**Dr. Harold A. Rosen**

- Dr. Harold A. Rosen, a founder of the modern communications satellite industry, is a consultant for Boeing Satellite Systems (BSS), the world's largest manufacturer of commercial communications satellites.

- Dr. Rosen lead the team that developed Syncom, the world's first synchronous communications satellite,for which he was inducted into the National Inventors Hall of Fame in May 2003.

- Rosen's groundbreaking work in communications technology began in 1959 with his concept of a small, spin-stabilized satellite.

- His work on the Syncom and Applications Technology Satellite (ATS) programs, developed for NASA by the then Hughes Aircraft Company, helped make the power of communications satellites available all over the world.

- Dr. Rosen's awards are as numerous as his accomplishments.

- He holds more than 60 patent awards and was honored by the Patent Law Association of Los
- Angeles as Southern California Inventor of the Year in 1973.

- He received his bachelor's degree in electrical engineering from Tulane University in 1947 and received master's and doctorate degrees from Caltech in 1948 and 1951, respectively.
- Tulane granted him a doctor of science degree in 1975 for his
- contributions to communications technology, and the next year Caltech named him a Distinguished Alumnus.

- Dr. Rosen retired from Boeing in 1993 after a 37-year career.

Arthur C. Clarke, who has been largely credited with coming up with the practical idea of communication satellites and named the "father" of the communications satellite industry, modestly declines the honor (preferring to be know as the "godfather'), naming instead two CalTech products (the prestigious California Institute of Technology) as the true fathers of communications satellites-- Drs. John Pierce and Harold Rosen. "John Pierce and Harold Rosen are the fathers of the communication satellite," said Clarke. "They designed, developed, and produced it, making real that which I and others thought only to write and dream about."

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**Geosynchronous Satellite**

Harold Rosen turned a prediction of science fiction into a reality, inventing the geosynchronous satellite --- the essential element of global telecommunications.

Harold Rosen was born in New Orleans, Louisiana in 1926. He resolved to become an engineer while still a child, even though the only engineer his family knew was forced by the Great Depression to drive a taxicab to earn a living. After receiving a BSEE from Tulane University in 1947, Rosen went on to earn an MS (1948) and PHD (1951) from the California Institute of Technology.

Rosen's first professional position was with Raytheon Company, working on guidance and control systems for early missiles. At Raytheon, he invented an improved homing guidance system for the Sparrow missile, based on radar- and accelerometer-based feedback, as well as a desktop-model analog computer.

In 1956, Rosen joined Hughes Aircraft Company, where he first worked on the research and development of anti-aircraft missiles, fire control systems, and radar. In 1957, he was assigned to new products for the radar division. Like many American engineers, Rosen felt both inspired and challenged by the launch of the first Soviet Sputnik satellite that year. He also learned from colleagues that in 1945, science fiction writer Arthur C. Clarke had described the benefits of a geosynchronous satellite --- that is, a satellite that held its position above a fixed point on the rotating earth.

Rosen's team decided to develop a communications satellite that could maintain such a geostationary "orbit." Other researchers had designed such satellites on paper, but these were far too heavy to be launched in the 1950s and '60s. After two years of effort, Rosen solved the problem, relying on a principle of physics that he had worked on in graduate school with the Nobel Prize-winning physicist Carl Anderson (discoverer of the positron), namely spin-stabilization.

Spinning objects are many times more impervious to outside forces, including resistance, than inert objects (which is why footballs and bullets are spun as they fly). Rosen's major insight was that a satellite made to spin at a constant rate would have the necessary stability that previous versions had lacked. Rosen's system used solar panels and spin-based impulses to control the satellite's thrusters economically, and a revolving antenna pattern that always encompassed the earth as the satellite spun. Improvements in communications design by Rosen, John R. Pierce, and their colleagues --- e.g., smaller repeaters and receivers, and a traveling-wave tube suitable for space --- allowed the satellite to be built small enough to be launched.

