

Amateur Radio
The Roots of Communication

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Zak Cohen -N6PK

Communications

- The history of communications is intertwined with the history of Amateur Radio
- “Amateur” means unpaid not unskilled
- The early innovators experimented and developed technologies on their own and, in most cases, were initially unpaid. It’s important to discuss the formative stages of commercial radio in conjunction with the history of ham radio, as early hams played a key role in the development of emerging RF technologies now associated with both commercial and non-commercial applications.

Past

1800s to 1980s



Pre Communications Technology

- 1864- Princeton University professor, Joseph Henry, and British physicists Michael Faraday and James C Maxwell discovered and explained Electro magnetic induction
- 1880's- German physicist Heinrich Hertz, performed experiments proving the electromagnetic theory

Initial Communications-Wired

- 1835 Samuel F. B. Morse formulates the elements of a relay system
- 1837 the system was demonstrated using 'Morse code,' an electronic alphabet that could carry messages
- A line was constructed between Baltimore and Washington and the first message, sent on May 24, 1844, was 'What hath God wrought!'

Initial Communications-Wired

- 1861 the two coasts of the United States were linked by telegraph
- 1861 - 1865 During the US Civil War, Telegraph is used extensively using more than fifteen thousand miles of lines for military purposes

Initial Communications-Wireless

- Guglielmo Marconi developed the first practical wireless telegraphy (radio) system in 1895. He used basic technologies from wired telegraphy
- Dec. 12, 1901 Marconi produced the first transatlantic wireless signal and (1909) patented the first horizontal antenna
- Many young scientists became interested and by 1912, there were so many stations on the air that radio laws became necessary to prevent interference

Early Communications-Wireless

The first pioneers of ham radio began making their mark following Marconi's experiments (1900-1908). Morse Code, using spark gap, became the transmitting mode and remained as such until sufficient numbers of amateurs had home brewed their first AM transmitters

