

# Packet Radio Revisited

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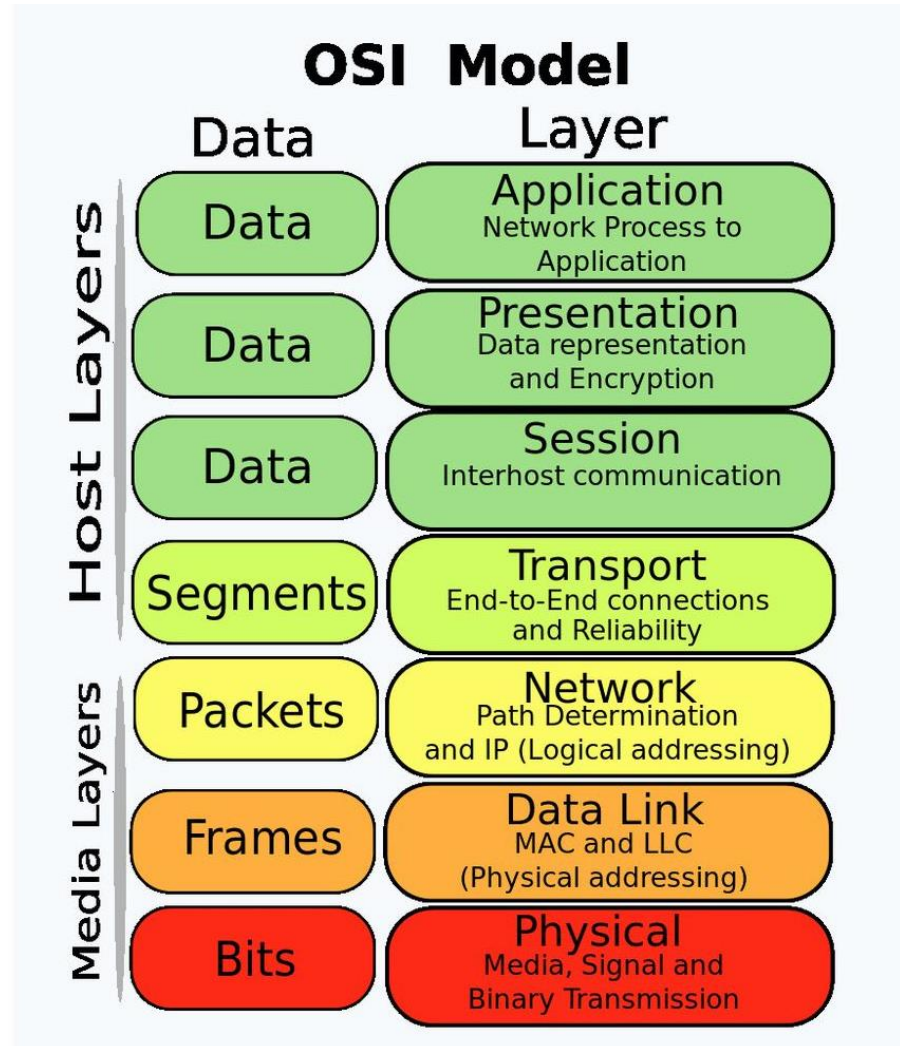
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# What is Packet Radio Again?