Rosen helped Hughes win additional funds from NASA and the US Department of Defense, which allowed the first geosynchronous satellite, Syncom I, to be launched in 1961. Syncom I exploded before reaching its final orbit. But just five months later, Syncom II succeeded, establishing orbit at 22,300 miles above the earth's surface: it went into service as an international telephone link in 1963. In 1964, Syncom III provided the world's first transoceanic television broadcast (of the Olympics), after Rosen and his team constructed a special earth terminal to receive its transmissions. Today, the importance---indeed, the absolute necessity---of geosynchronous satellites for telecommunications, television, and the Internet needs no elaboration.

Rosen remained at Hughes Aircraft, rising to Vice President before his retirement in 1992. From 1993-97 Rosen and his brother Benjamin operated Rosen Motors, whose focus was developing a hybrid motor vehicle with a special "turbogenerator" that could both generate and store energy.

Though unknown to the public, Harold Rosen is rightly famous in his field. Among the many honors he has won are the IEEE's Alexander Graham Bell Medal (1982), the National Medal of Technology (1985), and the National Academy of Engineering's Draper Prize (1995).

[Sept. 2000]

# What Hath Sputnik Wrought?

## The Impact of the Space Race on the Development of the Satellite Communications Industry

### Part 3 of a Series on A Brief History of the Satellite Communications Industry

*(Editor's note: the following is not intended to be a comprehensive and definitive history of a very complex and still evolving industry. It is a concise overview for those new to the satellite industry or for those who have worked in the industry and have a need to fill some historical gaps in their knowledge of the industry. The authors welcome suggestions, comments, corrections and or additional information. Please e-mail these to the attention of virgil@satnews.com)*

***by Virgil S. Labrador and Peter I. Galace***

We chose to go to the moon, we chose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because the goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one in which we intend to win, and the others, too.

**-John F. Kennedy**
*Address at Rice University, Texas, September 12, 1962*

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Heaven doth with us as we with torches do,
Not light them for themselves; for if our virtues
Did not go forth with us, 'twere all alike
As if we had them not...

**William Shakespeare**
Act 1 Scene 1 *Measure for Measure*

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When the story of our age comes to be told, we will be remembered as the first of all men to set their sign among the stars.

-Arthur C. Clarke
*The Making of a Moon*, 1957

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One of those very disturbed by the significance of the successful launch of Sputnik and the consequent change in the world's *realpolitik* was an up and coming 40-year old Senator from Massachusetts named John F. Kennedy. Kennedy spoke in Albuquerque, New Mexico two days after the launch on October 7, 1957 and warned that as a result of Sputnik "the impression began to move around the world that the Soviet Union was on the march, that it had definite goals, that it knew how to accomplish them, that it was moving and that we were standing still. That is what we have to overcome."[1]

The launch of America's first satellite--Explorer-1 using a Jupiter C rocket.

Later, Kennedy was to make a big issue of the loss of American prestige as a result of Sputnik in his 1960 presidential campaign against incumbent Vice-President Richard Nixon. This issue among others may have contributed to his narrow margin of victory in that election.

Immediately after Sputnik, the U.S. accelerated its satellite program by authorizing the Department of the Army to proceed with the launch of an artificial satellite using a modified Jupiter C rocket. The Army Ballistic Missile Agency (ABMA) which include in its team, the erstwhile head of the German Rocket Program, Dr. Werner von Braun, actually managed to launched a dummy payload filled with sand more than a year before Sputnik in September 20, 1956. The Jupiter C rocket reached an altitude of 682 miles at a speed of 13,000 miles an hour but stopped short of boosting its final stage into orbit. This was ostensibly to preserve the scientific nature of the project in accordance with the International Geophysical Year (IGY). This would have preceded Sputnik by over a year.

DAILY HERALD

WE SAY

Talking omelette

America's Sputnik dies bleeping on the ground

OH, WHAT A FLOPNIK!