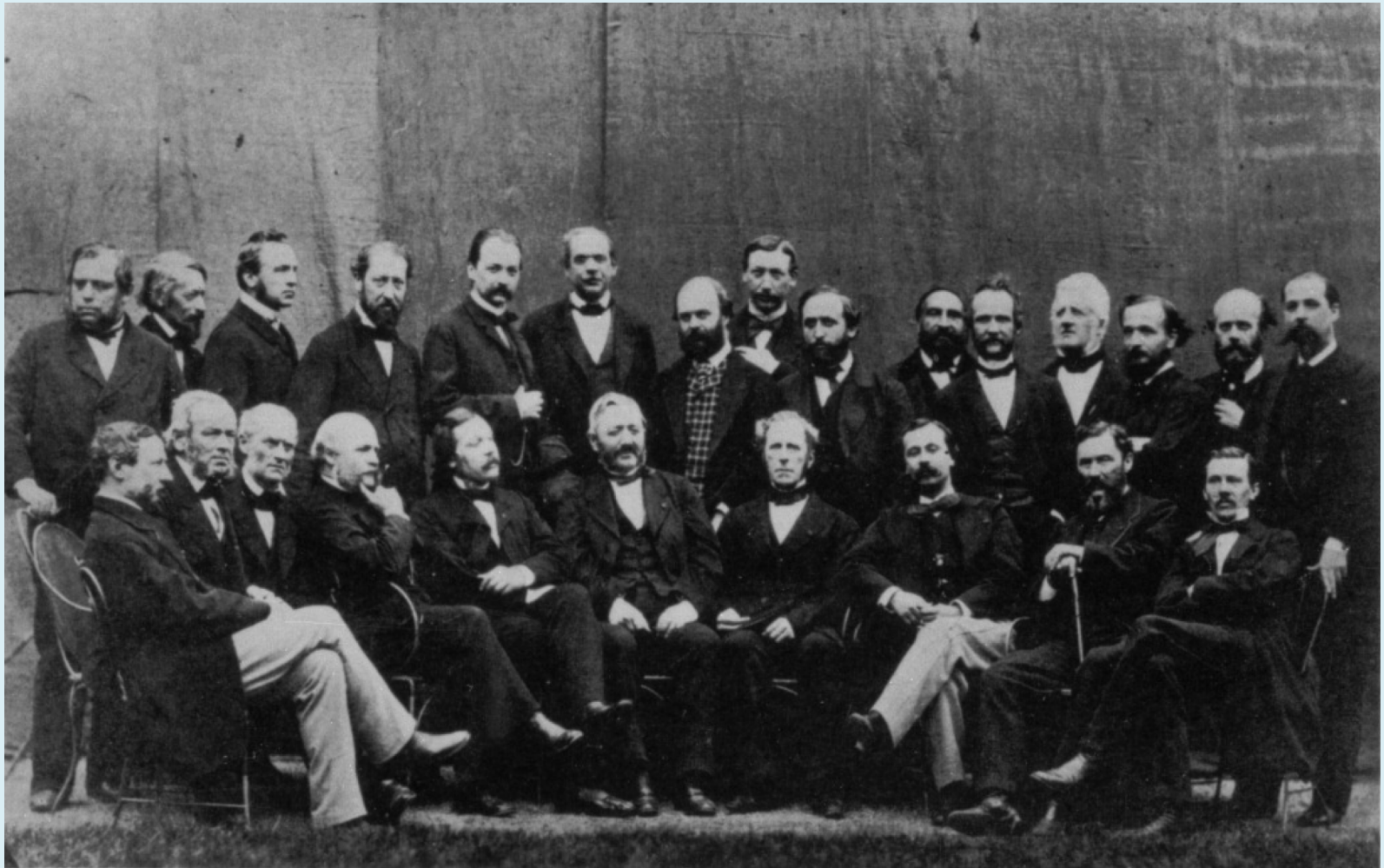
Early Communications

- 1865 - Mahlon Loomis 2 transmits wireless messages between two mountains 18 miles apart in Virginia using 2 kites
- 1870 - Loomis successfully transmitted wireless telegraphic signals between two ships two miles apart on the Chesapeake Bay

Early Legislation

- In 1865, an international conference established the International Telegraph Union and drew up an intergovernmental treaty that established the basic principles for international telegraphy
- Regulations for International Service covered matters of administrative detail, such as the interworking of equipment, operating procedures and settlement of accounts
- The use of Morse code as the international telegraph alphabet and the protection of the secrecy of correspondence were adopted
- Charges (tariffs) for international telegram exchanges were established. For the first time, all terminal and transit charges were coded and published in a table annexed to the Convention

1st ITU Convention



Amateur Radio

- Marconi presented a large number of lectures. One of the attendees was Meade Dennis who tried to repeat his experiments
- In 1898, Dennis installed a Woolwich Arsenal on the Dartford to London route that is considered the first amateur experimental radio station

First Amateur Stations

1898: Meade Dennis - Dennis built a four inches spark gap transmitter using rudimentary components, without antenna or ground. It was capable of reaching a distance of about seventy yards. Colonel Dennis is considered to be the owner of the first amateur experimental station in the world - a claim that was never challenged

1898/9 UK. L.Claude Willcox in Warminster. Age 17 years

1899 UK. Albert Megson

1901/2 USA. Irving Vermilya VN, 2OR, 1ZE

1902 USA. Lloyd Manuel 1MT

1902/3 USA. Newell A. Thompson KN

1906 Mexico. Manuel Medina 1N, XE1N

1906 New Zealand. R.Stark and S.Hicks (licensed 1908)

First Official Amateur

- Irving Vermilya built his first primitive set in December 1901, after returning from his trip to see Marconi. Other more advanced sets followed
- His spark transmissions were so frequently heard that he was offered jobs on ships that needed a wireless operator. He became a member of the newly formed Radio Club of America in 1911, using the call VN
- In late 1912, the government required that all wireless operators be licensed. Irv took the test at the Brooklyn Navy Yard and was given Certificate of Skill #1. For the rest of his life, he would be known as America's Number 1 Amateur

Amateur Radio

- An Englishman. Leslie Miller, an advanced amateur, published in the January 1898 issue of ***The Model Engineer and Amateur Electrician*** the first description of what he called a simple-to-build transmitter and receiver for an amateur audience. The July 1899 issue of *American Electrician* magazine gave details on the construction of Marconi's antenna and his wireless radio equipment
- Miller's intent clearly is to encourage the rise of amateur wireless experimenters, if not the general readership, then certainly from the wire-telegraph experimenters
- it is hard not to consider Leslie Miller the starting point of a community, backed by credentialed authority, of amateur wireless experimenters

