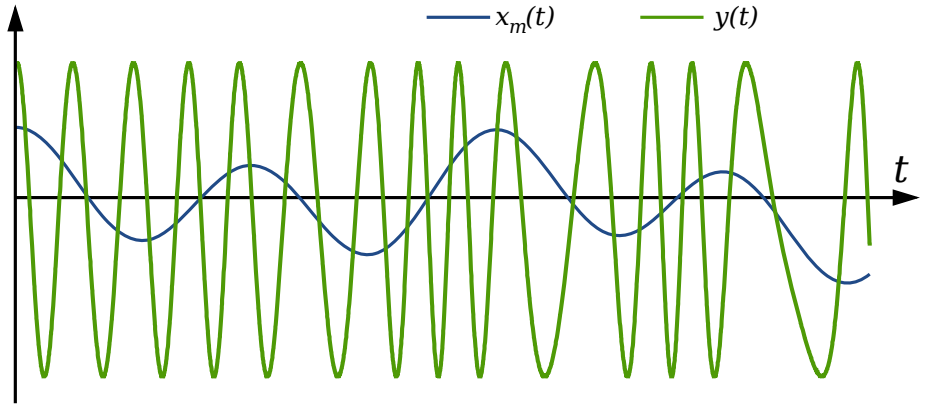
Major Digital Voice Systems on Amateur Radio

- John D Hays (K7VE)