Satellite blows up before take-off

Warship races to banana colony

QUIT ORDER TO 20,000 DUTCH

'ESCAPED PATIENT MAY HARM CHILDREN'

FATHER STILL HOPES...

'Destroy this letter' Bank chief told 'Leak' witness

BABYCHAM

The Daily Herald headline after the failed Vanguard launch.

Sputnik 1 was followed by Sputnik II with a live dog naimed *Laika* ("barker") less than one month later in November 3, 1957. American pride was at its nadir when finally after two successful Soviet launches, America's Vanguard TV-3 rocket exploded upon launch in Cape Canaveral, Florida in

December 6, 1957. The Daily Herald's headline "Oh What a Flopnik," introduced a new portmanteau word into the American language that was to be used in various contexts for decades to come.

On January 31, 1958, the turning point came, when the U.S. successfully launched Explorer I. This satellite carried a small scientific payload that eventually discovered the magnetic radiation belts around the Earth, named after principal investigator, University of Iowa astrophysicist James Van Allen. The Explorer program continued as a successful ongoing series of lightweight, scientifically useful spacecraft.

Directly as a result of the Sputnik launch, the U.S. Government created in February 7, 1958, the Advanced Research Projects Agency (ARPA). This agency had the mandate of ensuring US technological leadership and prevention of future "Sputniks." This is the same agency that will invent the INTERNET (with ARPANET in the late 60s), but its initial projects were in the realm of space technology and exploration, given the priority at that time.

The first project to be undertaken by the newly-created ARPA was Project SCORE (Signal Communication by Orbiting Relay Equipment) together with the Army Signal Corps and the U.S. Air Force.

On December 19, 1958, the first communications satellite carrying a holiday message from U.S. President Dwight D. Eisenhower was launched successfully from Cape Canaveral. It's tape-recorded holiday message in its entirety, heard all over the world was:

> "This is the President of the United States speaking. Through the marvels of scientific advance, my voice is coming to you from a satellite circling in outer space. My message is a simple one. Through this unique means I convey to you and all mankind America's wish for peace on earth and good will to men everywhere."

The Sputnik launch also led directly to the creation of the National Aeronautics and Space Administration (NASA). In July 1958, Congress passed the National Aeronautics and Space Act which created NASA as of October 1, 1958 from the National Advisory Committee for Aeronautics (NACA) and other government agencies. By the next year in 1959, Dr. von Braun and his team in the ABMA was to be absorbed by NASA, with the task of developing a massive rocket that could reach the moon (the *Saturn* rocket). The role of NASA in the Space Race that was to dominate the next decade of the 60s was legion. But that would be beyond the scope of this narrative. The development of communications satellites in the U.S. was a joint-effort of both the private and government sectors.

When asked what are the most significant impact of the space race on humankind, during an interview in 1989 with the pioneer broadcaster, Ted Turner, the visionary scientist, Carl Sagan, unhesitantly said that technology of satellite communications was the most significant contribution of the space race. As we can see, the space race created NASA and ARPA which would lead to the development of the commercial space industry--with the satellite segment forming its largest and most commercially successful part--and later the INTERNET.

What was even more astounding was the speed in which satellite communications technology developed in the sixties. By the end of the decade, just as President Kennedy promised at beginning of his term in 1961 (despite his own untimely death in 1963), the U.S. was to establish it preeminence in space with the landing of the first man on the moon on July 20, 1969--a feat viewed in real-time by over 500 million people on earth due to the advances in satellite communications technology that the space race help engender.

Arthur C. Clarke, who has been largely credited with coming up with the practical idea of communication satellites and named the "father" of the communications satellite industry, modestly declines the honor (preferring to be know as the "godfather'), naming instead two CalTech products (the prestigious California Institute of Technology) as the true fathers of communications satellites--Drs. John Pierce and Harold Rosen. "John Pierce and Harold Rosen are the fathers of the communication satellite," said Clarke. "They designed, developed, and produced it, making real that which I and others thought only to write and dream about."


