

# Telstar, A History

By John R. Pierce

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At the time of Echo and Telstar, Frederick Kappel, a large, determined, direct and good-natured man was Chairman of the Board of AT&T. I had first met Kappel a few years earlier, when he was president of Western Electric.

At that time work on psychology and related matters was in my division. Someone at AT&T doubted that this was a useful field of research for Bell Labs. Fred Kappel was appointed head of a committee that spent three days with us investigating the matter. He and the others listened to a sequence of presentations and talked with us. There must have been a favorable report, for work on psychology continued.

I saw Kappel occasionally after that. Sometimes it was at the annual "Cabinet" meetings, held for a few days at some quiet, remote location, which all executive directors and those of higher rank attended.

One meeting I do remember very distinctly. I encountered Kappel in the halls of the Murray Hill laboratories. He stopped me and said with a broad smile, "Look what you've got me into, John." What I had got him into was giving enthusiastic talks about satellite communication.

Echo had created a sensation in the nation, and within the Bell System as well. The public relations department had made of it everything they could; indeed, someone said that they had "taken it away from NASA". Everyone was convinced that satellite communication would be a part of the Bell System's future, and that the next step would be to launch an active satellite.

In the research department we had started work toward an active satellite at a modest level even before the launch of Echo. This work followed a satellite design set down by Roy Tillotson on August 24, 1959. The proposed satellite would have been at an altitude of 2,500 miles. It would have had an essentially omnidirectional radiation pattern, and would have had a transmitter power of one watt. The plan was to use broad-band frequency modulation, with a hundred-megahertz bandwidth. This would allow the transmission of one TV channel or of several hundred telephone channels. When, much later, I showed Tillotson's Memorandum to a man in the development area during work on Telstar, he was surprised at how close the satellite Tillotson had designed was to Telstar itself.

The research department of Bell Laboratories was small, around a tenth of the whole Laboratories, and those who could devote their time to satellite work were few. The enthusiasm for producing an effective active satellite was great. In the summer of 1960 the primary responsibility for an active satellite experiment was transferred to one of the vice-presidential areas of development, headed by McDavitt, a calm and able man. A. C. Dickieson was the executive director of the division responsible for the work, and Gene (E. F.) O'Neill was the project engineer for what became Telstar.

Telstar involved problems of a scope and magnitude far beyond any we had faced in Echo. The transistor and the traveling-wave tube were key components, but they had to survive a rocket launch and survive for a long time in space. The space background that the Whippany laboratories had acquired through their military work, especially, work on the Nike missile, was invaluable to Telstar.

Because of past relations with the Bell System, including participation in transatlantic telephone cable projects, the British and French telephone organizations (government operated) were anxious to cooperate. Indeed, they eventually built at their own expense earth stations which received and transmitted the first transatlantic television programs sent via Telstar.

In its many departments with a wide range of expertise, Bell Laboratories had the technology and manpower needed to build a reliable active satellite. AT&T was anxious to provide the funds, and could make arrangements with foreign telephone administrations. The sticky problem was to find a way to get an active satellite launched.

NASA was the obvious source of a launch vehicle. On November 4, 1958 a group of Bell Laboratories people visited NASA headquarters in Washington. I was there chiefly because of my work on Echo. The other Bell Laboratories people included, I believe, Julius Molnar, executive vice president of Bell Labs, and people from the development department.

We had what seemed to me at the time a very friendly talk with Hugh L. Dryden, then deputy administrator of NASA, Robert Seamans, Jr., associate administrator, and Leonard Jaffe, director of communications systems at NASA. Jaffe was the man we had dealt with in the Echo project. I had known Dryden for some time through the National Academy of Sciences; I think that he was Home Secretary at that time. I believe that Seamans was new to me, though I have come to know him well since.

At this meeting we were told that NASA planned to contract for its own experimental satellite (Relay), and we gathered that it would be a good idea to bid on Relay, even though AT&T was prepared to bear the full cost of the satellite and the launching.

