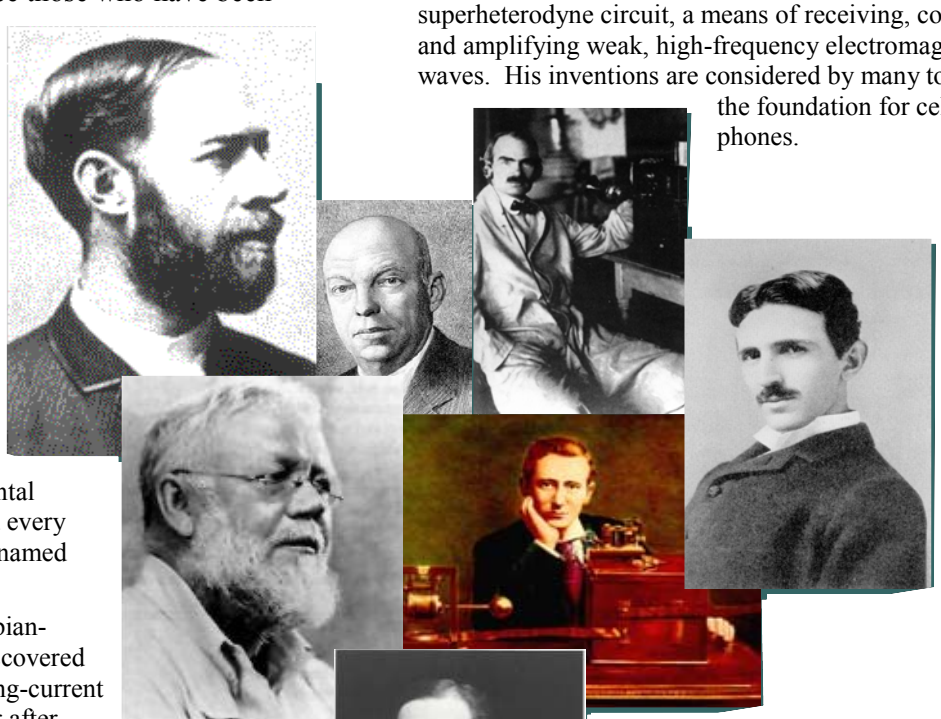


A Short History of Radio

With an Inside Focus on Mobile Radio

PIONEERS OF RADIO

If success has many fathers, then radio is one of the world's greatest successes. Perhaps one simple way to sort out this multiple parentage is to place those who have been given credit for "fathering" radio into groups.



Clockwise from bottom-Ernst Alexanderson (1878-1975), Reginald Fessinden (1866-1932), Heinrich Hertz (1857-1894), Edwin Armstrong (1890-1954), Lee DeForest (1873-1961), and Nikola Tesla (1856-1943). Center color photo is Guglielmo Marconi (1874-1937).

The Scientists:

- Henirich Hertz—this German physicist, who died of blood poisoning at age 37, was the first to prove that you could transmit and receive electric waves wirelessly. Although Hertz originally thought his work had no practical use, today it is recognized as the fundamental building block of radio and every frequency measurement is named after him (the Hertz).
- Nikola Tesla—was a Serbian-American inventor who discovered the basis for most alternating-current machinery. In 1884, a year after coming to the United States he sold the patent rights for his system of alternating-current dynamos, transformers, and motors to George Westinghouse. He then established his own lab where he invented, among other things, the Tesla coil, an induction coil widely used in radio.
- Ernst Alexanderson—born in Sweden, this remarkable inventor developed the first alternator to make transmission of speech (as opposed to the dots and dashes of telegraphs) possible. It is said that this holder of 344 patents "virtually invented everything General Electric did in the field of AM, FM, and TV."
- Reginald Fessenden—this Canadian spent much of his working life in the U.S. where he developed a way to combine sound and radio carrier waves. His first effort to transmit this mixed signal— to a receiver where the carrier wave would be removed and the listener could hear the original sound— failed. However, in 1906, using Alexanderson's Alternator, Fessenden made the first long-range transmission of voice from Brant Rock, MA.
- Edwin Armstrong—this WWI Army officer, Columbia University engineering professor, and creator of FM radio invented the regenerative circuit, the first amplifying receiver and reliable continuous-wave transmitter; and the superheterodyne circuit, a means of receiving, converting and amplifying weak, high-frequency electromagnetic waves. His inventions are considered by many to provide the foundation for cellular phones.

The Businessmen:

- Guglielmo Marconi—this Italian creator spent most of his working life in England where he introduced many of the first uses of wireless telegraphy to European navies. His radio apparatus is widely considered to be the reason that over 700 people survived the Titanic disaster in 1912—instead of dying as they likely would have if ships at sea were still using carrier pigeons to communicate over great distances.
- Lee DeForest—credited with being the "father of American radio." DeForest was a direct competitor to Marconi at the turn of the century (1899), when he was the chief scientist at the U.S.'s first radio firm—American Wireless Telephone and Telegraph—until Marconi took over the company's assets in 1912 after a series of financial scandals. Although he held 300 patents, DeForest's greatest technological contribution is considered to be his 1906 "Audion" vacuum tube.