Dr. Harold Rosen | Dr. John Pierce

Dr. Pierce was born in Des Moines, Iowa and grew up in California. He graduated from the California Institute of Technology in 1933 with a degree in aeronautics and electronics. He received his Ph.D. from Caltech in 1936 and accepted a job offer from the pioneering Bell Telephone Laboratories in New Jersey (Bell Labs, then the research arm of American Telephone and Telegraph Company, AT&T) and stayed till 1971 as executive director of research in communications.

During this three-decade span, Dr. Pierce invented various electronic devices. He was head of the team that invented the transistor and coined the word "transistor" in 1949. A man of many talents and interests, Dr. Pierce was also an accomplished musician (ending his remarkable career teaching music at Stanford) and a science fiction writer like Clarke, writing under the pen name, J.J. Coupling.

In the early 50s , Dr. Pierce started thinking about satellites as a relay medium for communications. In 1952 he published in *Astounding Science Fiction* an article called "Don't Write, Telegraph" where he calculated the power necessary to transmit signals between the earth and the moon as well as the planets and stars. He published his first concrete proposals for communications satellites in an article entitled "Orbital Radio Relays" published in the journal *Jet Propulsion* in April 1955.

Pierce not only envisioned the technical feasibility of communications satellites. He was the first to calculate its commercial value by estimating the market value of the services that a communications satellite capable of 1,000 simultaneous telephone calls at a billion dollars.

In 1958, Dr. Pierce learned that the NASA was experimenting with large balloon satellites for measuring air resistance. Dr. Pierce gave the project a different direction and with Dr. Rudolph Kompfner, director of electronic research, drew up plans for using a balloon as a passive satellite to relay radio communications. NASA sent Echo-1 aloft in August 12, 1960, the largest object to travel into space up until that time. Like Sputnik, Echo-1 was visible to the naked eye and was widely seen.

Echo-1 was a *passive* satellite. Radio waves bounced off its aluminum coating and were reflected back to Earth. Echo-1 made possible the first direct coast-to-coast television transmissions. Echo-1 also bounced phone calls across the USA from the Bell Labs facility in Crawford Hill, N.J. The giant balloon remained in orbit for eight years.

In the early 60s, Dr. Pierce played a key role in the development and launch of a satellite communications system called Telstar. The concept called for an operational system of between 50 and 120 simple active satellites in orbits about 7,000 miles high. With the satellites in random orbits, Bell Labs calculated that a system of 40 satellites in polar orbits and 15 in equatorial orbits would provide service 99.9 per cent of the time between any two points on earth. AT&T has proposed that the system contain about 25 ground stations so placed as to provide global coverage.

Under Dr. Pierce's leadership, Bell Labs designed and built Telstar with AT&T corporate funds. The first Telstars were prototypes that would prove the concepts behind the large constellation system that was being planned.

Although not the first communications satellite, Telstar ushered in the era of satellite communications.

Although not the first communications satellite, Telstar is the best known of all and is probably considered by most observers to have ushered in the era of satellite communications. Telstar-1 was launched on July 10, 1962, and on that same day live television pictures originating in the United States were received in France.

Telstar-1 weighed 171 pounds and was shaped like a faceted sphere with a diameter of a little over 34 inches. Of six spacecraft built, two were launched. The spacecraft was spin stabilized, and its receive and transmit antennas consisted of belts of small apertures (72 and 48 respectively) around the middle of the spacecraft resulting in a circularly polarized antenna with an isotropic pattern around the equator of the spacecraft. Telstar was also the first satellite to use a Travelling Wave Tube (TWT) amplifier. It carried an active broadband 6.39/4.17GHz transponder (transmitter-receiver), offering 600 voice channels and one black and white TV channel.