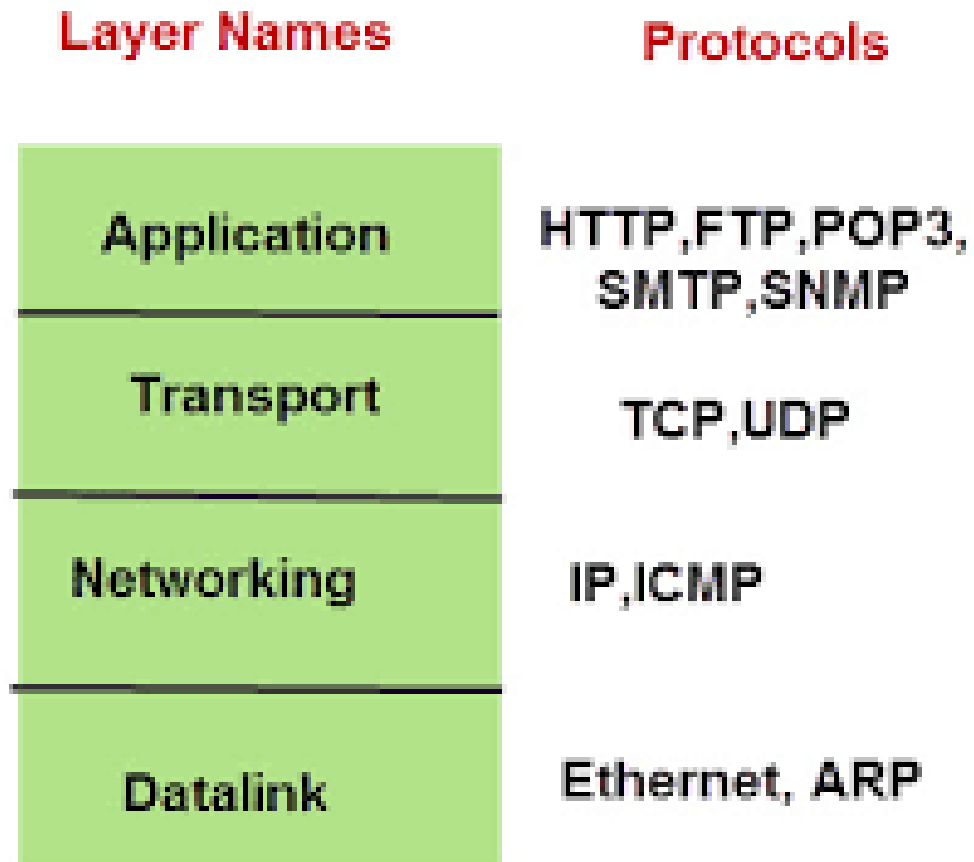
- ▶ We talked about packet radio before
- ▶ [Advanced Topics - 13 August 2020 - Packet Radio](#)
- ▶ Packet radio is a way of using networking protocols over RF
- ▶ Information is encapsulated in discrete "packets"
- ▶ These packets are encoded into an audio form (remember modems from "the past"?)
- ▶ The data is transmitted over the air on a particular frequency
- ▶ Other stations can receive and act upon the data that has been sent

# How Do Networks Work?

- ▶ OSI (Open System Interconnection) Networking Model
- ▶ Network "stack" is a set of layers
- ▶ Lower layers are more simple
- ▶ Higher layers are more complex/abstract

