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- First successful attempt in 1946 by the U.S. Army Signal Corps
- Not too long thereafter replaced by artificial satellites
- First amtateur radio attempts in 1953
- Today mostly for amateur radio applications still challenging but really cool



Some Basics - Radio Frequencies



Marshall Brain, http://www.howstuffworks.com/radio-spectrum.htm



Radio Communication through Space

Some Basics - Decibel

- A logarithmic unit of ratio, 1/10 of a bel but not an absolute value
- 3 dB equals doubling of power, 10 dB equals 10 times the power
- dB, dBm
- But why?



Reaching the moon, and why is it diffucult

- The moon is far, far away
- Path losses
- Signal polarisation
- Natural and manmade noise
- Ionosphere



Reaching the moon, a simple example

- 100 W transmitter output (50 dBm)
- Antenna gain on transmit 16 dB (66 dBm)
- Path loss 250 db (-184 dBm)
- Antenna gain on receive 16 dB (-168 dBm)
- -168 dBm ~ 0.00000000000000000016 mW



Ouch, that's really low power - what can we do?

- The brute force attempt, increasing power
- The structural attempt bigger antennas
- The smart attempt choosing a clever communication protocol
- We have to use all of them to be successful



Available EME communication modes

- Voice communication
- Digital modes
 - Morse Code
 - Computer assisted (RTTY, AX.25, PSK, ..., JT65)



Radio Communication through Space

Latest developments by Joe Taylor, K1JT

- American astrophysicist and Nobel laureate
- Can use Arecibo observatory for moonbounce
- WSJT open source program suite for weaksignal digital communication
- JT65 specifically designed for moonbounce, can detect signals many decibels below noise floor



Latest developments by Joe Taylor, K1JT



- You don't have to use JT65 with that antenna, but still...
- Now more about that cool JT65...









Radio Communication through Space





Radio Communication through Space

JT65

- JT65 A/B/C
- Joe Taylor 65 tones (FSK)
- Here (2m/144MHz) JT65B
- One Tone at a time, cont. Amplitude
- Bandwidth 355 Hz
- Tone spacing 5.4 Hz
- ½ time pilot tone



JT65

- Massive FEC Reed Solomon
- Successful decode up to -27 dB SNR
- Time synchronous
- 47 sec sending
- 1 min sending, 1 min istening
- 13 sec decoding and user interaction
- Prepared text messages



JT65

Sound examples (tnx OE6TZE)



Radio Communication through Space

Standard QSO

CQ OE5XML		
	OE5XML K1JT	
K1JT OE5XML OOO		
	RO	
RRR		
	73	
		/⊴□



Sucess?

- 2.5 sec delay for moon and back again
- Berlin Paris: 3/1000 sec
- Echoes
- Ping



Our Setup

- 2 stacked Yagi-Uda 10 elements
 - linear polarization, 16 dBi gain
- LNA 28 dB gain, 0.3 dB noise
- PA linear 750W
- 1/2" cable
 - super low loss 0.2 dB/m@6GHz
- High power coaxial relay











Radio Communication through Space

After Moonset

- 1957 Sputnik
- 1961 OSCAR 1
 - Non-government
 - Non-commercial
- > 70 amateur radio satellites
- Community funded/built/operated



Orbits





Radio Communication through Space

Equipment

- Handheld Radio
- Yagi-Uda antenna
 - good dipole antenna possibly
- Better: station transceiver
 - LNA
 - Rotor
- High transmission power is not required!



Operation Modes

- CW, beacons and QSO
- SSB
- FM
- Digimodes: PSK31 etc.
- Packet radio
- Cool new stuff: QPSK1000



Tracking

- Tons of software
 - Search for "pass prediction"
 - I like gpredict ;-)
 - Alexandru Csete OZ9AEC
 - http://gpredict.oz9aec.net/





13. August 2011, CCCamp Fiowfurt/Germany

See you

- Moon Bounce / EME:
 - Right next to Baikonur
 - Red Pylon
- Satellite:
 - Right next to Baikonur
 - Blue Pole
 - Weird people on street with dangerous rods
- How to build a satellite: mur.sat







Radio Communication through Space