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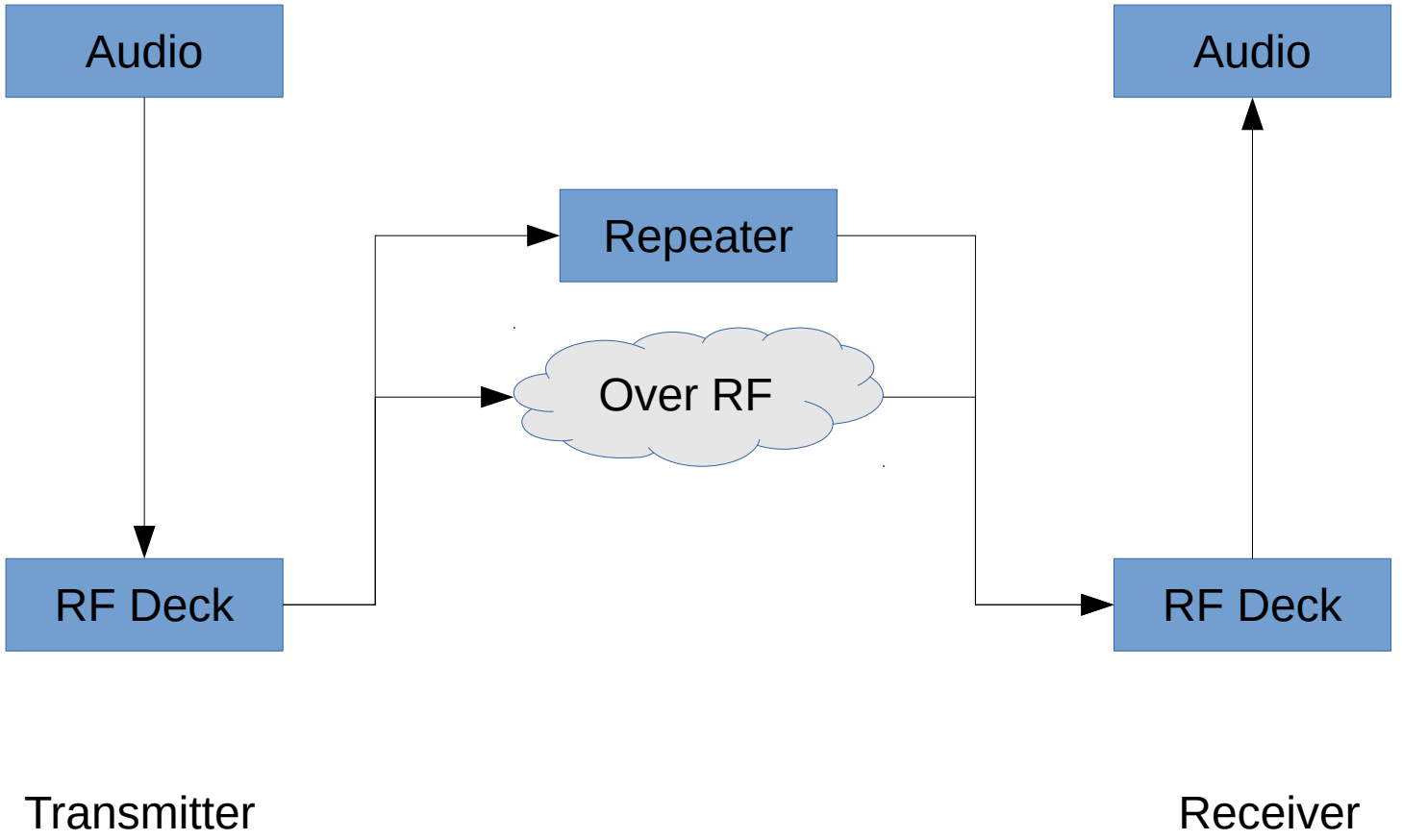