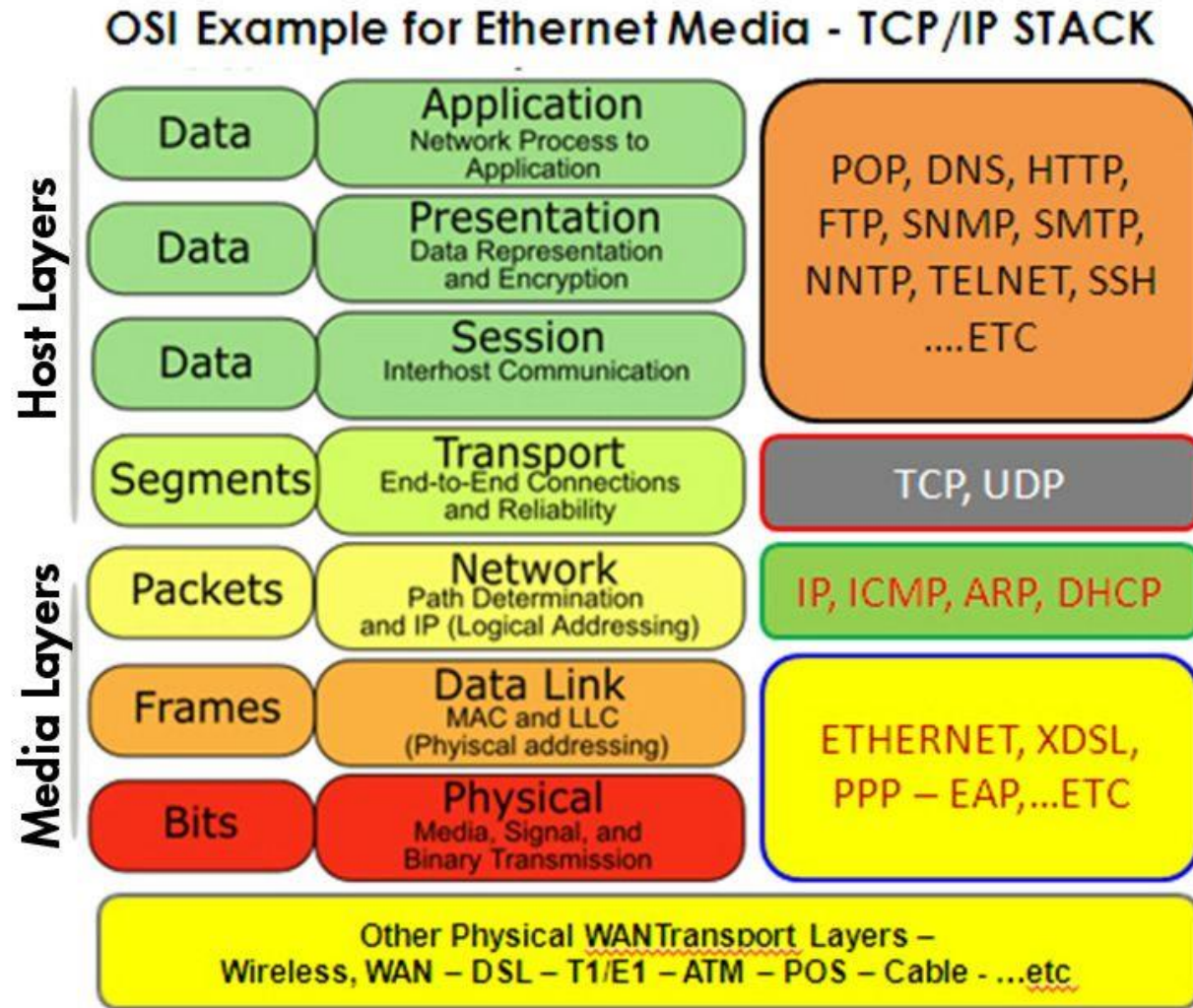


# Simplified "Internet" Model



**TCP/IP Networking Model**

# Mapping the Four Layer Stack into the OSI Model



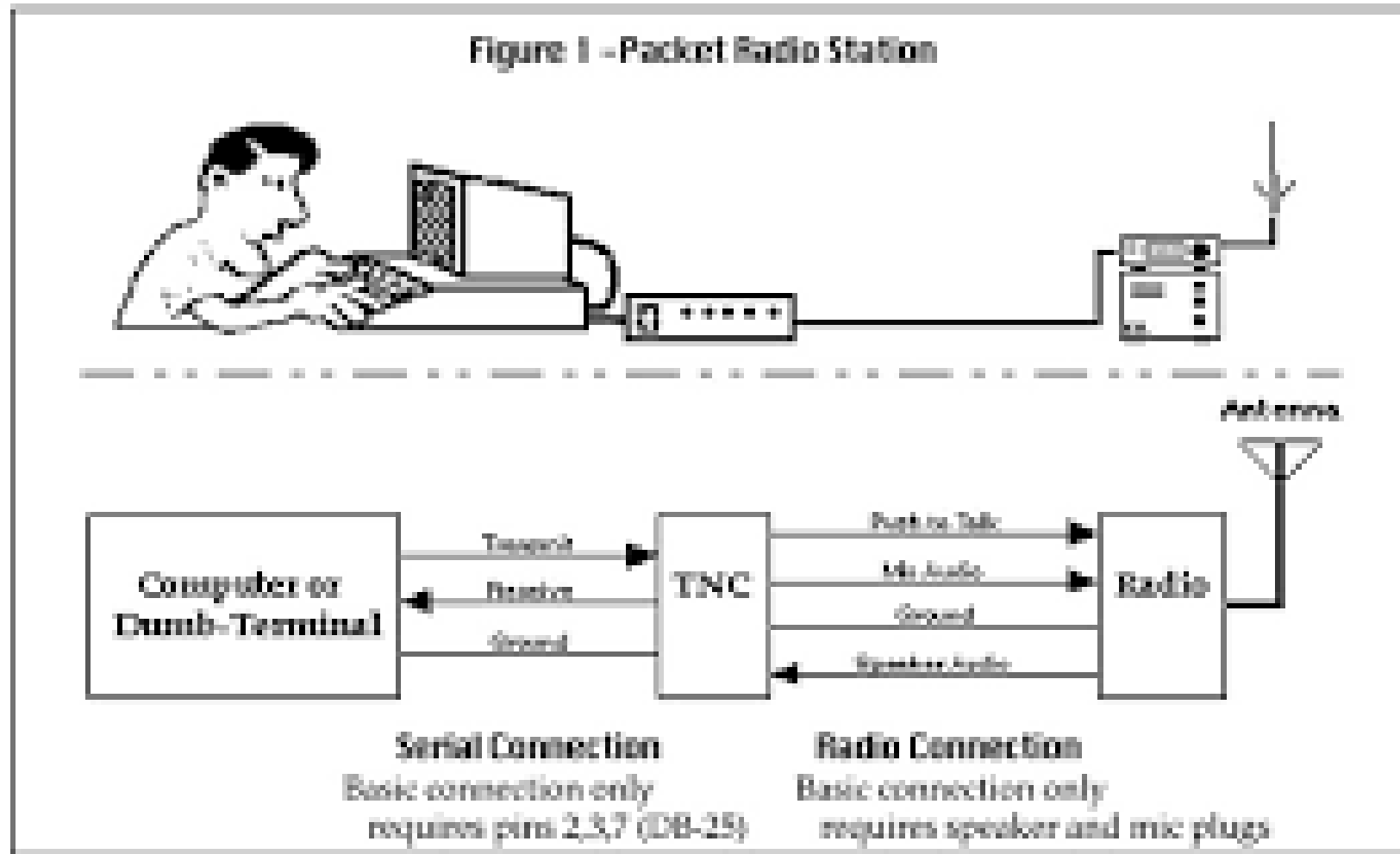
# I Thought We Were Talking About Amateur Radio, not Networking

