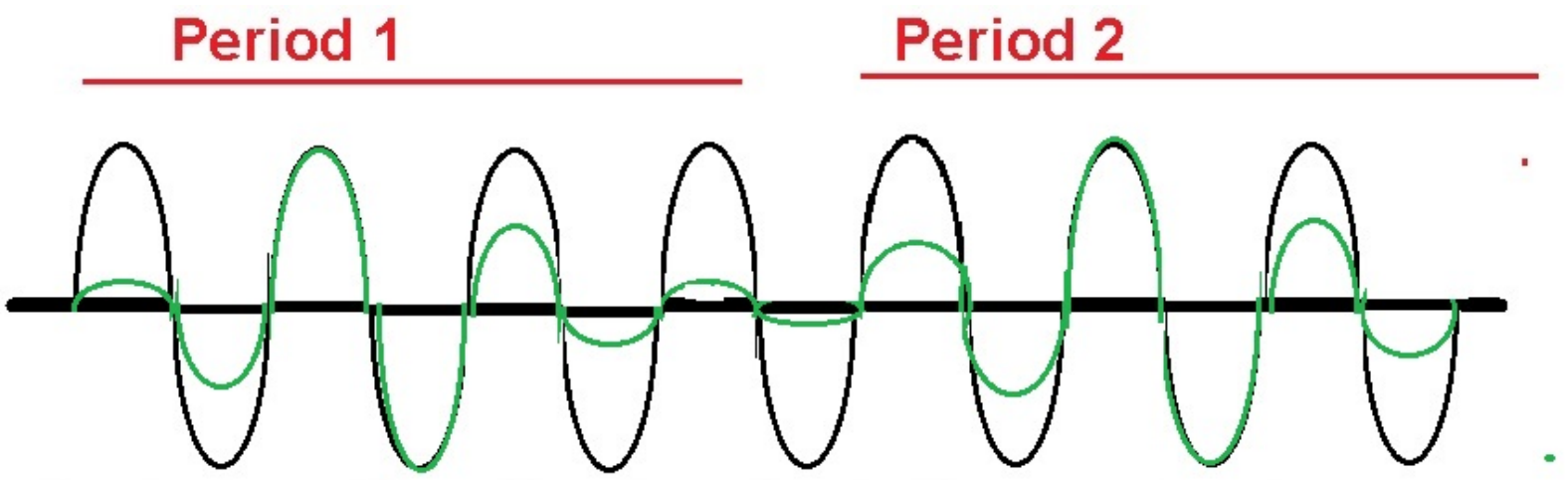


This is a ONE

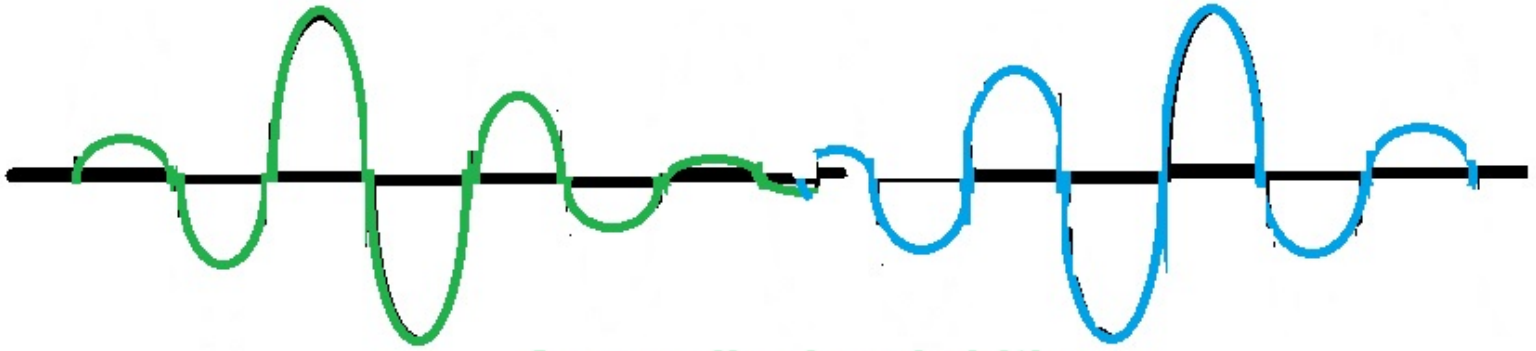
Completely reversed phase (180deg) -- this is a ZERO