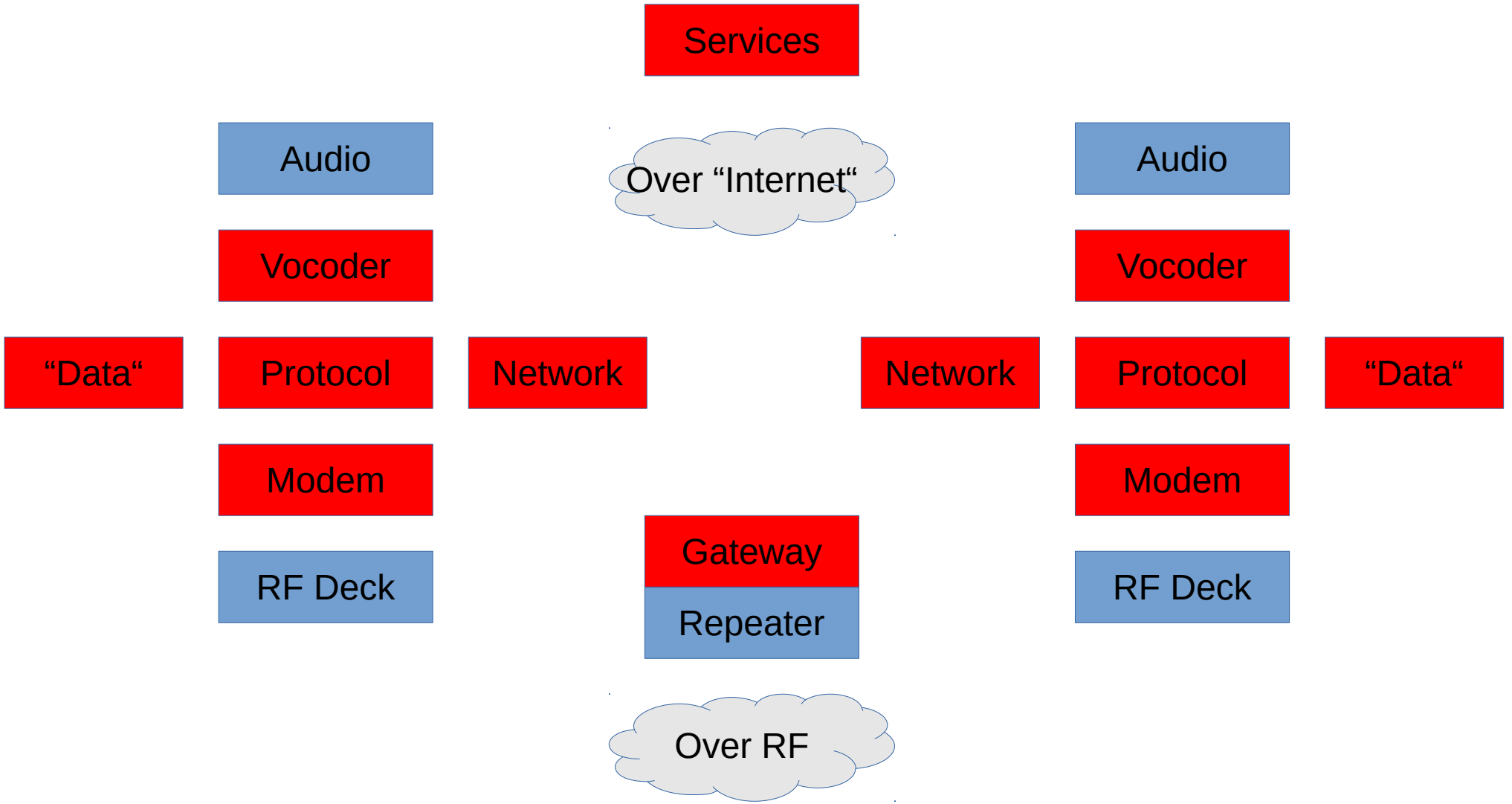
DV System Key Components