- ▶ What is Amateur Radio about?
- ▶ Communications!
- ▶ Is there only "one true way to communicate?"
- ▶ If that were the case, we would all be doing CW with straight keys only
  
- ▶ What is Packet Radio again?
- ▶ Running a network on an RF physical layer

# So What's Different with Amateur Radio?

- ▶ The big differences are at the Physical and Data Link layers
- ▶ The Physical medium is the first big difference... or is it?
- ▶ We are going to use RF for the physical layer
- ▶ Interestingly enough, Ethernet is based on radio (!)
- ▶ The computer has an Ethernet "transceiver"
- ▶ The transceiver is connected to an Ethernet cable (like an antenna?)
- ▶ The network's physical properties are determined by the frequency and bandwidth of the cable

# So, What's the Physical Layer Look Like





# Physical Link and Associated Hardware

- ▶ You need a radio (typically VHF/UHF, but there are mechanisms for packet over HF)
- ▶ You need a TNC (think of this as a modem and interface, more on this later)
- ▶ You need a computer (or a terminal)

# What's this TNC?

- ▶ A TNC is a "Terminal Node Controller"
- ▶ It acts as a modem, converting digital data to/from audio signal
- ▶ It acts as a NODE and can also act as a DIGIPEATER

# Okay, What's a NODE?

- ▶ Think of a node in packet radio as a station
- ▶ A node can be an "endpoint"
- ▶ A node can also be an intermediate point in the network