Naively, I told my Bell Laboratories colleagues, "They're trying to help us," and I urged bidding on the NASA project. But, why should NASA try to help Bell Labs? The responsibility of NASA was NASA. Also, Bell Labs had got more credit for Echo than NASA itself had. Dryden was a wonderful man, and so is Seamans. Bidding on Relay may have been a good idea. My conviction that NASA was primarily "trying to help us" was naïve.

Various companies came forward with proposals for launching the AT&T satellite for a fee, but NASA really controlled the boosters. Thus, when a request for a proposal on Relay was finally received on January 4, 1961, AT&T decided to bid on it, even though this meant a substantial change in plans in order to meet NASA specifications, including a change in the microwave frequencies to be used. AT&T put in its bid on Relay on March 20, 1961. On May 18 it was announced that the contract had gone to RCA (Radio Corporation of America). Choosing among piles of paper is tricky. Relay was built and launched after Telstar, and so received comparatively little notice. In my judgment, it was inferior to Telstar in design and construction.

AT&T was firmly committed to carrying Telstar through, but how to get it launched? When V. S. Chernov of the Lebedev Institute in Moscow visited Bell Laboratories in April of 1961, Rudi Kompfner and I asked if we couldn't get a Soviet booster to launch Telstar. He said that he considered the idea impractical. He himself couldn't even take a skindiving outfit back to the Soviet Union from the United States.

A very senior Bell Labs man visited an Air Force installation (I forget which one), with the idea that the Air Force might supply a launch vehicle. He was told that they already had the communication satellite problem well in hand—they had devised a scheme by means of which two satellites could be nested together and launched at the same time. This at a time when designing and building a satellite that would have a high probability of surviving and functioning in space was the major problem!

Some of the most competent and astute technical men I have met have been Air Force officers, but the Air Force also has its dreamers who confuse sketches and the encouragement of those in the aerospace industry with reality. Unfortunately, the Bell Labs man was taken in for the moment. Nothing came of this but criticism by outsiders who knew better.

Negotiations with NASA continued, though I knew nothing of the details. Finally, on July 27, 1961 NASA agreed to supply, AT&T with a booster. The price was \$3.5 million per launch, a worldwide license to use all inventions in the satellite field made during the course of the work, and a right to license anyone else

to use these inventions. We felt quite confident that Telstar would succeed. The Western Electric guidance equipment that was used had been successful in many launchings. There was more experience with the Thor Delta booster (later called the Delta vehicle) than there had been when Echo was launched. We felt sure that the satellite would function properly in orbit.

On the evening of July 10, 1962 there were reporters and guests at Cape Canaveral (now Cape Kennedy), at Andover, Maine, where a new ground terminal had been built, in Washington, D.C., and at Crawford Hill, where various research department people, myself included, were ready to view Telstar transmissions using the old Echo receiving terminal. And, the English terminal at Goonhilly Downs and the French terminal at Pleumeur Badeau were ready and waiting.

With two exceptions, everything worked perfectly. One was a little trouble with transmission on the ground. The other was that the British definition of right-hand and lefthand polarization was contrary to that used by the rest of the world. Initially their ground station was set up to receive the wrong polarization. Transmission between France and the United States was excellent. Care in planning and construction had insured success.

The confusion about polarization was soon corrected. On July 23, transmission via Telstar gave the world its very first live international television program. Viewers in the United States and Europe saw pickups from Britain, France and the US. A US Information Agency poll showed that in the weeks after this event, 82% of the people in Britain could identify Telstar by name, 79% knew that it was an American achievement and 59% had seen the program beamed from the United States. In a message broadcast to the people of the Commonwealth on Christmas day, 1962, Queen Elizabeth referred to Telstar as "the invisible focus of a million eyes."

In the view of AT&T and the telephone administrations of Britain and France, Telstar was a first successful step to an early commercial satellite link between the United States and Europe. A higher power intervened. On August 31, 1962 Congress passed, and the president signed, the Communications Satellite Act, which gave a new organization, COMSAT (Communications Satellite Corporation) an eternal monopoly of United States participation in international communication satellite transmission.