- Common Air Interface
  - Define Modulation Method
  - Modem Synchronization
  - Stream Framing
  - TDMA Clocking*
- Network
  - Routing of Traffic
  - Transport (Usually IP)
  - Command and Control
  - Access and Services
- Protocol Structure
  - Define Start and End
  - Payload and Interleave
  - Meta Data
  - Addressing and ID
- Voice / Data Encoding
  - Vocoder Type and Rate
  - Data Payload Types
  - Data Format

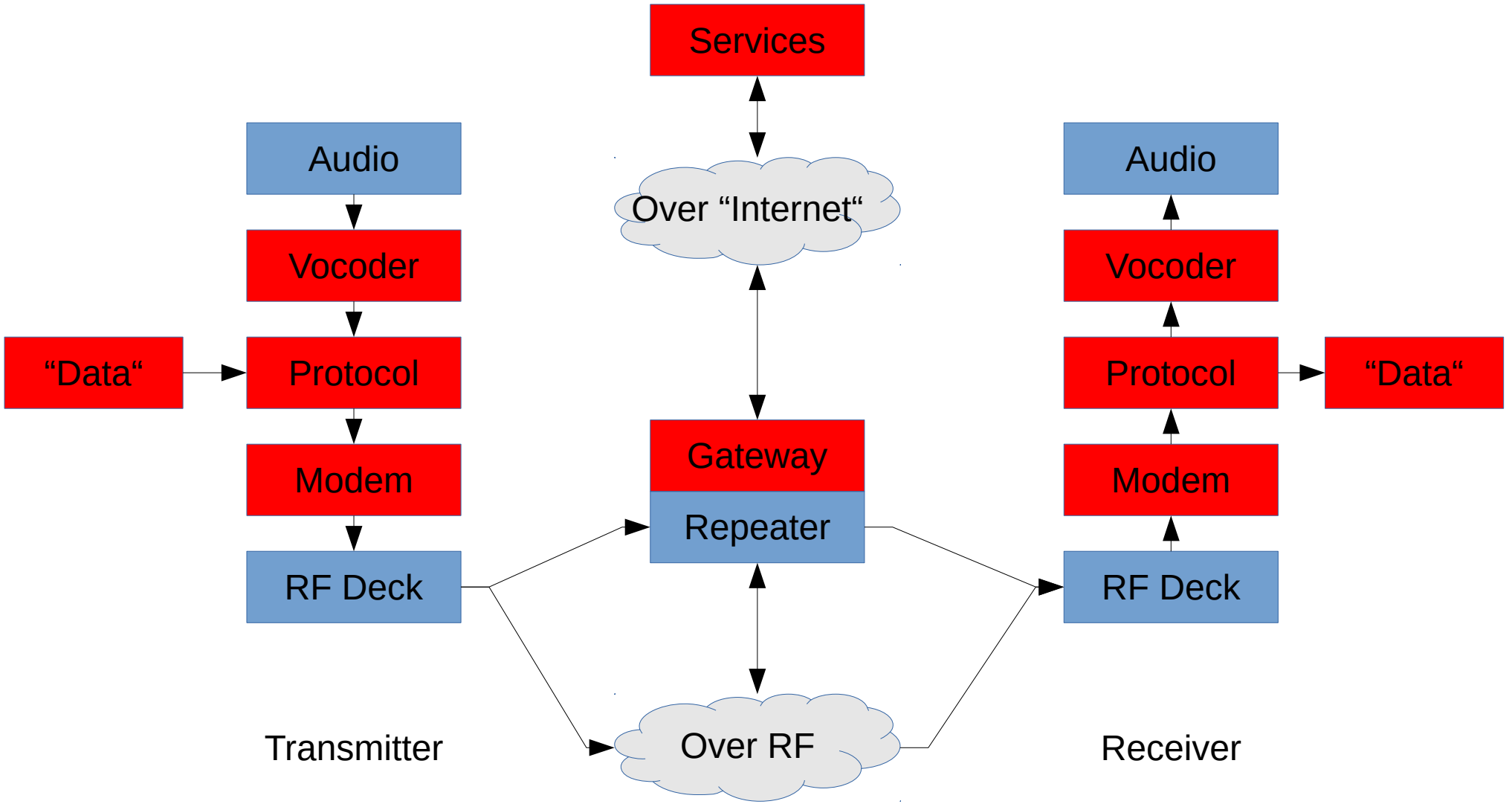
Non-DV Radio


Audio
Repeater
Over RF
RF Deck
Audio
RF Deck
Transmitter
Receiver

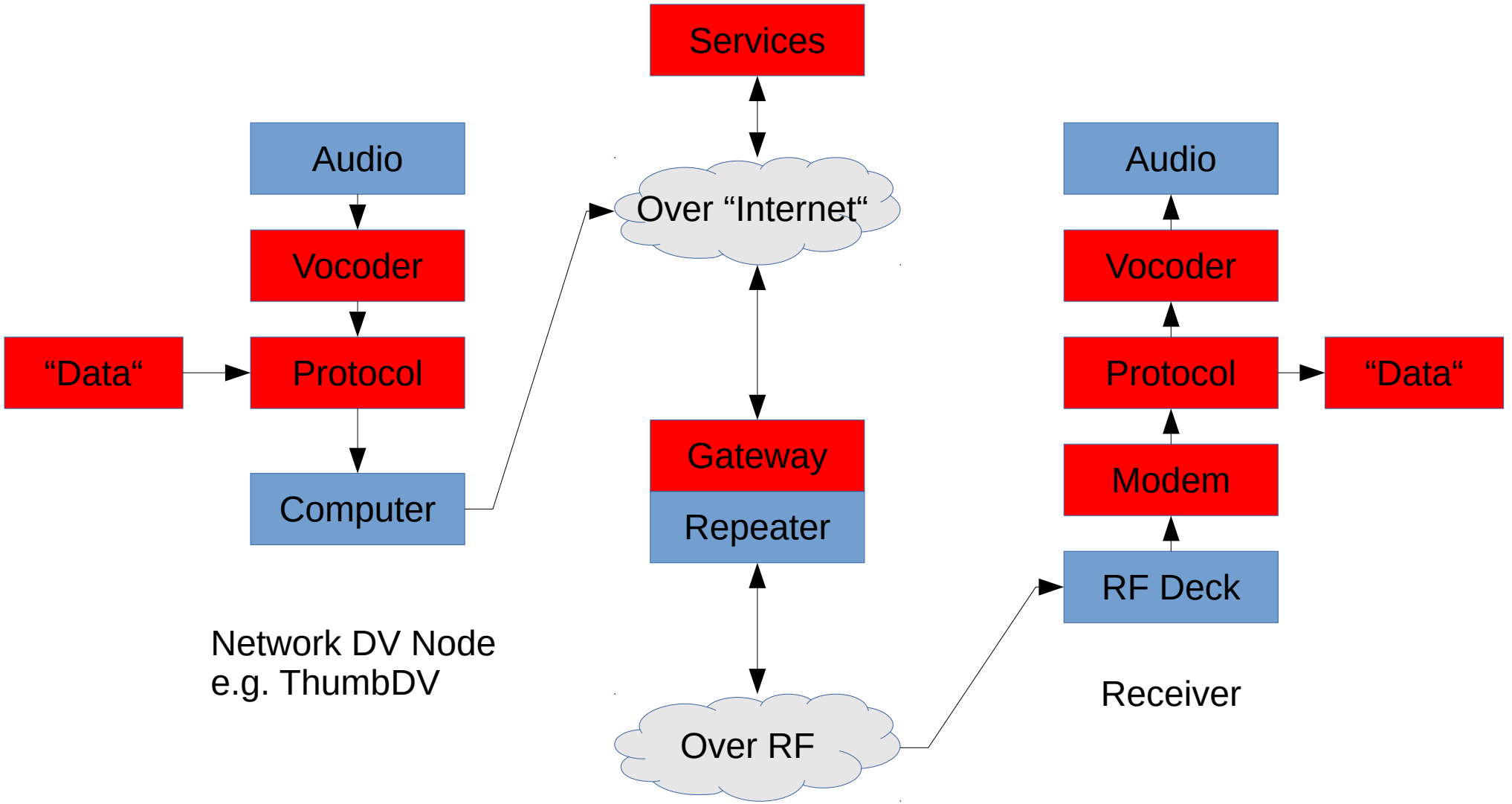
Add In DV Building Blocks



DV Repeater & Services



Non-RF over Network to RF



Four Key DV Systems

- D-STAR (JARL)
  - AMBE+
  - FDMA (6.25 Khz)
  - HF / VHF / UHF / ++
  - GMSK* (Others)
- System Fusion (Yaesu)
  - AMBE+2 (HR/FR)
  - FDMA (12.5 Khz.)
  - 10m / 2m / 70cm
  - C4FM (4FSK)
- DMR (ETSI)
  - AMBE+2 (HR)*
  - TDMA (12.5 Khz.)
  - VHF / UHF / 33cm
  - 4FSK
- FreeDV (Open Source)
  - Codec-2
  - FDMA (< 4 Khz. ++)
  - HF / VHF / UHF / ++
  - OFDM, GMSK and TBD

DV Systems (Less used)

- APCO 25 Phase 1 (IMBE)