Early Legislation

- **November 1906** – The "Berlin International Wireless Telegraph Convention" defined call letters, operating procedures and signals for Coastal Stations and ships at sea
- The committee decided that henceforth the term "Radio" would better describe wireless. Radio is derived from the Latin radius (ray or beam of light). The term wireless lingered for many years, but in 1912 "radio" was used in legislation

Initial Voice Communications

- 1906 First wireless communication of human speech (and music) on December 24, 1906. Fessenden spoke and broadcasted music by radio from Brant Rock, Massachusetts, to ships in the Atlantic Ocean
- Charles Herrold began broadcasting actual audio programming in California in 1910 on a station he built which later become KCBS

First List of Call Signs

- The First Wireless Bluebook of the Wireless Association of America (May 1909) contained a list of the Merchant Vessels, Vessels of the USN, Revenue Cutters, and U.S. Amateur Stations – published by Modern Electronics Publication by H. Gernsback
- Gernsback also started the Radio League of America in 1915

Broadcast Radio

- 1916 – Frank Conrad, an employee of Westinghouse Electric, began transmitting from home in Wilkinsburg, PA with the call letters 8XK
- The station relocated on November 2, 1920 as KDKA, the world's first commercially licensed broadcast station

Amateurs Go To War

- 1917-The US entered WWI
- Amateurs are ordered to dismantle their transmitters and receivers. With no radio operations, 4000 hams joined the army
- QST ceased publication

Private Wired Networks

Amateurs operating private telegraph lines, wanted to expand their range without having to ask for permission to string their wires.

Amateur Telegraphers, from the August 6, 1892 Electrical Review, reviewed a plan in Cranford, New Jersey to interconnect 30 locations by telegraph lines

Early Legislation

In 1910, Senator Chauncey Depew (NY) introduced a bill which would have prohibited amateur radio experimentation - fearing that hams would cause communications interference to the US Navy. ***Fortunately, this bill was defeated***

Early Legislation

The Wireless Ship Act of 1910, required all ships traveling over 200 miles off the coast and carrying over 50 passengers be equipped with wireless radio equipment with a range of 100 miles. The legislation was prompted by a shipping accident in 1909, where a single wireless operator saved the lives of 1,200 people

Early Legislation

- The Titanic disaster pointed out the need for additional Wireless Regulation
- The Radio Act of 1912:
 - Limited "private stations" (i.e. amateurs) to only 200 meters - The number of "private stations" drops from an estimated 10,000 to 1200
 - Mandated that all radio stations in the United States be licensed by the federal government
 - Mandating that seagoing vessels continuously monitor distress frequencies
 - Set a precedent for international and federal legislation of wireless communications

Early Legislation

- The earliest allotment of call letters was also made at the 1912 London International Radiotelegraphic Convention
- The call letters of stations in the international system must each be formed of a group of three letters, which shall be distinguishable from one another. The Convention made a partial allotment of call letters among nations that signed the Convention

Early Legislation

- 1912 is significant to the US and certainly to amateur radio worldwide. Ham radio achieved a true level of legitimacy that year
- Recognition of ham radio operators as a group and the fact that laws and rules were put in place to regulate operation, designate frequencies and introduce licensing truly gave impetus to the hobby, while recognizing contributions to the growth of radio technologies

Early Legislation

- 1927-The Radio Act of 1927 created the Federal Radio Commission. The word "amateur" is used for the first time in a Federal Statute
- The International Radiotelegraph Conference is held in Washington. 70 Nations send representatives and International call sign prefixes are assigned

Federal Radio Commission

- Although the Commission's primary responsibility was radio, on February 25, 1928, Charles Jenkins Laboratories of Washington, DC, became the first holder of television license W3XK from the Federal Radio Commission
- There were even a few amateur radio stations authorized to broadcast television including Mel Dunbrack, W1BHD-TV, who began broadcasting mechanical television in the 1920s, and Truett Kimzey, W5AGO, in March 1934.