Result: switch phase at soft point





Base signal is a rapidly (but smoothly) pulsing audio tone



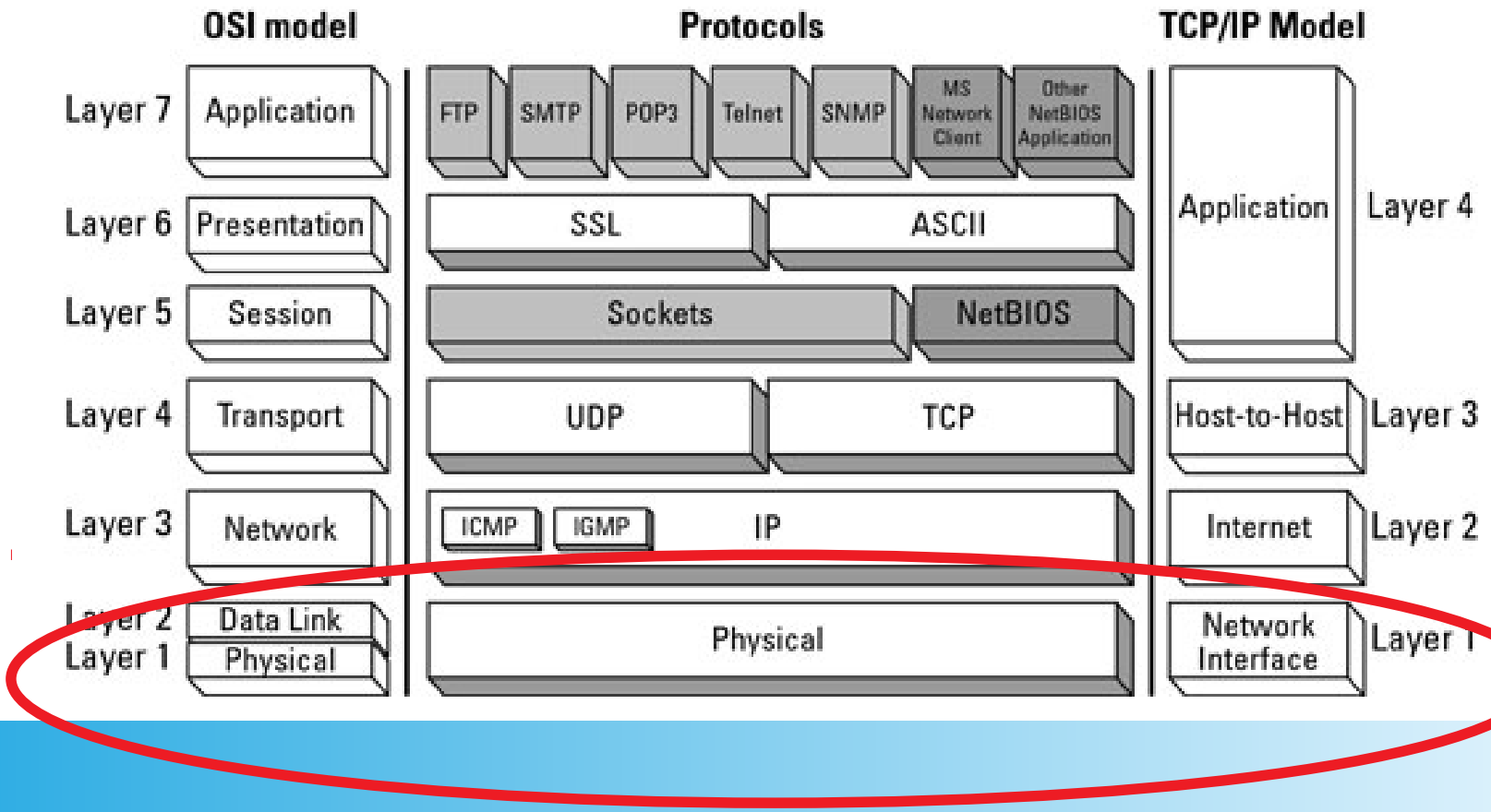
far smaller bandwidth

ONE (normal phase) ----->phase shift--> ZERO

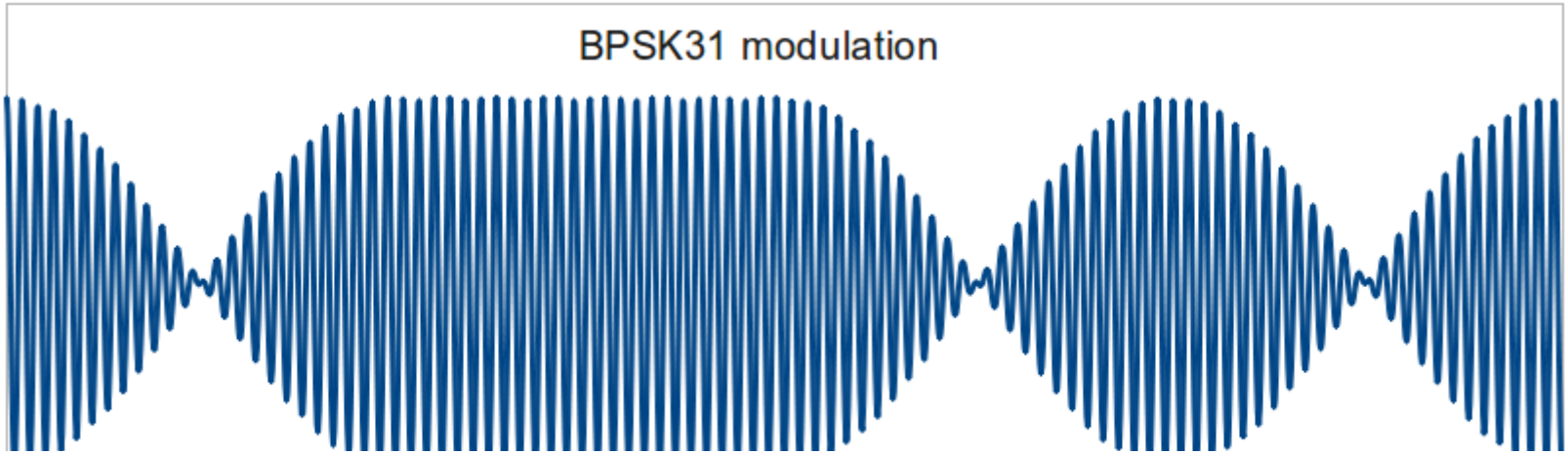
Switching the phase at point of low mic signal means far less power at wider frequencies

Physical/Data Bottom Layers

- Physical: single sideband or FM signal
- Data Link: the pulsing phase-shifting packet signal
- Could be 80meters; 2 meters; 2.397 GHz....same!



PSK-31 drawing.