- APCO 25 Phase 2 (AMBE+2)
- dPMR (AMBE+2, RAWLCI, others)
- Tetra
- Others

- Two Routing Networks using Gateways
  - Icom V1/G2 (Proprietary supports Icom Gateways)
  - IrcDDB (Open and Largest, supports Icom and Homebrew)
- Three Linking Systems, Callsign Addressing, and 'Talk Group' System
  - DPLUS, DExtra, DCS/CCS (Gateway to Gateway and Reflectors)
  - STARnet Digital Groups and routing by Callsign
- 4800 bps in 6.25 KHz using GMSK modulation
  - 3600 bps combined AMBE+ w/FEC and 1200 bps for meta data/data
  - Higher data mode in latest version (for for data transfer w/o voice)

- Over 10 years of deployment
  - Multiple generations of radio improvements
  - New features such as GPS based repeater search and large database inside radio
  - Highest number of Repeaters, Users, and Network services
- Equipment and Software
  - Icom is primary radio manufacturer (HF/VHF/UHF/23 cm, Repeaters)
  - At least 2 other manufacturers have committed to build radios.
  - Robust secondary component market (DV Mega/DVAP, Node Adapter / DV RPTR, ThumbDV/DV3000/DVDongle, ...)
  - Multiple Sofware Developers in Amateur Radio community.