# Wait, Now we Have a Network?

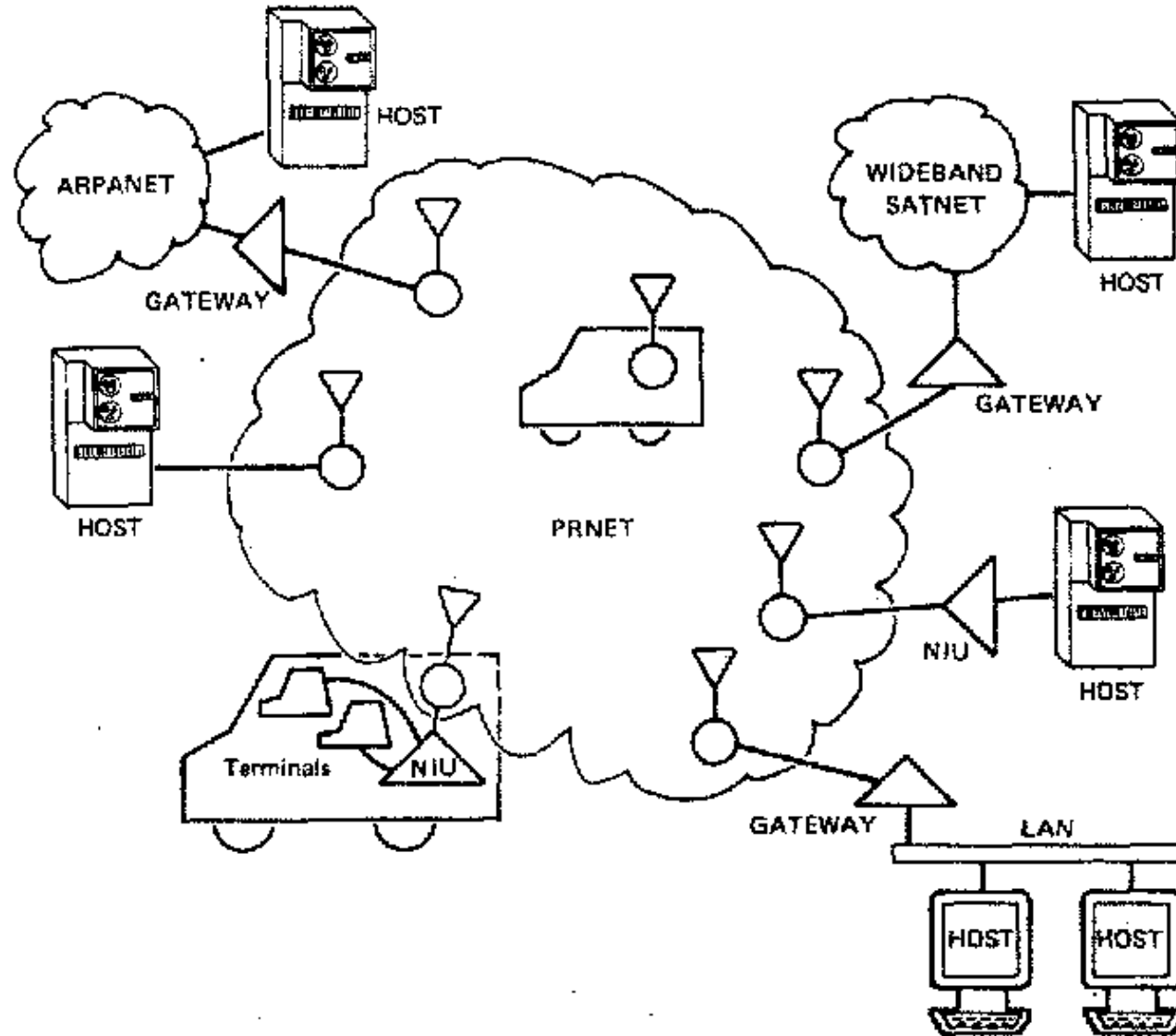
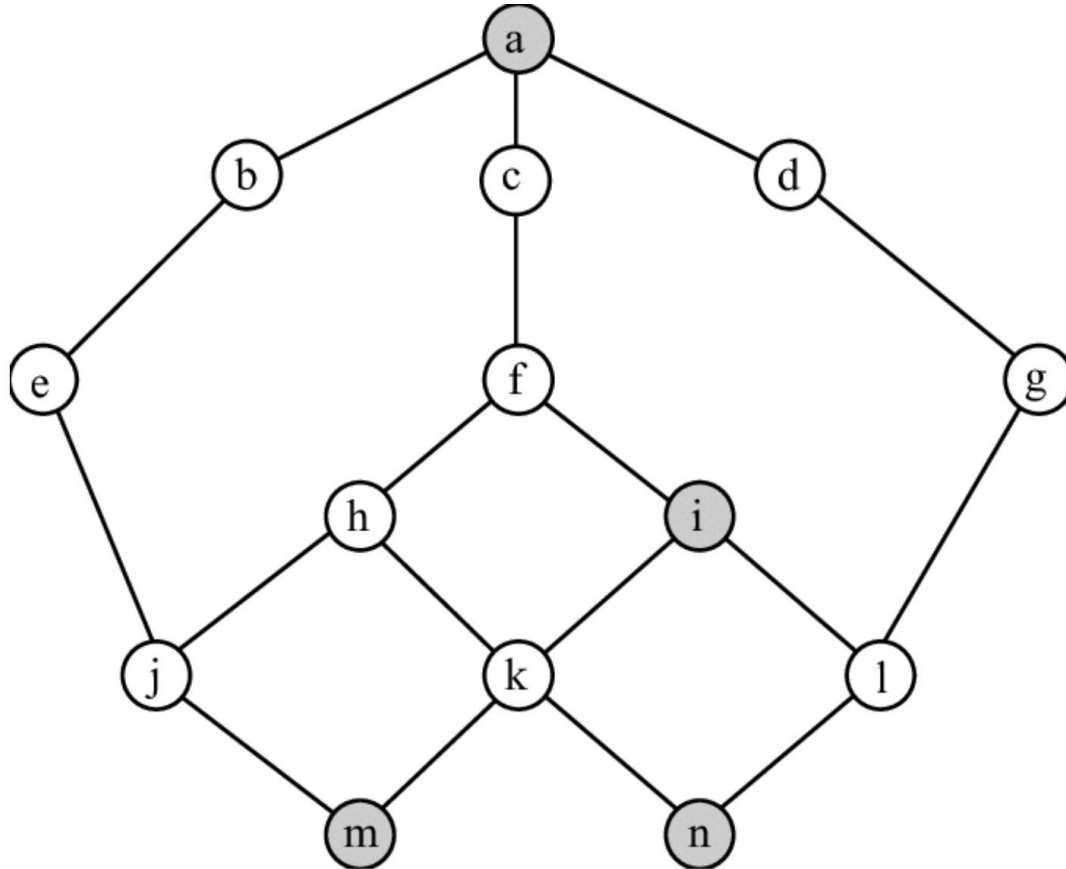