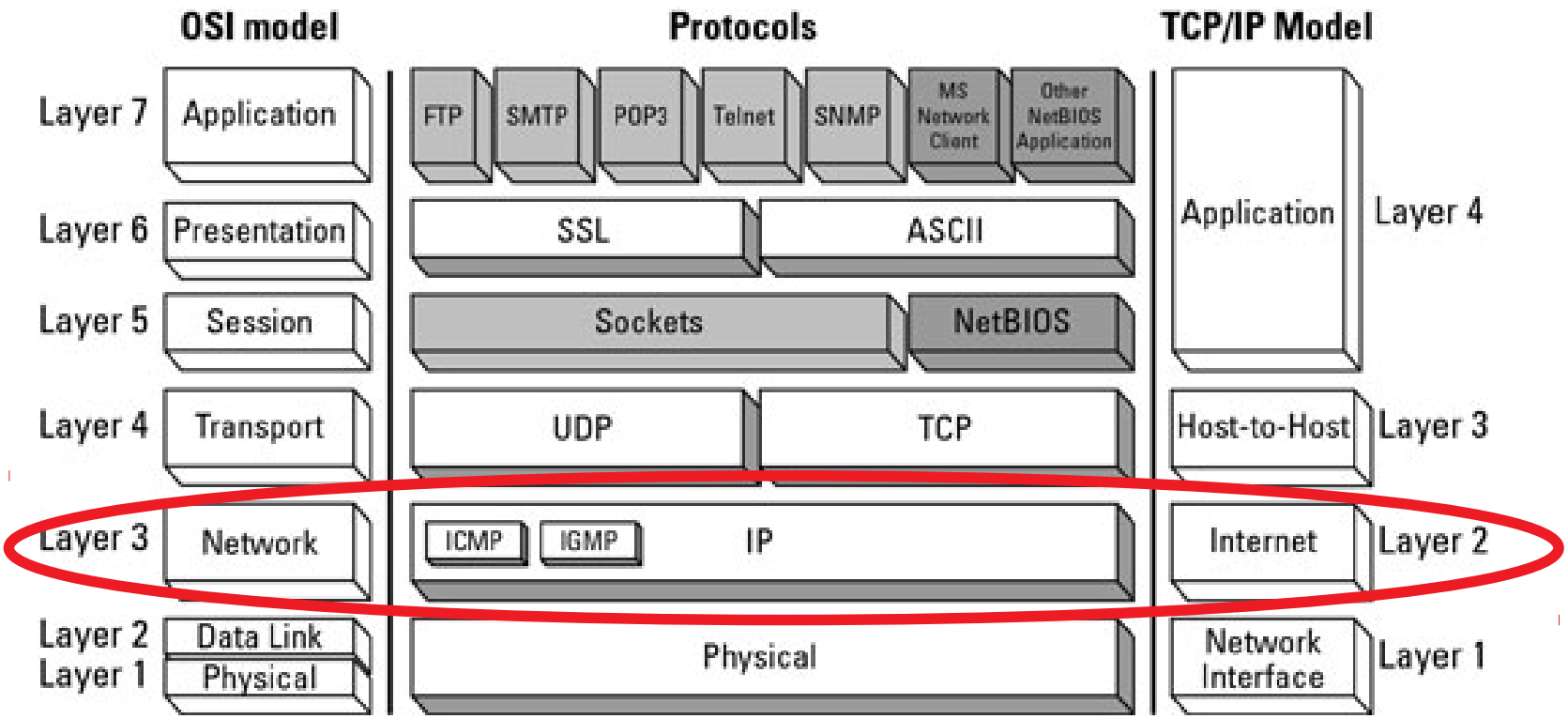
Gotta move on!

We could talk for hours about the physical layer....modulation... how we can increase the throughput by using a higher audio frequency and shorter periods (faster clocking)--and look at the SIDEBANDS of that audio “carrier” that we’re creating -- or how we could add more TONES and modulate each of them with different info -- “OFDM” (orthogonal frequency division multiplexing) and how that works....but we can’t do an entire RF ENGINEER curriculum tonight...

Add “ID”

- Once we have 1’s and 0’s understood, we can add a “callsign” -- or in network language, we add identifying numbers -- such as the INTERNET PROTOCOL NUMBER of a computer (IP NUMBER)
- [You advanced types: yes, I’ll get to MACs. hold your horses]

IP numberrs come from Network (or Internet) layer



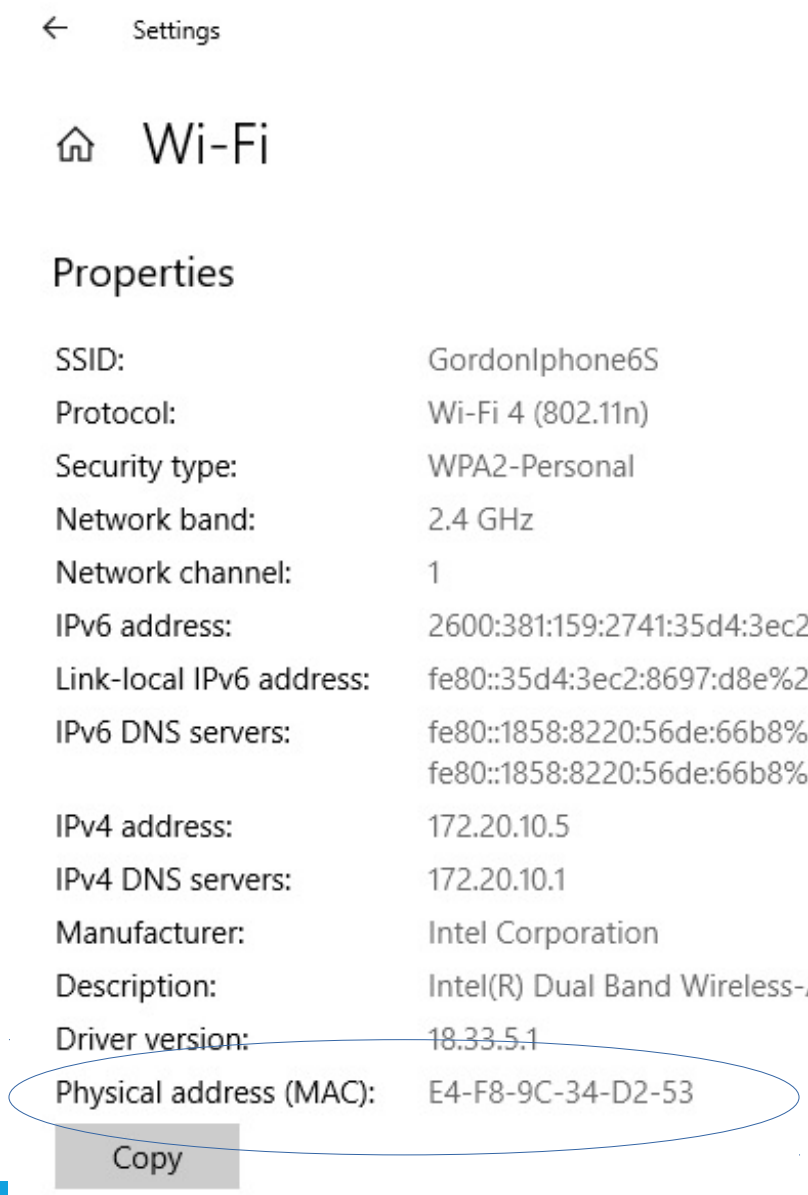
REF: https://24itworld.wordpress.com/2016/08/04/iso-osi-model-layers-of-the-network/

Configure Router

- We are going to configure a household router to set up a “sub-net” and to provide DHCP services for that subnet.
- What is DHCP?