DMR

- Two Internet Based Networks
  - DMR-MARC (Motorola Proprietary)
  - Hytera (Hytera Proprietary)
- Two Slot TDMA in 12.5 KHz Channel 4FSK
  - A single repeater has 2 timeslots interleaved
  - DMR TDMA has ≈75km (46.6 mile) DX limitation due to inter-slot guard band
  - 9600 bps data stream, even with one slot being used
  - Only 'legal' on Amateur Repeaters for a couple of years
- Designed for Commercial Usage (No Field Setup)

DMR

- Newer AMBE+2 Vocoder (DVSI 3000 Technology)*
  - Shifts 50 bits from FEC to voice in 3600 bps stream
  - Not required by the ETSI standard, so be careful of off brands
  - Side note: DVSI AMBE-3000 can also do AMBE+ and may provide better audio on D-STAR
- Multiple Licensed Manufacturers
  - Patent holders must cross license essential patents (large up front, plus per unit charge, no 'Mom and Pop' manufacturers)
  - Handheld radios can be had for single band for well under $200
- Talk groups (C-Bridge), 'Private', Radio IDs
- SMS and GPS

Codec-2

- Open Source and should be free of Intellectual Property Encumberances
- FreeDV Program
- Most activity on HF (See http://qso.freedv.org)
- Some work on VHF/UHF implementations, mostly on GMSK
- Multiple data rates, “Light“ data path for Callsign and short message.

Codec-2

- SmartMic add-on for SSB and FM radios. See http://www.rowetel.com/blog/?p=3125
- SDR “HT“ being developed by Chris Testa and Bruce Perens
- Possible implementation for UDRX-440

System Fusion

- Open CAI specification on Yaesu Website
- Product line of radios include base (w/HF), mobile, and handhelds. Only Yaesu (Possibly others in future).
- Radios and Repeaters provide both analog FM and HR/FR digital voice as well as digital data modes
- Repeater has built-in AMBE-3000 technology and can convert between Analog and Digital Voice within the repeater.

System Fusion

- Wires-X for networking
  - Closed Source – Windows Only
  - HRI-200
  - Use mobile to create “Hotspot“ or Network Link
- Uses Callsigns in protocol
- Many repeaters deployed due to promotion, network is still developing.
- DR-1X repeater, factory direct at $500 (Dual Band)
  - Promotional Offer

“Can't We All Just Get Along?“

- Each technology has it's 'camp' and there are those who don't want any 'crossover'
- We should encourage new protocols and experimentation
- Some 'watering holes' are emerging to allow one technology to 'talk' (audio only) to the others
- Some companies making multi-protocol products
  - CSI, C-Bridge, NW Digital Radio

My Experience with the DR-1X

- My club bought a DR-1X - NW7DR
  - Coordinated 444.725+ in Edmonds/Mukilteo (Low elevation)
  - Operates DV in DV out and Analog in Analog out (usually)
  - Use 20 Watt setting (rated 100% duty in climate controlled site)
  - $500 delivered + $100 for a UHF duplexer
- Been on the air since early January, no issues
  - Other than understanding setup
- Dual mode on a single frequency isn't a particularly good technological decision but makes it easy to migrate an existing analog repeater.

My Experience with the DR-1X

- If we are going to do dual mode, why not see if we can go tri-mode? (Fusion Digital, Analog, D-STAR)
  - Repeater has internal controller
  - Firmware keeps the Fusion Digital on the internal controller
  - Switchable to 'base' mode to allow external analog controller
- I've converted Kenwood x20 repeaters for D-STAR
  - Could I do it for the DR-1X?
  - Study what others have done
  - Reports of internal controller locking up when using external controller

DR-1X Initial D-STAR

- I've have been able to use the external controller accessory jack to make the DR-1X Analog / D-STAR Dual Mode
  - Set repeater up for remote mode
  - Pull pin 1 to Ground
  - Jumper pins 10 (GND) and 12 (FM in / FM out)
  - Set for 9600 baud 'Packet'
  - Connect PTT, Disc, and Modulator (flat) to DVRPTR V1 board USB to Rapsberry Pi
  - Run dstarrepeater and ircddbgateway software from G4KLX

Tri-Mode? Work to be done

- Need to splice into the internal PTT line (Yellow Wire) to monitor when Fusion Digital is being passed
- Use GPIO pins on Raspberry Pi to acquire and release 'remote' control based on GMSK detection
- Test, test, and test …
- I think it can be done, will report when done.

Questions?