Legislation

- 1933-1934--The Communications Act of 1934 creates the Federal Communications Commission
- Amateur Licenses are reorganized into Class A, Class B, and Class C

History of FM Transmission

- In the late 1920's, the concept of FM was known, but it was widely believed to be impractical, if not impossible
- Edward Armstrong, proved them wrong, and by 1933-34 had developed an operational, noise free, wideband FM system. He offered it to RCA, which had the first right of refusal. – they refused
- Armstrong turned to GE. In Schenectady, NY, he found an ally in W.R.G. Baker, a GE Vice President, who saw the potential in FM

History of FM Transmission

- GE's helped to develop FM, and pushed the FCC to allocate a slice of the VHF spectrum for FM broadcasting (42-50 Mc)
- They set up the first FM broadcasting station-W2XMN in Alpine, NJ. Followed by W1XPW in Meriden, CT, and W2XOY in Schenectady in 1939-1940

FM Broadcast Band

- In January 1945 the FM Broadcast band moved to 84-102 MHz. from 42-50 MHz which made every FM station and receiver obsolete
- Edwin Armstrong, inventor of the Regenerative, Superregenerative and Superheterodyne receivers, and the Father of FM was not happy with the change
- He knew that David Sarnoff of RCA was behind this, as RCA wanted television in the frequencies now occupied by FM. RCA said that FM should be moved higher in frequency to avoid the Sporadic E skip

History of Television

- David Sarnoff rose from a telegraph boy and then a wireless operator. He copied the "Olympic" wireless signals about the doomed "Titanic", and had risen quickly in the Marconi organization, and was with RCA from the start
- David Sarnoff had watched the progress of FM. However, he had other plans for RCA. Sarnoff was convinced that television was the future and radio was the past
- Throughout the 1930's, he had poured millions of RCA's dollars into an all electronic television system, to replace the crude mechanical "spinning disk" sets that were in the experimental stage. By the late 1930's, he had a viable, all electronic system ready to go

History of Television

- The first TV broadcast aired was the dedication of the RCA pavilion at the 1939 New York World's Fairgrounds introduced by Sarnoff
- April 30, opening day ceremonies was the first major production, with a speech by President Franklin D. Roosevelt, the first US President to appear on TV. These telecasts were seen only in New York City, since NBC television had only one station at the time, W2XBS Channel 1, now WNBC Channel 4. The broadcast was seen by an estimated 1,000 viewers on the 200 TV sets which existed at the time

History of Television

- In 1940, CBS was looking for a way to get past Sarnoff and RCA's stranglehold of patents on their all electronic black and white system
- Peter Goldmark came up with a solution using a spinning disk (which he called a color wheel) with red, blue and green filters, which was scanned by an electron beam. On the receiving end, a similar "color wheel" synchronized to spin at the same speed detected the color signal
- On August 28 and September 4, 1940, CBS gave demonstrations of their color TV system to the FCC. The FCC was very impressed with the vivid, sharp clarity of the colors they saw on the screen. By contrast, RCA's color system was an embarrassing flop

Amateur Television

- Fast Scan (ATV) is used on 420 Mhz and higher bands using standard signals
- Slow Scan Television (SSTV), is used on HF frequency bands and has a narrowband structure. It is not decodable by a commercially available television receiver

Satellite Communications

- More than 70 Amateur Radio satellites have been launched over four decades
- OSCAR-1, was launched on December 12, 1961 by the Radio Amateur Satellite Corporation (AMSAT) headquartered at Washington, D.C. It's membership is composed of volunteer spacecraft designers, builders and operators across America and around the world

Digital Voice

- In the 1960's commercial communications changed. Voice transmissions were digitized using CODECs enabling multiple signals to be time division multiplexed over one signal path using T1 (1.54 Mbps) and T3 (45 Mbps equipment
- Using SONET over fiber cables allowed for higher multiplexed signals

Digital Data Signals

- Teletype uses a code of 5 bits (marks and spaces) to encode letters at 30-100 Bps
- Teletype (RTTY) Exchange systems such as Telex and TWX are real-time circuits between two machines
- Early users were: Western Union, UP, API, National Weather Service, Police and the military
- Replaced by the internet by commercial users but still used by amateurs

Packet Technology

- Serial digitized voice and data signals could be chopped up into small units and transmitted. The receive unit could reconnect the units
- The initial standard protocol (TCP/IP) was used for a specific application – the Internet
- Another communications protocol (X.25) was adopted for general communication uses