GENERAL RADIO TIMELINE

1885	Heinrich Hertz proved that electricity can be transmitted in electromagnetic waves. He conducted experiments in sending and receiving these waves during the late 1880s.
1891	Radios (what we'd call wireless telegraphs today) began to appear on ships at sea. This reduced the isolation of the ships thus improving both reliability and safety.
1892 to 1893	Nikola Tesla wirelessly transmitted electromagnetic energy. He made the first public demonstration of radio in St. Louis in 1893.
1896 to 1897	Guglielmo Marconi filed for patent protection of his radio apparatus. He established the Wireless Telegraph and Signal Company in 1897.
1899	The R.F. Matthews was the first ship to request emergency assistance using a wireless apparatus (Marconi's system).
1901	First transAtlantic signal sent-by Marconi from Ireland to Canada.
1902	Amateur (today known as "ham") radio introduced to the U.S. via a *Scientific American* article on "How to Construct an Efficient Wireless Telegraphy Apparatus at Small Cost."

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MOBILE RADIO AT WORK

There are hundreds, if not thousands, of uses of radio spectrum and technology. Everything from baby monitors and broadcasting to radar and radio beacons are applications of radio. These two pages focus on the first historical use of radio—mobile radio.

Detroit police radio car with antennas running across the roof (1921).

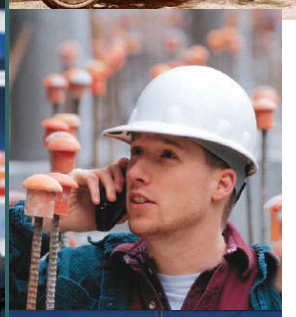


Robert Loraine was the second pilot to demonstrate wireless transmission from a plane (1910).



But mobile radio isn't just for safety purposes today. Taxi drivers, tow truck dispatchers, and package delivery services are just a few of the businesses that make innovative use of mobile radio.

Technologies that underpin mobile radio were first put to work in the 1890s on behalf of ocean-going ships, which had previously relied on carrier pigeons and flags for their communications.

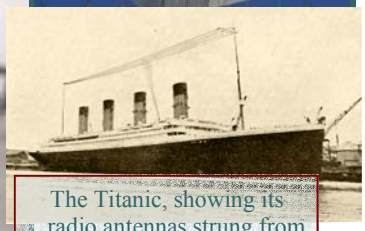




In 1910, Frederick Baldwin and John McCurdy were the first to trail an aerial behind their bi-plane to demonstrate radio's uses for aviation.



In 1921, Detroit police commissioner William Rutledge was the first public safety official to use radio equipped vehicles.



The Titanic, showing its radio antennas strung from bow to stern (1912).

Today, maritime, aviation, and land-based mobile radio systems remain among the most important non-broadcast uses of the radio spectrum.

In fact, mobile radio has become such a key tool in all business communications that one of the FCC's major challenges is ensuring efficient and effective use of the radio spectrum by business, while guaranteeing the reliability and interoperability of all public safety radio uses.

In finding a way to make this all work, the FCC helps make America a safer and better place to live.

CELL PHONES—ONE OF TODAY'S MOST POPULAR USES OF MOBILE RADIO

Cellular phones, including Personal Communication Service devices, may seem like one of the newest land mobile services, but the idea of a mobile radio telephone has been around for quite a while.

In the early 1920s both the Marconi company and the Bell Laboratories were testing car-based telephone systems. Bell Labs believes its 1924 system was actually the first two-way, voice-based radio telephone.

Other predecessors to today's cell phones included the radio telephones used by the military during both World Wars.

The science behind cell phones, as we know them today, was clearly known by 1945 as evidenced by a *Saturday Evening Post* article, "Phone Me by Air," which quoted FCC Commissioner E.K. Jett on frequency reuse for "small zone systems." He said, "In each zone, the…frequencies will provide from 70 to 100 different channels, half of which may be used simultaneously in the same area without overlapping."

Although not yet a cellular system, in 1946 Bell initiated America's first commercial mobile radio telephone system. Bell, as well as Ericsson, Nokia, and Motorola then went on to develop cell phone technologies throughout the 1950s and 1960s. The FCC approved a major allocation of spectrum for mobile radio systems in 1970. In 1973, Motorola's Martin Cooper was credited with the invention of the first personal, handheld cellular radio telephone.

The year after the FCC made its final 1982 decision on spectrum for cellular systems, Ameritech Mobile Communications (Chicago) and CellularOne (Washington, D.C.) became the first operational commercial cellular providers in the United States.