DHCP

- DHCP assigns IP (internet protocol) numbers to computers.
- **BECAUSE:** Computers do not come from the factory with IP numbers assigned, because the factory does not know if they will be used at your house, or at McDonalds -- which have different subnets!
- Network interfaces come from the factory with a MAC NUMBER assigned. (Media Access Control)



Go deep enough into your computer's settings and you can discover the MAC number for each network interface.

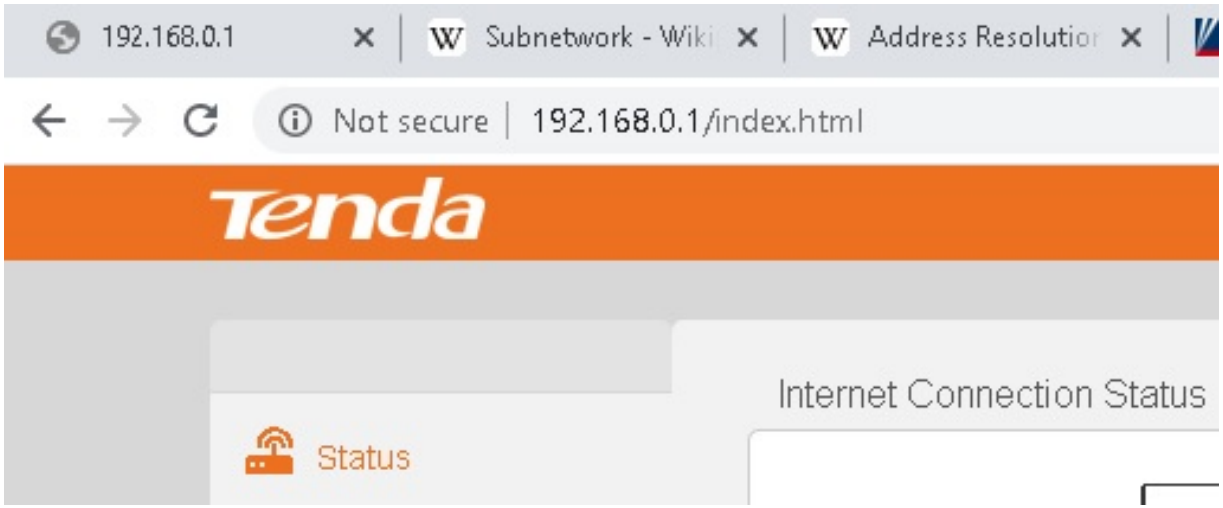
They should all be unique.
Assigned at the Factory.

(But of course.....hackers have ways to "spoof" and make their computer LOOK like it is something it isn't.

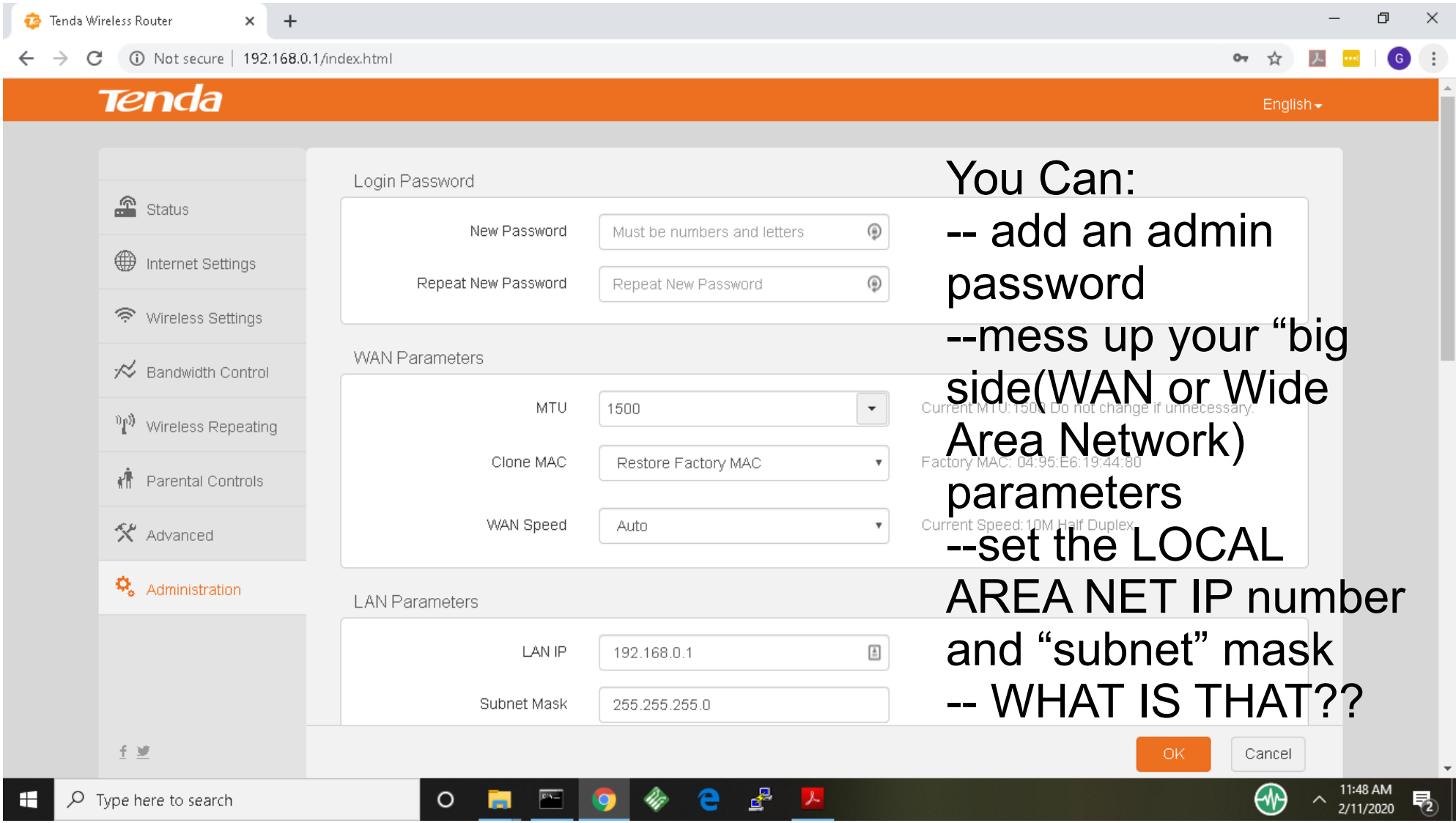
- Let’s come back to this MAC number stuff in a bit.
- First, lets connect to our household router.
  - Either by WIFI, where you select “your” router fromm those showing up in your wifi list
  - Or by an actual cable going to one of the LAN (not WAN) ports on your router.