Dr. Pierce's unique contribution to the technology that made communications satellites possible was the improvement of the Travelling Wave Tube, a broad-band amplifier of microwaves. With his genius for electronics and miniturization, Dr. Pierce was able to create a working TWT that was light enough to be launched into space and work reliably for long periods in space environment.

Dr. Harold Rosen was born in New Orleans, Louisiana in 1926. After receiving a BSEE from Tulane University in 1947, Rosen went on to earn an MS (1948) and Ph.D. (1951) from the California Institute of Technology.

Rosen's first worked for the Raytheon Company where he invented an improved homing guidance system for the Sparrow air-to-air missile and a desktop-model analog computer.

In 1956, he joined Hughes Aircraft Company (later known as Hughes Space and Communications Company and now Boeing Satellite Systems, Inc.), where he first worked on the research and development of anti-aircraft missiles, fire control systems, and radar. At Hughes, Dr. Rosen's team which included Donald Williams and Thomas Hudspeth decided to develop a communications satellite that could maintain such a geostationary orbit as envisioned by Arthur Clarke 12 years before. After two years of effort, Dr. Rosen solved the problem, using a principle of physics that he had worked on in graduate school with the Nobel Prize-winning physicist Carl Anderson (discoverer of the positron), namely spin-stabilization.

Dr. Rosen's major insight was that a satellite made to spin at a constant rate would have the necessary stability that previous versions had lacked. Rosen's system used solar panels and spin-based impulses to control the satellite's thrusters economically,


Syncom, the first geosynchronous satellite.

and a revolving antenna pattern that always encompassed the earth as the satellite spun. The team decided to call their satellite "Syncom" short for synchronous communications. Dr. Rosen and his team set to build the first geosynchronous satellite.

Communications satellites before Rosen's Syncom used low earth orbits (LEOs). Huge swiveling ground antennas and expensive tracking computers were needed to stay in contact with these LEO satellites during the brief time they soared overhead.

In contrast, a synchronous satellite could communicate directly and continuously with any ground station in its line of sight using fixed antennas. No complex tracking antennas were necessary. Synchronous altitude also meant that a satellite would be in sunlight 99 percent of the time over the course of a year, eliminating the need for an active temperature control system.

Remembering that a spinning body is much more stable in flight and more resistant to external influences, Dr. Rosen reasoned that a spinning satellite configuration was the easiest way to simplify attitude and velocity control and achieve the low weight necessary for the limited launch vehicle capacity then available.

By 1961, the team had designed and built a workable prototype satellite. In August, Hughes won a US$4 million contract from NASA Goddard Space Flight Center and the Department of Defense to build three synchronous communications satellites.

The three major project objectives were to place a satellite in synchronous orbit; demonstrate on-orbit station keeping and perform communications and engineering tests on a high-altitude synchronous satellite.

The launch of Syncom-1 on Valentine's Day, 1963, reached the 24-hour orbit successfully, then silence. The satellite probably was destroyed by an explosion of its apogee kick motor as it entered final orbit. Undeterred by the setback, Dr. Rosen's team quickly made improvements on Syncom-2 to enhance reliability.

Only five months later, on July 26, 1963, Syncom-2 successfully reached synchronous orbit over the Atlantic Ocean. Syncom 2 measured 2 feet, 4 inches in diameter. Its solar panels were 1 foot, 3 inches in height. Its weight in orbit was 78 pounds. The satellite was a spin-stabilized cylinder faced with 3,840 positive-on-negative silicon solar cells.

The public first noticed the revolutionary capabilities of Syncom-2 when President John F. Kennedy in Washington, D.C., telephoned Nigerian Prime Minister Abubaker Balewa in Africa later that year. This was the first live two-way call between heads of state by satellite relay. During Syncom-2's first year, NASA conducted voice, teletype, and facsimile tests, as well as 110 public demonstrations to acquaint people with Syncom's capabilities and invite their feedback.

