

## AMATEUR RADIO II – DIGITAL, COMPUTERS, AND SPACE COMMUNICATIONS

Fred Kemmerer, AB1OC

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# DIGITAL COMMUNICATIONS AND COMPUTERS

Fred Kemmerer, AB1OC

## **Digital Communications & Computers**

#### Questions that we want to answer

- How are **Digital Signals** different than the **Analog Signals**?
- How is Video and other information sent over Digital Radio?
- How can we use Digital Amateur Radio and Computers to make difficult and unusual contacts?
- How can we use the Internet to see where our Digital signals are being heard?
  - How can we see how the **lonosphere** is reflecting our signals?
- What is a **Software Defined Radio** and how can we use and SDR to do Amateur Radio?

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## How Are Digital Signals Different Than Analog?

# ANALOG VS DIGITAL

- How do Analog Signals carry information?
- How do Digital Signals carry information?
- Why do Digital Signals work better on radio links when there is noise and interference?

## Why Do We Use Digital Signals on Radio Links?



Amateur Digital TV

- Digital Signals can be used to transmit different kinds of information
  - Pictures, Video, Text, and Voice
  - Information is sent as 1's and 0's
- Digital Signals can go much further with less power
  - They are less likely to be affected by interference and static
- Digital Signals and Computers are used in Amateur Radio to make difficult contacts in ways that would be impossible otherwise
  - Bounce signals off **Meteors** as they burn up in the atmosphere

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Digital Text Sent Long Distances

## **Digital Television** How Does It Work?



How Does Digital TV Work?

#### We use Digital Signals to send and receive video over the air

- How does Digital TV represent pictures and sound?
- How many MHz does a TV channel use?
  - How does this compare to the voice signals we used to talk to Richard in England? They used only 3 KHz. (1 MHz = 1,000 KHz)
  - How many voice channels would fit in one TV channel's frequencies?

## **Digital Television**

## **Using Amateur Radio**

## FAST SCAN DIGITAL ATV ON 70 CM FRED AB10C SKIP K1NKR

Amateur Digital TV Radio Contact

- What frequency is used for Amateur Television on the UHF Band in the demonstration?
- Computers control the equipment in our Digital TV station
  - What sorts of things do computers (the Raspberry Pi) and software do in the Amateur Radio Digital TV Station?

## **Digital Contacts Using The HF Bands**

And using the Internet to see where our signals are heard

- We can use Software and Computers to make contacts on the HF bands
  - Our signals go much further this way
  - We can use much lower power
  - Software can receive many different signals at the same time
- Software detects errors and automatically corrects the information that we receive
  - This prevents static and interference from effecting our signals
- All stations send the signals that they hear to a central place on the Internet. We can:
  - Search the data there to learn about where our signal is being heard
  - See how the lonosphere reflects signals





## **Digital Radio Makes Difficult Contacts Possible**

#### Making contacts using Meteors



Bouncing Digital Signals Off Of A Meteor

- Digital Signals and Computers can make radio contacts possible in difficult situations
- What frequency in the VHF part of the spectrum were we using to make our contact?
- How long did the Meteors enable us to "hear" the station we were communicating with while the Meteors were burning up?
- What was the call sign of the station that we contacted? The station is located here.



- Software Defined Radios (SDRs) turn Radio Waves into a Stream of Numbers and uses Software to implement the rest of the radio
  - Very fast processors, digital circuits, and advanced software are needed
- Virtually all modern radio transmitters and receivers are using SDRs
  - You are probably already using SDRs. What gadgets have an SDR?
- You can use an online SDR to try out Amateur Radio
  - <u>https://www.hamradiosecrets.com/listen-to-ham-radio-online.html#WSDR</u>
  - Lookup the callsigns on <u>https://qrz.com</u>

## **Getting an Amateur Radio License**

- You need an FCC license to operate an Amateur Radio Transmitter. Its easy to get a License.
- Three Levels of Licenses are available
  - **Technician** Local and Space communications on VHF and above bands at limited power.
  - **General** Communicate around the World using HF bands. Full access to all Amateur Radio bands with some frequency restrictions at full legal power.
  - Extra Access to all available Amateur Radio bands and frequencies at full legal power
- Must pass a multiple-choice questions test covering rules and regulations, radio station operation, antennas, and some electronics
  - Questions and answers are published
  - Each level of License requires more knowledge and has increasing technical content
- Its easy to earn a license
  - The Nashua Area Radio Society offers classes
  - Preparation involves studying a license book
  - Hams like me will administer and grade your exam





# **Questions?**

**Contact Information:** 

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Much more information, pictures and video are available on our Blog at:

#### stationproject.blog

and on the Nashua Area Radio Society's website at:

#### www.n1fd.org

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# AMATEUR RADIO SATELLITES AND THE ISS

Fred Kemmerer, AB1OC

## Ham Satellite Communications

Questions that we want to answer

- What is a **CubeSat** and how do we get them into space?
- What does LEO mean?
- What is a Polar Orbit?
- How can we track satellites in space?
- What do satellite Uplink, Downlink, and Mode mean?
- What is **Doppler Shift**?