Fig. 4. Packet radio network in the Internet

# Why do we Need a Network?

- ▶ No single node can see ALL other nodes
- ▶ Some nodes might not be online all the time



Multihop packet radio network with destinations i, m, and n.

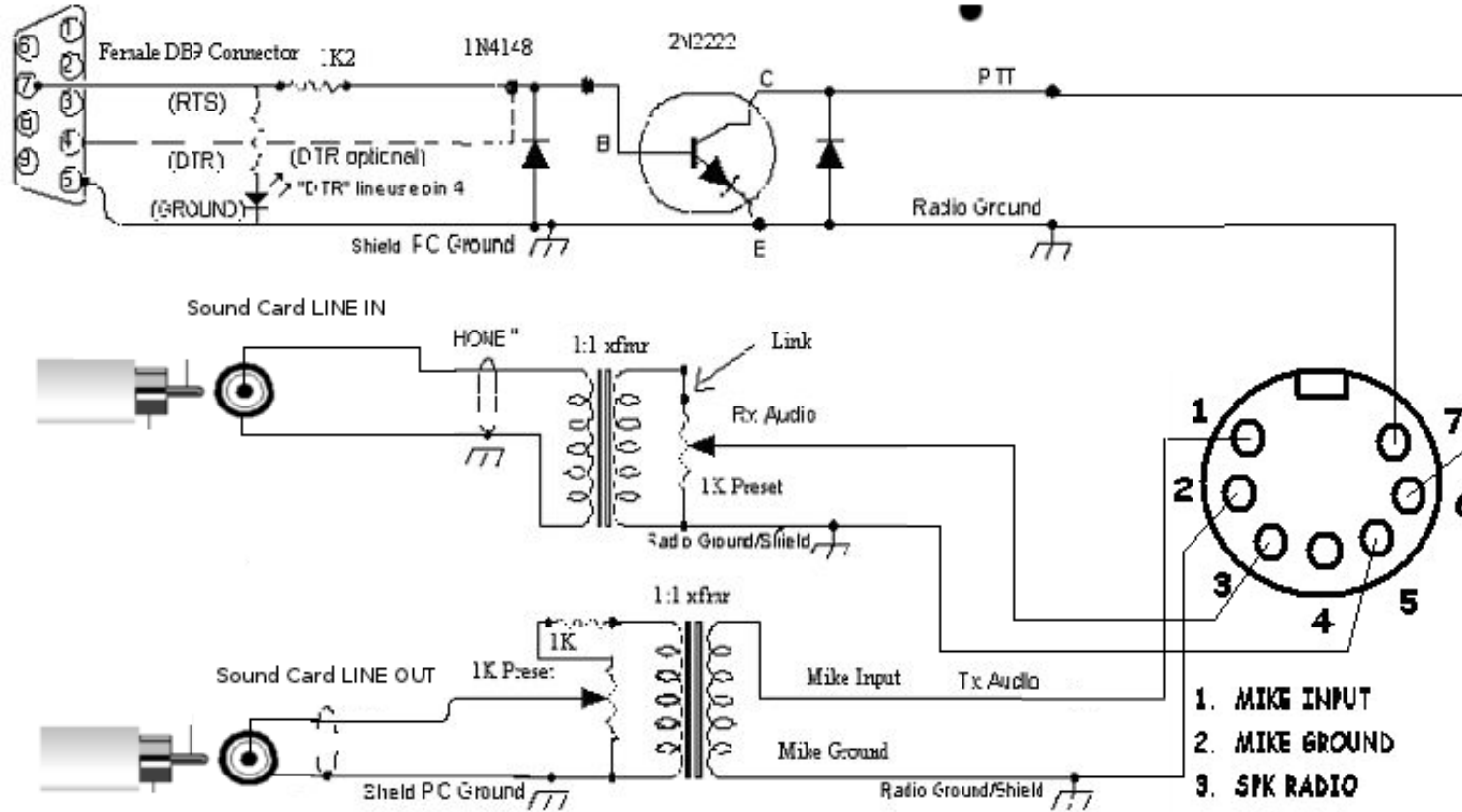
# What if I Don't Have a TNC?