Once Connected

- Use your browser to go to the address (gotten from the MANUAL) 192.168.0.1
- Hit Enter (the system added the /index.html by itself)
- You get this page:

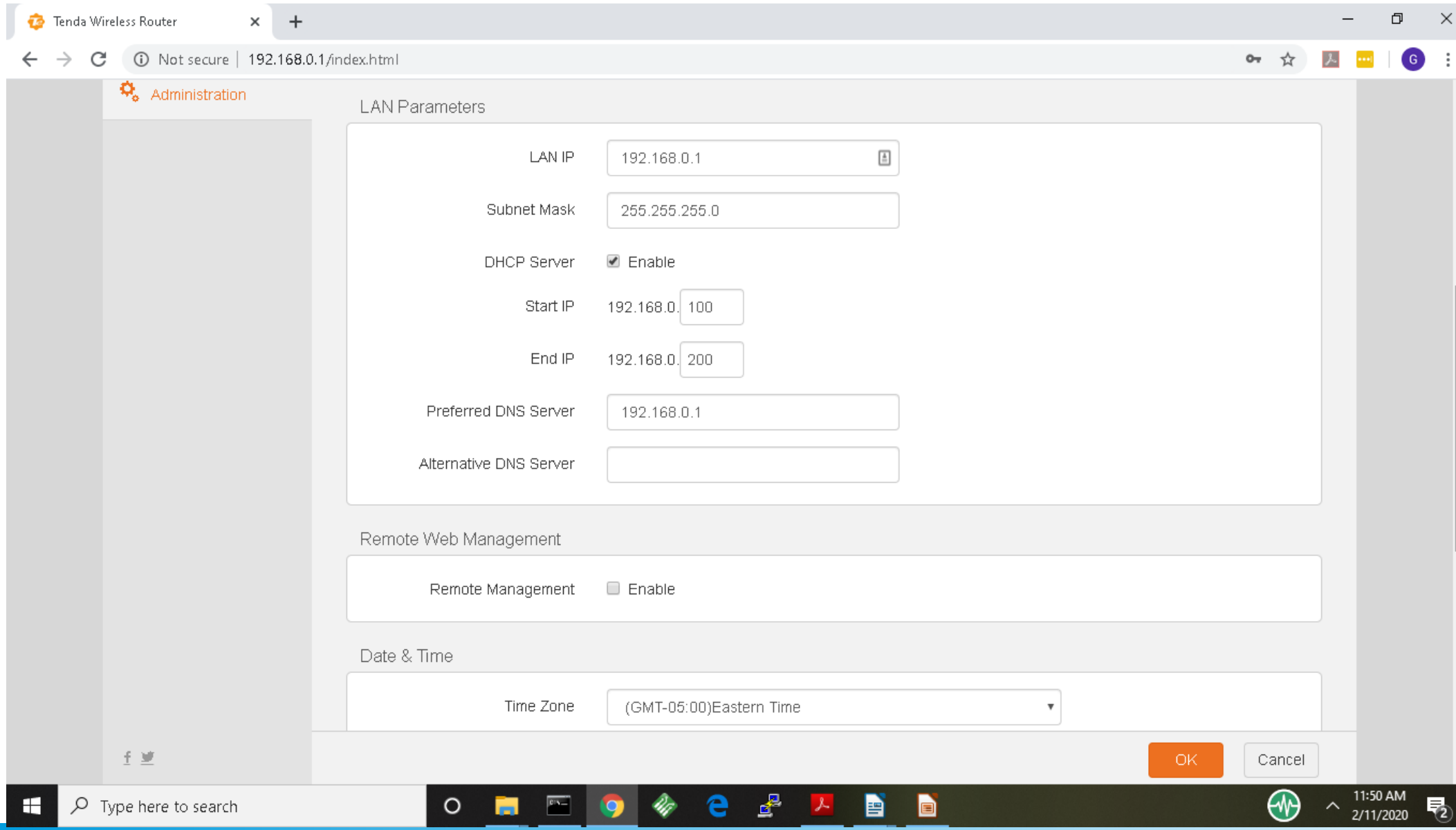


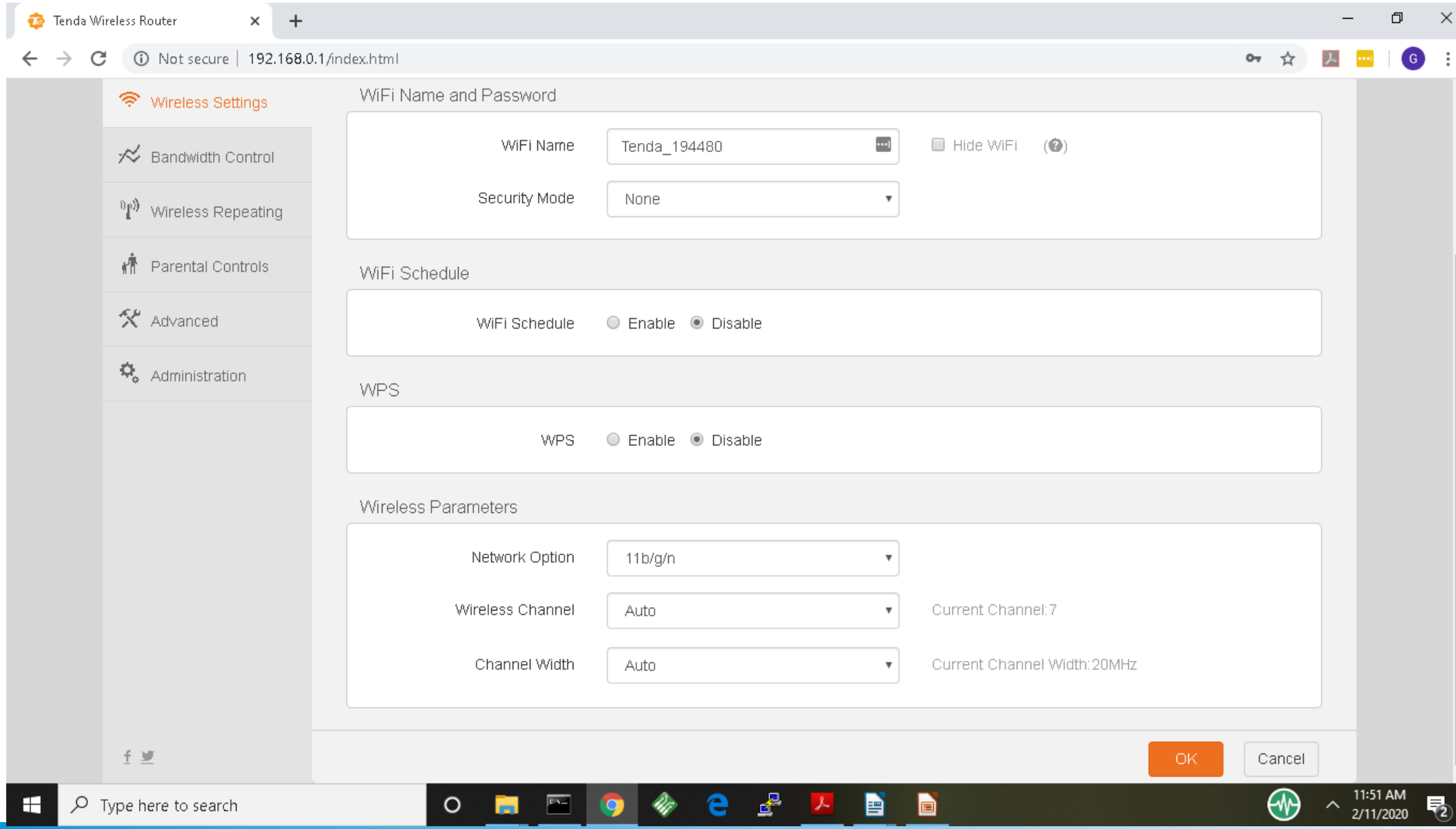
- If there are preliminary settings, work through them and then click on ADMINISTRATION on the left hand menu



You Can:
-- add an admin password
--mess up your “big side(WAN or Wide Area Network) parameters
--set the LOCAL AREA NET IP number and “subnet” mask
-- WHAT IS THAT??

- AND THAT is what we are going to learn about here....


Tenda Wireless Router
Not secure | 192.168.0.1/index.html
Administration
LAN Parameters
LAN IP
192.168.0.1
Subnet Mask
255.255.255.0
DHCP Server
Enable
Start IP
192.168.0.
100
End IP
192.168.0.
200
Preferred DNS Server
192.168.0.1
Alternative DNS Server
Remote Web Management
Remote Management
Enable
Date & Time
Time Zone
(GMT-05:00)Eastern Time
OK
Cancel
Type here to search
11:50 AM
2/11/2020


Tenda Wireless Router
Not secure | 192.168.0.1/index.html
Wireless Settings
Bandwidth Control
Wireless Repeating
Parental Controls
Advanced
Administration
WiFi Name and Password
WiFi Name
Tenda_194480
Hide WiFi
Security Mode
None
WiFi Schedule
WiFi Schedule
Enable
Disable
WPS
WPS
Enable
Disable
Wireless Parameters
Network Option
11b/g/n
Wireless Channel
Auto
Current Channel:7
Channel Width
Auto
Current Channel Width:20MHz
OK
Cancel
Type here to search
11:51 AM
2/11/2020

- In IP-speak, one of our computers on our local area net is a “host”
-

- IP Address in binary
- 10101010.10101010.10101010.10101010
- 170.170.170.170
- Local subnet may use a portion of the IP's
- 10101010.10101010.10101010.10101XXX
- 3 bits = 8 possible numbers. (.168-.175)

- 10101010.10101010.10101010.10101XXX
- 3 bits = 8 possible numbers. (.168-.175)
- Base number is
  - 10101010.10101010.10101010.10101000
  - 170.170.170.168

  Network portion = everything but the last 3