Personal communications for people on–the-go, not just those in vehicles, evolved further in the 1990s and continues growing today.



Clockwise from top right—a WWI mobile military phone, of the type Edwin Armstrong used to develop his ground-breaking inventions; Marconi's 1922 car phone system with receivers, amplifiers, and speakers mounted on the running boards; Martin Cooper with his 1973 cellular telephone; older and newer generations of mobile radio telephones; and Bell Labs' 1924 test of a mobile radio telephone.

WHERE TO LEARN MORE

Find out more about the history and technology of radio by visiting any of the following sites:

- Early Radio History—http://earlyradiohistory.us
- Engineering history—http://www.ieee.org/organizations/history_center/
- Electromagnetic spectrum—http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html
- Radio History Society—http://www.radiohistory.org/
- Surfing the Aether—http://www.northwinds.net/bchris/
- Marconi Calling—http://www.marconicalling.com/front.htm
- Edwin Armstrong—http://users.erols.com/oldradio/index.htm
- Mobile Telephone History—http://www.privateline.com/index.html
- Mobile Services—http://www.ntia.doc.gov/openness/sp_rqmnts/mobile1.html
- FCC Regulation of Wireless Services—http://wireless.fcc.gov/services/

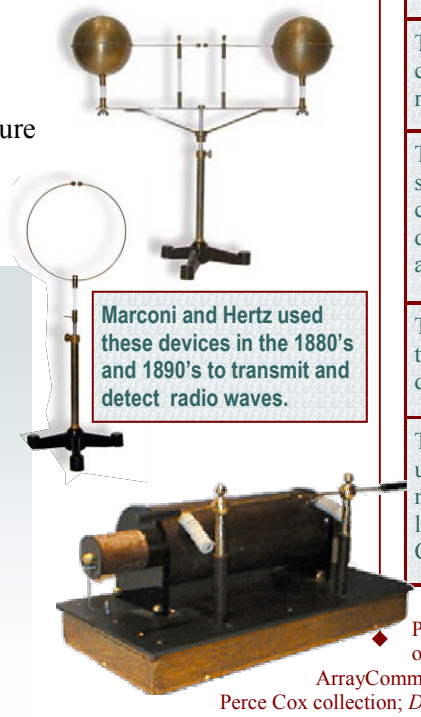
WIRELESS—ONE WORD, MANY MEANINGS

While a rose may smell the same regardless of what it's called, the term "wireless" has referred to distinctly different things throughout the past century. The one common characteristic among all these uses of the word is that they all describe a communication product that sends or receives information via electromagnetic waves.

- 1900s—sending a wireless meant you were aboard a ship sending a telegram to the home office to let them know when you'd arrive.
- 1920s—listening to the wireless meant you could hear the Navy's time and weather reports, USDA's crop and market news, as well as concerts, lectures, and sermons.
- 1980s—talking on your wireless unit meant you had a cellular or PCS telephone.
- 2003—using wireless likely means taking a picture using your digital 3G-enabled cell/PCS phone and sending it, along with a text message, to a friend's Internet email address.

Albert Einstein, when asked, in 1938, to explain radio, is widely reported to have said:

"You see, wire telegraph is a kind of a very, very long cat. You pull his tail in New York and his head is meowing in Los Angeles. Do you understand this? And radio operates exactly the same way: you send signals here, they receive them there. The only difference is that there is no cat."



Marconi and Hertz used these devices in the 1880's and 1890's to transmit and detect radio waves.

TIMELINE

Reginald Fessenden is the 1st to transmit a program of speech and music.	1906
Lee DeForest produces the "Audion," a triode vacuum tube that allowed for amplification of radio signals.	1906
First radio transmission from an airplane.	1910
Federal regulation of American airwaves begins. Amateurs had to be licensed; ships had to have a radio and trained operators.	1912
All U.S. radio stations not needed by the government are closed as WWI begins.	1917
Edwin Armstrong patented the Super Heterodyne Receiver based on work he did as an officer in the Army Signal Corp.	1918
The Federal Radio Commission established to bring order to chaotic airwaves.	1927
Cellular radio telephony, with call handoff and frequency reuse, was conceived at Bell Laboratories.	1947
The FCC reallocated TV channels 70-83 for mobile radio services.	1970
The FCC permitted spread spectrum, the technology of choice for many of today's digital, commercial cellular and PCS services.	1985
The FCC reallocated spectrum at 2 GHz for emerging digital mobile services.	1992
The first cellular system using digital CDMA technology was commercially launched by QUALCOMM.	1995

Photos courtesy of: American Institute of Physics, Emilio Segré Archives; ArrayComm; AT&T History Collection; David Massey, Perce Cox collection; *Detroit Free Press*; IEEE Canada; IEEE History Center; John Jenkins and the Spark Museum; Mike Katzdorn; Marconi PLC; Tesla Memorial Society; Thinkstock; and Thomas White.