- ▶ All you need is a sound card, interface to a radio, and a computer
- ▶ And some kind of software TNC
  - ▶ Direwolf - cross platform (PC, Mac, Linux)
  - ▶ AGWPE - Windows only
  - ▶ Soundmodem - Windows and Linux
  - ▶ UZ7HO - Windows
- ▶ **BUT!**
  - ▶ These software modems only provide the modem part of the data link layer
  - ▶ More on this later

# What About the Physical Connection to the Radio?

- ▶ So, now we have a sound card that is converting digital signals to audio and back (i.e. a modem = modulator/demodulator)
- ▶ How do we hook that up to the radio?
- ▶ There are three connection points (sometimes four)
  - ▶ Audio out (of the computer and into the radio)
  - ▶ Audio in (to the computer and from the radio)
  - ▶ PTT (so the computer can tell the radio when to key up)
- ▶ Optionally, Carrier Detect signal (so the radio can tell the computer when it is busy) - this is typically not used since if the interface hears tones on the audio input, it knows the channel is busy

# What's the Physical Interface Look like?



ZS1I SOUND CARD INTERFACE II

1. MIKE INPUT
2. MIKE GROUND
3. SPK RADIO
4. NOT USED
5. SPK GROUND
6. PTT RADIO
7. PTT GROUND

NOTE: IN EARLY MODELS THE PIN NUMBERS DID NOT CORRESPOND

Looking at female connector on ZS1I connection



# Physical Interface Considerations

- ▶ You want some type of isolation
  - ▶ Typically done with little transformers or
  - ▶ Opto-isolators can also be used
- ▶ That PTT signal can be skipped if you set the radio for VOX
  - ▶ VOX = Voice Operated Transmit, the radio detects incoming audio and automatically keys up to transmit

# Commercially Available Interfaces

- ▶ Some examples of commercially available interfaces are
  - ▶ I used to have something that did this (audio cables on one side, radio connection on the other)
  - ▶ I wasn't able to find anything like this still available today... everyone has moved to interfaces with a built in sound card
- ▶ Interfaces with build-in sound card
  - ▶ West Mountain Radio's RIGblaster
  - ▶ Signalink
  - ▶ Digirig

# What "Other Part" of the Data Link Layer?

- ▶ The data link layer provides the interface between the physical layer and higher layers
- ▶ In protocols like Ethernet, this layer describes the framing of the data as well as the radio frequencies used at the physical layer
- ▶ In packet radio, we use a protocol layer called AX.25
- ▶ A TNC implements both the physical interface part of the protocol AND the AX.25 layer (more on this later)
- ▶ A software modem ONLY implements the physical interface part

# KISS and AGWPE Protocols

- ▶ These sound card-based modems do one thing and one thing well... they convert the digital information to audio and audio to digital
- ▶ They do NOT implement all of the functions of a real TNC
- ▶ Typically, they will present a KISS or AGWPE (or both) interface to other software
  
- ▶ These protocols are simplified ... they basically allow other software to talk to the radio device

# Why Would I Want a Real TNC?

- ▶ The TNC, in addition to handling the physical connection to the radio, actually implements the NODE part of the system
- ▶ The TNC implements the AX.25 part of the protocol
- ▶ Remember, the Node is the station... everything else we've talked about is just connecting hardware together
- ▶ With a TNC, you don't even need a computer (or at least, you don't need to leave it turned on all the time)

