

## NERVOUS SYSTEM: THE GLAMOUR GIRL'S SECRET PRIVACY WEAPON

'Nervous System,' which approaches data privacy and cybersecurity issues from the context of history, explores how movie star Hedy Lamarr was part of the frequency-hopping technology implementation still used today.

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*With the aggressive pace of technological change and the onslaught of news regarding data breaches, cyber-attacks, and technological threats to privacy and security, it is easy to assume these are fundamentally new threats. The pace of technological change is slower than it feels, and many seemingly new categories of threats have actually been with us longer than we remember. Nervous System is a monthly blog that approaches issues of data privacy and cybersecurity from the context of history—to look to the past for clues about how to interpret the present and prepare for the future.*

During World War II, Allied forces had a powerful technological advantage: using radio signals to guide torpedoes from a safe distance away. But this technology had an Achilles heel. If the good guys could use radio to guide an explosive device, then the bad guys could use the same radio waves to jam or hijack the same device.

Then one day, a bright inventor came up with a clever solution: a way to insulate the radio control signal so that the transmitter and receiver remained in touch but were inaccessible to outside interference.



Hedy Lamarr publicity photo for the film *The Heavenly Body*, 1944.

The inventor patented the device and showed it to the Navy... which turned it down. Perhaps the military was skeptical of an idea brought to them by a woman—a movie star at that, the fabled “most beautiful woman in the world.” Hedy Lamarr would have the last laugh, though. Her idea is still in use today—and you’ve used it yourself, since the same frequency-hopping technology is found in cell phones and Wi-Fi. All invented by a movie star, and she never made a dime on it.

Lamarr was an Austrian actress who fled the Nazis and an arms-deal-

ing husband to start anew in Hollywood. But by 1940, tired of being typecast as exotic femme fatales and restless with the way Hollywood only valued her for her looks, she was thinking about not just breaking her contract, but also quitting acting altogether and going to Washington, D.C., to join the newly formed National Inventors Council. She was, you see, an engineer.

As the story goes, she met scientist George Antheil at a dinner party and allegedly approached him with a question about glandular stimulation. Whether breast augmentation was the

icebreaker between them or not, they quickly formed a working collaboration. Their mutual interest was... remote-controlled guidance systems.

Lamarr's idea was to protect a radio signal by having it skip across a range of frequencies. The signal would be safe from jamming or hijacking, but required a secure synchronization with the receiver, jumping across the same frequencies in time with the transmitter.

Imagine that one of Lamarr's movies, say *The Strange Woman*, is playing on television. You tune to that channel to watch it, but someone who wants to stop you can effectively blot it out because they know which channel to block. Now, imagine instead that the movie is not shown on just one channel but bounces around. It starts on channel 90, then jumps to 22 to 115 to 53 to 81 and on and on. If you could somehow keep up, clicking away furiously at your remote control and maintaining synch with the show, you could watch the movie without being bothered that the signal was jumping all over the place. That was the basic idea, in a crude nutshell, but the trick was synchronizing the frequency shifts.

Lamarr and Antheil used player piano rolls to do it, and spread their control signals across a spectrum of eighty-eight frequencies—the same as the number of keys on a piano. It was a simple, elegant solution, and with the help of Charles Kettering, director of research for GM and head of the National Inventors Council, they patented their device as “Secret Communications System” and showed it to the Navy.

The advantages of the Secret Communications System, or “Frequency-

hopping spread spectrum” (FHSS) as it is known today, are many. Skipping across frequencies insulates the transmission from the effects of many kinds of interference, because any interference is localized and will only be a factor during the brief interval that the transmission passes through that frequency, so the overall effect is suppressed. This also works in reverse—an FHSS signal and other unrelated transmissions can share a frequency band without interfering too much with one another. Eavesdroppers attempting to intercept an FHSS signal will be frustrated unless they have the frequency-hopping key.

The Navy, however, turned away Lamarr and Antheil. Lamarr kept her patent, but there is no indication she ever built a working version.

To hear Lamarr tell the story, their mistake was adapting ideas from the world of music into something with military applications. She felt the Navy brass was too narrow-minded to make the conceptual leap and that they probably thought Lamarr was suggesting they actually install pianos inside each torpedo. There is also the possibility that the military was skeptical of an idea brought to them by a woman, a movie star, an Austrian.

The military may also have been unmoved by an idea they had seen before. Frequency-hopping had been suggested, experimented with, and even prototyped by other inventors. Guglielmo Marconi, inventor of the telegraph, had toyed with the idea. Nikola Tesla alluded to it in his writings. Polish inventor Leonard Danilewicz tried to interest the Polish military in the idea in 1929 and received the same cool

response. Danilewicz later described frequency-hopping as a “truly barbaric idea,” which suggests he may not have been the best salesperson for the concept.

At any rate, it's a curious coincidence that in the late 1950s, as soon as Lamarr and Antheil's patent expired, suddenly the US military decided the thing *did* have potential and rushed to adapt it to incorporate transistor technology. The ships sent to blockade Cuba in 1962 used Lamarr's invention to secure their communications. Her invention is still in use today in defense communication satellites—and, for that matter, frequency-hopping is found in Bluetooth and Wi-Fi technologies, hobbyist radio-control devices, and communications systems that operate in the 2.4 GHz band.

Lamarr returned to the movies and eventually became a movie producer in addition to a star. In 1997, she received the Electronic Frontier Foundation's Pioneer Award, for people who have made significant contributions to empowering individuals through computer science. After her passing in 2000, she and Antheil were posthumously inducted into the National Inventors Hall of Fame.

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