- The bits that are part of the Network Identifier
- 11111111. 11111111. 11111111. 11111 _ _ _
- (remainder are the host identifiers)
- Expressed as a number, the Network portion is
- 255.255.255.248 = NETMASK.
-
- If we had all 255 numbers in our local area net, the network identifier would be 255.255.255.0
-

- Net mask just explains in a binary way which portions of the IP number belong above us, and which ones are at our local area net level (host identifiers)

ARP

- Network cards come with MAC numbers, not IP numbers.
- DHCP “assigns” IP numbers to cards’ MAC numbers, builds a TABLE.
- You can also do this STATIC, yourself....no DHCP server needed.

How IP communications work

- Packets go from a mac number to a mac number at the lowest level.
- Highest IP number = broadcast -- everyone listens to it.
- You want to send a packe to 170.170.170.172, you send a broadcast request to the broadcast address 170.170.170.175 for, “who is .172?”
- The card with .172 assigned answers and tells their MAC number. Now you pass the packet.

ipconfig (windows)

- Find your own IP address and what is working

```
Wireless LAN adapter Wi-Fi:

   Connection-specific DNS Suffix  . :
   IPv6 Address. . . . . . . . . . . : 2600:8807:c000:1fe::2fd2
   IPv6 Address. . . . . . . . . . . : 2600:8807:c000:1fe:35d4:3ec2:8697:d8e
   Temporary IPv6 Address. . . . . . : 2600:8807:c000:1fe:81f6:99a4:bf02:85b4
   Link-local IPv6 Address . . . . . : fe80::35d4:3ec2:8697:d8e%28
   IPv4 Address. . . . . . . . . . . : 192.168.1.247
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : fe80::5a19:f8ff:fed0:caa4%28
                                       192.168.1.1

Ethernet adapter Bluetooth Network Connection:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :
```

192.168.1.1 is my default gateway (to the outer world) -- MY ROUTER

MEMORIZE

- ipconfig
- Tells you your ipnumber for each interface and lets you know basically what is working.