# Examples of TNCs

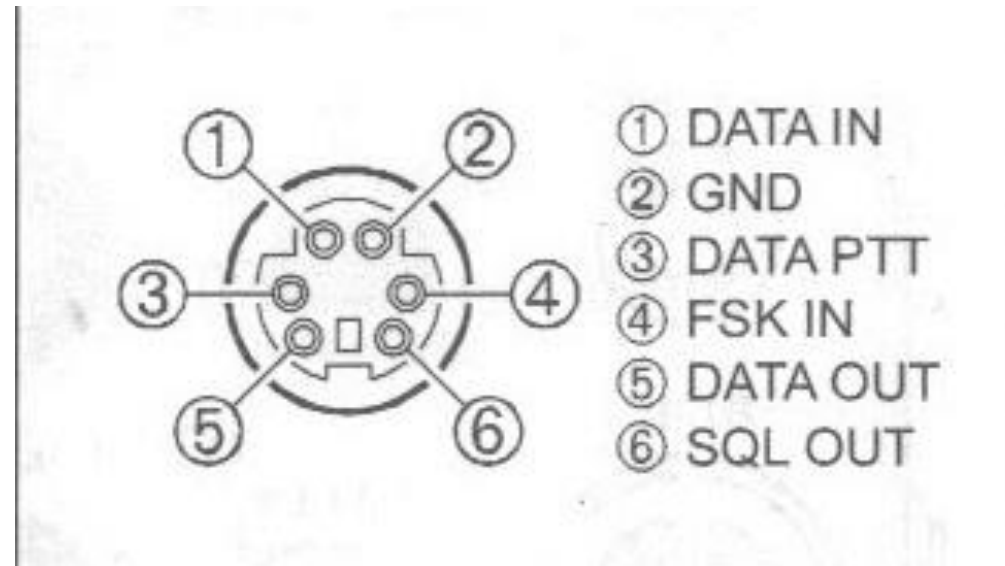
- ▶ Several vendors are still making full TNC devices
- ▶ You can often find used TNCs for sale online or at hamfests/swap meets
  - ▶ Kantronics KPC-3 (and others)
  - ▶ MFJ -1270C

# Hybrid Solutions... KISS TNCs

- ▶ There are also hardware devices that implement the modem part in hardware
- ▶ They present a KISS or AGWPE style interface to the computer side
  - ▶ Most modern software works with these
  - ▶ Anything that works with a sound modem will work with these
- ▶ Examples include
  - ▶ TNC-X (and derivatives)
  - ▶ Mobilinkd TNC
  - ▶ TNC-9k6

# Let's Talk Radios

- ▶ So, now we need to hook this thing up to a radio
- ▶ Some radios (generally not the cheap-o Chinese rigs) include a special "data" port
  - ▶ Not really data... it provides a way to plug in to the mic, pre-squelch audio, and the PTT
  - ▶ There are different "standards"
  - ▶ Here's a typical port





# My Radio Doesn't Have a Nifty "Data" Port, What do I do?

- ▶ You can connect to the radio's mic and speaker ports
- ▶ You may be able to purchase a ready-made cable
- ▶ You might have to "roll your own"
  
- ▶ Caveats:
  - ▶ Open the squelch!
  - ▶ Adjust the volume (and maybe mic gain if you can)
  - ▶ Use the radio's PTT signal (usually on the mic connector)
  - ▶ Hopefully your manual is decent and explains the pinouts of the mic connector

# Radios with Integrated TNCs

- ▶ Some Kenwood radios have a built-in TNC
  - ▶ TH-D7, TH-D72, TH-D74 handhelds
  - ▶ TM-D700, TM-D710 mobiles
- ▶ These radios have the TNC built right into the radio
- ▶ They will often have a serial port or USB port for connecting to a computer
  
- ▶ NOTE: Yaesu radios with APRS built-in have an internal TNC, but they do NOT allow you to access it from a computer... they only use it for their internal APRS implementation

# APRS?

- ▶ APRS is the Automatic Packet Reporting System developed by Bob Bruninga (WB4APR, SK)
- ▶ It uses the AX.25 framing and same hardware as packet radio
- ▶ It does NOT interoperate with normal packet radio stations
- ▶ We've talked about APRS before: <https://www.murrayarc.org/2020/05/15/training-class-aprs/>
- ▶ We'll talk about it some more in another class (January 12th)

# So What Can We Do With Packet?

- ▶ Remember, packet radio is just a mechanism for moving digital data via RF
- ▶ Anything you can do with digital data, you can do with packet radio
- ▶ Chat
- ▶ E-mail (typically Winlink, but you're not limited to that)
- ▶ BBS (remember the 1980s!?)
- ▶ NTS Message Passing
- ▶ Special applications
  - ▶ Wasatch 100 uses packet radio to track runners in and out of aid stations
  - ▶ DX Cluster
  - ▶ Other protocols on top of AX.25



# References and Q&A