## **Modern CubeSat Satellites**

#### Link to PSLV-C40 Video



**Amateur Communications Satellite AO-92** 



#### **AO-92 Internal Electronics**



How large is a CubeSat?



Satellite Launch and Deployment (PSLV-C40 Mission Deploys Satellites including AO-92)

## Ham Satellite Communications

#### A Review

- What is a CubeSat and how do we get them into space?
  - A: **CubeSats** are small satellites about the size of a softball. We can launch many of them on a single rocket.



## **Satellite Orbits**

LEO Satellites and Polar Orbits





## **Tracking Objects Using a Computer**



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## Ham Satellite Communications

#### A Review

- What does LEO mean?
  - A: LEO is **Low Earth Orbit** with an altitude of about 400 km 1,500 km.



- What is a Polar Orbit?
  - A: A LEO satellite orbit that passes over the North and South Poles.
- How can we track satellites in space?
  - A: We can use computer software.



## **Satellite Radio Links and Modes**

**Uplink and Downlink** 

20



- We send our signal to a satellite on the uplink and we receive other user's signals on the downlink.
- Satellites use different frequencies and bands to receive our signals and return them to earth.
- A Satellite's <u>Mode</u> is determined from the <u>Frequency Bands</u> that are used for the uplink and downlink. (FO-29 is <u>V/U Mode</u>)

## Satellite Doppler Shift

#### **Changing Radio Frequencies**







Basics of The Doppler Effect Link to Video

- LEO Satellites and the ISS are in low orbits and must move at high speeds
  - Typical orbital velocity ~= 17,100 mph or 4.8 miles/sec

A Satellite Ground Station must adjust its transmit (uplink) and receive (downlink) radio frequencies to compensate for Doppler Shift.

## Ham Satellite Communications

Questions we want to answer

- What do satellite Uplink, Downlink, and Mode mean?
  - A: We send a radio signal to a satellite by transmitting on its
    <u>Uplink Frequency</u> and we hear other stations by receiving on the satellite's **Downlink Frequency**.
- A: A satellite's <u>Mode</u> is just the letters for the bands it uses for it's <u>Uplink</u> and <u>Downlink</u>. (Example: FO-29 is <u>V/U Mode</u>).
- What is Doppler Shift?
- A: The change in the satellite's Uplink and Downlink Frequencies when it is moving towards us or away from us.



## **Amateur Radio Space Ground Station**



- Our Radio Transceiver sends our signal on the satellite's Uplink Frequency and receives on the satellite's Downlink Frequency.
- Computer software tracks the satellite, points our antennas, and adjusts our Radio's frequencies to correct for Doppler Shift.

## **Space Communications**

**Computer Controlled Satellite Ground Station Operation** 

## PORTABLE SATELLITE STATION 2.0 ANITA AB1QB FRED AB10C

Link to Video

## Where Am I Located?

#### Maidenhead Grid Squares

- Maidenhead Grid Squares divide up the world into a combination of 2 letters + 2 digits
- Each grid is approx. 70 miles X 100 miles



#### **AB1OC** Satellite Grids



- Hams try to work a station in every grid square
- Earn a VUCC Award for confirming 100+ grids 25

## **LEO Communications Satellite Demo**

#### Linear Transponder Satellite FO-29



#### Link to Video

## **Getting Started with Amateur Radio Satellites** Handheld Antenna and Portable Radios



Video on YouTube

## **ISS Crew Contact Via Amateur Radio**

**Hudson Memorial School** 

## HUDSON MEMORIAL SCHOOL ISS CREW CONTACT DECEMBER 2018

ISS Contact Video on Vimeo

## A High-Altitude Balloon

**Carrying Amateur Radio** 

# HIGH-ALTITUDE BALLOON LAUNCH

#### A NASHUA AREA RADIO SOCIETY STEM PROJECT

HAB Video on Vimeo

## **Getting an Amateur Radio License**

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