The difference was packet delivery guarantee

Packet Transmission

- The use of TCP/IP on amateur radio using packet radio networks, preceded the appearance of the public Internet
- The class A 44 net block of 16.7 Million IP addresses was set aside for amateur radio users worldwide, having been secured in the 1970s by Hank Magnuski
- Address complexity doomed this approach so amateurs focused on X.25 and created AX.25 for digital communications

Present

1980s to 2013



Fork in the Road

- In the 1980's Commercial Communications took a huge change of direction due to "Divesture"
- Bell Labs and other R&D facilities stopped research into new technologies and worked on service applications that would be profitable or increase in bandwidth/capacity

Technologies - Commercial

Using Wired, Wireless, Cell and Satellite media:

- ✓ Analog Voice – for local service
- ✓ Digitized Voice – entry to voice networks
- ✓ Packetized Voice- voice networks

VoIP – used for voice networks

-Non-guaranteed voice VoIP – Skype, etc.

-Guaranteed voice delivery VoIP - Verizon, ATT, etc.

(Uses VPN/Tag protocol)

Technologies - Amateur

Using Radio and Satellite media:

✓ Analog Voice

- Amplitude modulation (AM)

- Double Sideband Suppressed Carrier (DSB-SC)

- Independent Sideband (ISB)

- Single Sideband (SSB)

- Amplitude Modulation Equivalent (AME)

- Frequency modulation (FM)

- Phase modulation (PM)

✓ Digital Voice

- APCO-25 –Commercial system being tried on Amateur radio

- D-Star –Used on VHF and UHF for connectivity to the Internet

Technologies - Amateur

✓ Digital Data

- Phase-shift keying:
 - 31 baud binary phase shift keying: PSK31
 - 31 baud quadrature phase shift keying: QPSK31
 - 63 baud binary phase shift keying: PSK63
 - 63 baud quadrature phase shift keying: QPSK63
- Multiple frequency-shift keying (MFSK) modes such as
 - FSK441, JT6M, JT65 and
 - Olivia MFSK
- Discrete multi-tone modulation modes such as Multi Tone 63 (MT63)
- Amateur teleprinting over radio (AMTOR) – Similar to TTY using PSK
- PACTOR

✓ Packet radio - AX25

Digital Services - Commercial

- Unified Communications

Unified communications (UC) is the integration of real-time communication services such as instant messaging, presence information, telephony (including IP telephony), video conferencing, data, call control and speech recognition with non-real-time communication services such as unified messaging (integrated voicemail, e-mail, SMS and fax) and Internet Protocol Television (IPTV)

UC is not necessarily a single product, but a set of products that provides a consistent unified user interface and user experience across multiple devices and media

Digital Services - Commercial

- Cloud Services

Cloud computing is the use of computing resources (hardware and software) that are delivered as a service over a network (typically the Internet). The name comes from the use of a cloud-shaped symbol as an abstraction for the complex infrastructure it contains in system diagrams. Cloud computing entrusts remote services with a user's data, software and computation

Digital Services - Amateur

- **Winlink** – Radio Connection to Internet for E-mail
- **Echolink** – Connects amateurs and amateur stations via the internet for Voice
- **Internet Radio Linking Project (IRLP)** –Links amateur radio stations around the world by using Voice over IP (VoIP) on the Internet
- **Earth-Moon-Earth (EME)** uses the Moon to communicate over long distances
- **Satellite (OSCAR)**- Orbiting Satellite Carrying Amateur Radio
- **Automatic Packet Reporting System - (APRS)** is a radio-based system for real time tactical digital communications of information and location of immediate value

Future



Amateur Radio Future

- Increased licensed operators
 - Focus on Emergency Communications
- Increased networks
 - Special interest groups
 - Push for increased frequency allocation
- Digital networks and technologies increasing
- More use of alternative communications
 - TV
 - Packet
 - Internet

Commercial Communications Future

- Commercial Communications
 - Make money through increased capacity and services

Public Service

- Public Emergency Radio
 - ARES
 - ACS
- Emergency Radio Networks
 - Red Cross
 - Religious Based Networks

Questions

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