Memorize: ping

- For devices that are open to it, allows you to test whether you can reach them by IP
- Ping my router:

```
C:\Users\Gordon>ping 192.168.1.1

Pinging 192.168.1.1 with 32 bytes of data:
Reply from 192.168.1.1: bytes=32 time=3ms TTL=64
Reply from 192.168.1.1: bytes=32 time=3ms TTL=64
Reply from 192.168.1.1: bytes=32 time=3ms TTL=64
Reply from 192.168.1.1: bytes=32 time=4ms TTL=64

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 4ms, Average = 3ms
```

Memorize: arp -a

- arp -a
- Let's you see the MAC<->IP table for all hosts known on your network by your computer (recently)

```
C:\Users\Gordon>arp -a

Interface: 192.168.1.247 --- 0x1c
  Internet Address      Physical Address      Type
  192.168.1.1           58-19-f8-d0-ca-a4     dynamic
  192.168.1.255         ff-ff-ff-ff-ff-ff     static
  224.0.0.22            01-00-5e-00-00-16     static
  224.0.0.251           01-00-5e-00-00-fb     static
  224.0.0.252           01-00-5e-00-00-fc     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
  255.255.255.255       ff-ff-ff-ff-ff-ff     static
```

Memorize: tracert ("trace route")

- tracert foxnews.com

```
C:\Users\Gordon>tracert foxnews.com

Tracing route to foxnews.com [72.246.85.98]
over a maximum of 30 hops:

  1     3 ms     3 ms     3 ms  192.168.1.1
  2    13 ms    13 ms    11 ms  10.5.0.1
  3    15 ms    15 ms    13 ms  100.122.94.66
  4    13 ms    13 ms    10 ms  100.122.93.66
  5    42 ms    35 ms    34 ms  dalsbbrj02-ae3.0.rd.dl.cox.net [68.1.5.134]
  6    43 ms    46 ms    42 ms  68.105.30.26
  7   126 ms    37 ms    44 ms  ae5.databank-dfw3.netarch.akamai.com [23.203.147.211]
  8    37 ms    35 ms    42 ms  a72-246-85-98.deploy.static.akamaitechnologies.com [72.246.85.98]

Trace complete.
```

BACK TO MESH HAM RADIO

- You are used to this router setup

YOUR SIDE	ROUTER	REST OF WORLD
WIFI	router connects	coax, cable, something .

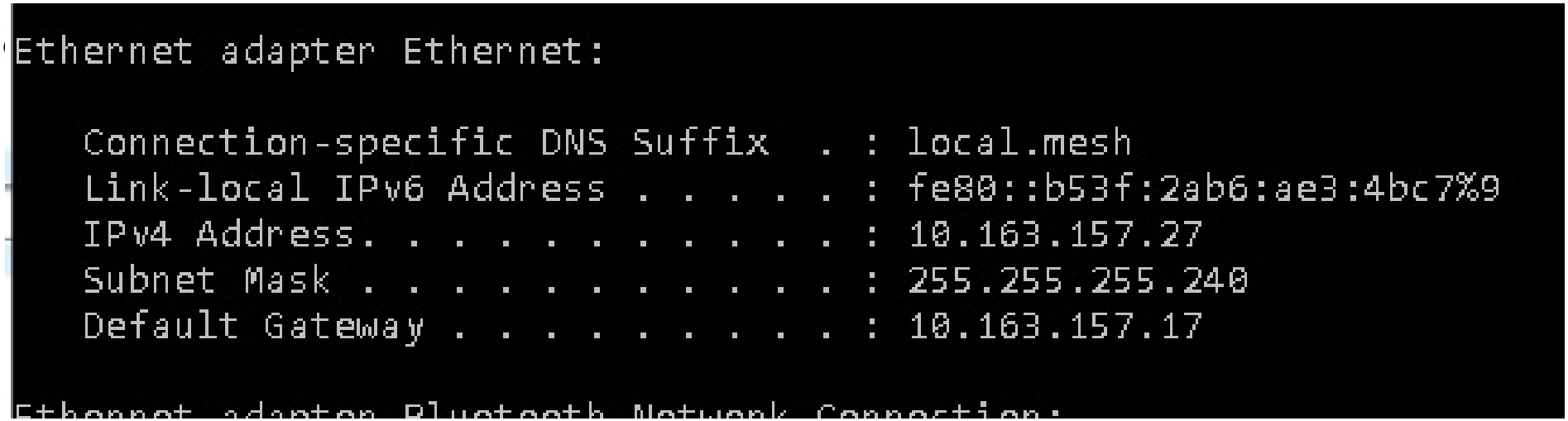
BUT IT DOESNT HAVE TO BE THAT WAY! Routers can be manufactured either way.


System
SF 100-16 16-Port 10/100 Switch
LINK
ACT
LINKSYS
Model No. EF3124 24-Port 10/100 Ethernet Switch
Module
CISCO SYSTEMS
LINK/ACT
FDX
LINK/ACT
Power FDX
66.207.62.83
Enterprise Router
MultiService Security VoIP
LAN
WAN/DMZ
VPN
Firewall
QoS
LNK
100
FDX
Factory Reset
PWR ACT
Console
TracStar Systems
MVS SERIES
ACU
ANTENNA CONTROLLER
POWER
TracStar Systems
MVS SERIES
ACU
RUN:(+/-stop)100
GPSsent 11.10

MESH ROUTER

your end	MESH UBIQUITI ROUTER	far end
DHCP provided for wired clients -- could be computers, printers, VOIP telephones....even a WIFI router to give access to WIFI-based devices		The connection to the big wide world here is WIFI and connects to other ham radio MESH devices -- and the computers and telephones, winlink gateways or whatever THEY are connected to.