The Communication Satellite Act legislated the Bell System out of international satellite communication. AT&T eventually entered domestic satellite communication, which the Act did not cover. The Act legislated me out of satellite work abruptly and finally. This made me feel awful.

Satellite communication was an interlude in my technical life. Its roots were as much in my science-fiction background as in my earlier work at Bell Labs, though my research on traveling-wave tubes was important to Telstar and subsequent active satellites, and the Holmdel Laboratory, which was in my division, provided just the sort of expertise necessary to Echo and some aspects of Telstar.

My work on satellites led to speaking engagements, honorary degrees and various awards. Yet the years of my active concern were few. Despite the fact that I talked and wrote about satellites in 1954 and 1955, I would date my actual participation in satellite work from the launch of Sputnik on October 4, 1957 to the passage of the Communications Satellite Act on August 1, 1962.

Though I have told almost everything about my direct involvement, I find that I can't leave the subject without saying something more.

Commercial satellite communication came into being with the launching by COMSAT of Intelsat 1, or Early Bird on April 6, 1965. Unlike Telstar, Early Bird was a synchronous satellite, hanging 22,300 miles above one spot on the earth's surface as the earth rotated and the satellite revolved around it in the same direction. Early Bird was built by Hughes Aircraft, and in design it was very close to the Hughes Syncom 2, the very first synchronous communication satellite, that NASA launched on July 26, 1963. How was it

that Syncom, a synchronous satellite, was a colossal success while Advent, a proposed synchronous satellite, had been a dismal failure?

The success of Syncom was made possible by a design so ingenious and simple that this synchronous satellite, which had an active station-keeping and attitude-control system, was lighter than Telstar, which did not. This, and some advances in propulsion, made it possible for the Thor Delta vehicle which had put Telstar in a lower orbit to launch Syncom into a much higher synchronous orbit.

I am somewhat embarrassed to recount that Harold Rosen and his colleagues Don Williams and Tom Hudspeth visited the Holmdel Laboratory in 1960, when we had Tillotson's proposal for a lower orbit active satellite in mind. Rosen told us about his highly ingenious design for a synchronous satellite. He told us that he hoped that his satellite could be launched with a Scout rocket (an early small solid-fuel booster) using four upper stages. This didn't make much sense to me. Also, he showed pictures of a large antenna built into the ground, aimed fixedly at the point in the sky over which his satellite would hover. This was irrelevant.

The real problem was the difficulty and cost of the satellite, not the cost of a ground antenna, tracking or not tracking. I concluded that Harold Rosen was irresponsible, and I didn't pay enough attention to what he had to say. Actually, he was (and is) a tremendously ingenious, inventive, careful engineer. When he saw us, he was desperate to get his satellite built and launched, and he used every argument he could think of, good and bad.

Satellite communication via synchronous satellites is an amazing resource. It gives us visual access to all of the world. It links together the telephone networks of all nations, small and large. It is our best resource in mobile communication. But, it is not as powerful for communication within and between densely populated areas as are optical fibers. Further, two-way satellite traffic suffers some degradation through the time delay of almost a third of a second to the satellite and back, or almost two thirds of a second round trip.

A satellite conversation with echo suppressors is pretty bad. Echo cancellers make two-way satellite telephone circuits only a little inferior to a ground circuit, fiber or wire. Still, I note in television interviews conducted via satellite that the person at the far end gives the impression of hesitating before answering a sharp question. Really, he hasn't heard the question yet.

Why were communication satellites as we now know them not thought of earlier, in science fiction, for instance? The reason is that writers about space were preoccupied with men in space. The earliest references to communication in space, which are traced in Arthur Clarke's book, *Ascent to Orbit, a Scientific Autobiography*, involve communication of men in satellites with earth. Hermann Oberth's first book, *The Rocket Into Planetary Space* (1923) suggests that men in a space station could communicate with earth, including ships at sea, with candles at night and hand-mirrors by day. Presumably, Oberth felt the radio of his day impractical in space.