- Turn off my WIFI connections
- Connect up wired ethernet to MESH



Connect to my new router (port 8080 for this web system)
10.163.157.17:8080

KX4Z-002

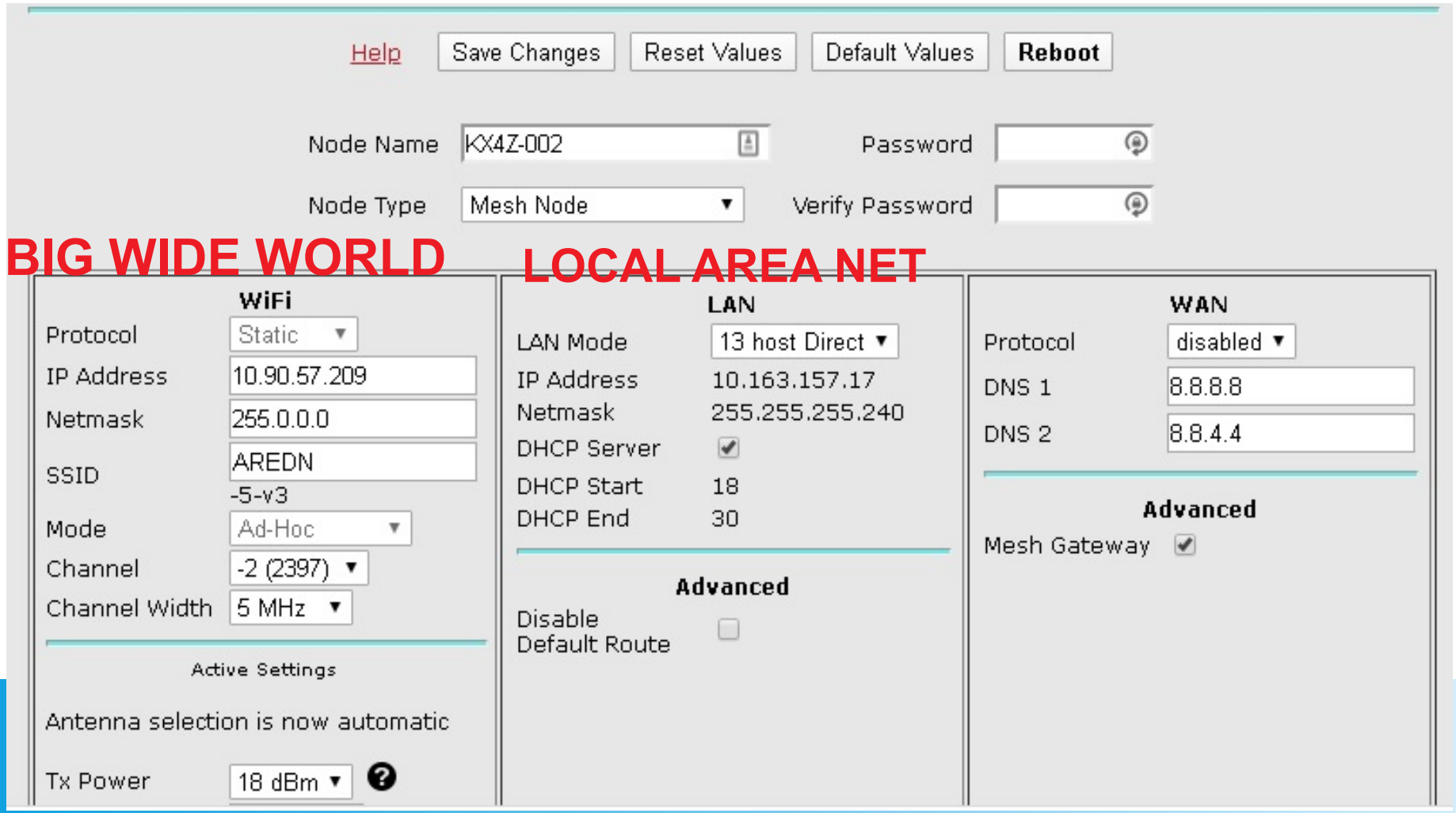
Help | Refresh | Mesh Status | OLSR Status | WiFi Scan | Setup | Select a theme

WiFi address	10.90.57.209 / 8 fe80::6a72:51ff:fe5a:39d1 Link		**Signal/Noise/Ratio**	-46 / -95 / 49 dB	Charts
LAN address	10.163.157.17 / 28 fe80::6a72:51ff:fe5b:39d1 Link		**firmware version**	3.16.1.1	
WAN address	none fe80::6a72:51ff:fe5b:39d1 Link		**configuration**	mesh	
default gateway	none		**system time**	Tue Feb 28 2017 19:08:22 UTC	
			uptime	3 min	
			load average	0.14, 0.23, 0.11	
			free space	flash = 2480 KB /tmp = 14320 KB memory = 4152 KB	

Part of the AREDN™ Project. For more details please see here

Click on “setup”

- Similar to setting up our home router -- just the big wide world is now WIFI....and our local area network...is wired, with a subnetmask etc.

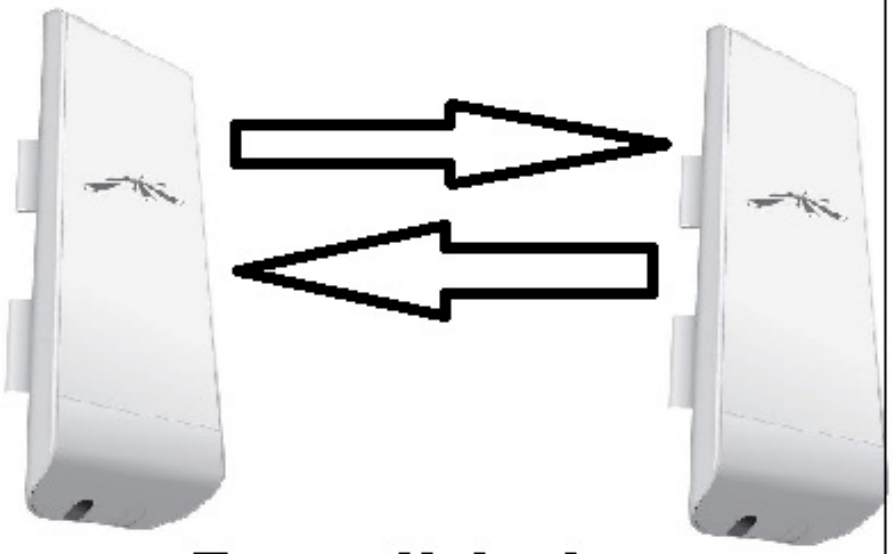


Disaster Usage?

- Only passes TCP/IP packets
- useful for anything that works over data
- huge bandwidth -- 5 to 20 MHz (far far wider than ham radio -- like your own cell tower connection)
- ham radio limitation -- no encryption, no $$

High Point...to High Point

Local Area Net -- computers VOIP phones anything that uses Internet



Possibly long distance radio

RESOURCES potentially
web servers
? limited internet
WINLINK gateways
WebEOC
Resource ordering systems