Captain H. Totocnik, writing under the name Hermann Noordung in 1928, described a manned space station in synchronous orbit and assumed that there would be radio links between earth and the station.

In a 1942 science-fiction story, George O. Smith told of a manned space station at the Trojan position, sixty degrees ahead of Venus, used to maintain communication between Venus and earth when the sun blocked the direct path.

In the February, 1945 issue of *The Wireless World*, Clarke published a letter suggesting that synchronous satellites could give television and microwave coverage of the entire planet. In the October, 1945 issue of the same journal he published *Extra-Terrestrial Relays*, in which he elaborated on the idea of worldwide communication through manned space stations in synchronous orbit, something that we still don't have.

Who first had the idea of unmanned satellites of the sort we actually do have? I don't know. George Brown has written me that in 1935 he and Loren Jones, then manager of transmission engineering at RCA, were tremendously enthusiastic about synchronous communication satellites, but their enthusiasm was recorded only in notebooks.

When I talked about unmanned communication satellites in 1954 and wrote about them in 1955, I didn't think of this as a new idea, but only as a good one.

I received the Marconi International Fellowship, chiefly for my work on satellite communication. Clarke received the same award later. A fellow I know at COMSAT called concerning Clarke's nomination and asked me what Clarke had done. I said that Clarke had published the first paper about communication satellites, and that I cited it in whatever I wrote.

It took more than writing to convince people that communication satellites would actually provide a useful means of communication. To demonstrate this, someone had to build and launch a satellite.

The very first communication satellite was the United States Government's SCORE (Signal Communication by Orbiting Relay Equipment), launched on December 18, 1958. SCORE functioned for 13 days, until its batteries ran down.

The U.S. Army Signal Corps's Courier project was a further development of the SCORE approach, but it was not launched until shortly after Echo. It operated for only 17 days.

Neither SCORE nor Courier received much public notice. They convinced few if any that communication satellites would have an early and important role in telecommunications.

Echo did, and Telstar clinched the conviction. Koji Kobayashi, chairman of the board of NEC, has told me that at the time Telstar was launched he had been working for some years on improving tropospheric scatter communication, in order to provide communication between Japan and the United States by means of a sequence of repeaters along the Aleutians. Kobayashi was in the United States when Telstar was launched and demonstrated. He saw immediately that his tropospheric scatter idea was outmoded. He learned of Harold Rosen's lonely struggle to promote the synchronous satellite which finally became Syncom. Kobayashi visited Hughes and came to believe that NEC's best role would be to build satellite ground terminals.

Echo was built and launched by NASA. The east-coast ground terminal was designed and constructed by members of the Bell Labs research department, with help from other parts of Bell Labs. Telstar was designed and constructed in the development department of Bell Labs, and by Western Electric. It incorporated suggestions and work of members of the research department.

Echo and Telstar established satellite communication firmly as a part of the future of telecommunications. Neither satellite could have been built and launched without NASA, or without the American missile programs (all the launch vehicles prior to the Space Shuttle were adaptations of ballistic missiles), or without the expertise and hard work of Bell Laboratories, of which I was one employee. What was my part in this?

Had I not been in my position at Bell Laboratories at that time, Echo would not have been launched, and Telstar would not have followed. I was fortunate to be the executive director of the part of the research department most crucial to these undertakings. Better yet, I was on good terms both with my bosses and with the people qualified to do the work. They respected my technical ability and were willing to pursue the opportunity that I pointed out.

Calvin Tomkins wrote a profile of me which appeared in the New Yorker of September, 1963. When I spoke with him he had already talked to others who had worked on Echo. He said to me, with, I thought, a bit of surprise, "They like you." That pleased me greatly. And, if "they" had not liked me, there would have been no Echo or Telstar. –JRP

*John Pierce, father of communications satellites, died on April 2, 2002, at the age of 92. Gifts in memory of Pierce may be sent c/o Chris Chafe, CCRMA/Music Department, Stanford, CA 94305-3076. Checks should be payable to "Stanford University" and have written in the memo: "John Pierce Memorial Fund, c/o Chris Chafe."*