Syncom-2 went on to prove that its maneuvering and station keeping system worked as well as its communications system. By firing its gas jets in brief pulses, the satellite moved under its own power from its initial position over the Atlantic to a location above the Indian Ocean. It also maintained the correct orbit in both locations. Syncom-2 successfully passed all tests and fulfilled all mission objectives.

Syncom-2's severe inclination of 33 degrees, however, meant that it was not a true geosynchronous satellite. That honor went to its successor, Syncom-3, which achieved true geostationary orbit on August 19, 1964.

Both Syncom satellites expanded direct, 24-hour communications access to two-thirds of Earth's surface. Syncom-2 and -3 satellites carried television and telephone transmissions including the Tokyo Olympics of 1964, and after the Department of Defense assumed stewardship in 1965 served as the primary communications link between Southeast Asia and the Western Pacific during part of the Vietnam conflict. They were decommissioned and retired in April 1969.

The breakthrough efforts of Drs. Pierce and Rosen made the development of worldwide satellite communications system technically feasible. Dr. Pierce's development of the Travelling Wave Tube and Dr. Rosen's spin-stablization technology overcame the last technological hurdles to a working geostationary communications satelllite. These developments coupled with NASA's development of rocket booster technology with the ability to launch larger payloads in space made possible in less than 20 years after Arthur Clarke's proposed the concept of a geostationary communications satellite, instead of the fifty years he initially thought it would take. When Clarke initially conceived the geostationary communications satellite, he thought it would be manned and that the electronics would be the larger vaccum tube-type variety. Drs. Pierce and Rosen took it to the next level. For their efforts, Drs. Pierce and Rosen were jointly awarded the 1995 Draper Prize--the most prestigious award in the engineering profession.

The regulatory framework for such as system was provided by the passing by the U.S. Congress of the Communications Satellite Act on August 27, 1962. The Act was signed into law four days later by President John F. Kennedy, setting forth U.S. policy to establish an international satellite cooperative system and authorizing the formation of the "Communciations Satellite Corporation" (COMSAT), a private company to represent the United States in a new international satellite communications organization to be called "INTELSAT."

An industry is born.

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1 As quoted in Paul Dickson, Sputnik the Shock of the Century, Walker and Co., NY, 2001, p. 118.

2 Dickson, *op. cit.*, pp. 88-89.

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**Next Chapter:** **IV - The Birth of a Global Industry: COMSAT, INTELSAT and INTERSPUTNIK**

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*Virgil Labrador is the Vice-President of Satnews Publishers. He is responsible for all editorial and* *marketing functions of the organization. He is the editor of Satnews Online Magazine, and Associate Editor of the International Satellite Directory and Satnews Asia. He has worked in various capacities in the industry, more recently, as marketing director of the Asia Broadcast Centre in Singapore--a full-service teleport owned by CBS. He has co-written several books on Media Management and Communications Policy. He holds a master's degree in communications management from the Annenberg School of Communication of the University of Southern California.*

*Peter Galace is editorial director of Satnews Publishers. He has written extensively on the telecommunications developments in Asia for numerous publications. Currently he is the editor of Satnews Asia (http://www.satnewsasia.com) and associate editor of Satnews Online Magazine and Sateprofiles (http://www.sateprofiles.com).*

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**CONTACT:** Rini Paiva
330-849-6916
rpaiva@invent.org

Melissa Davis
216-736-4446
mdavis@landaupr.com

**GEO-SYNCHRONOUS SATELLITE PIONEER HAROLD ROSEN TO JOIN THE NATIONAL INVENTORS HALL OF FAME**

*Rosen's work revolutionized international communication.*

FEBRUARY 11, 2003, WASHINGTON, D.C.—In 1965, Harold Rosen predicted in the *New York Journal-American* that geosynchronous satellites would "result in a multimillion-channel equatorial communications network carrying television, voice, photo, facsimile and teletype everywhere in the world." He wasn't clairvoyant. He was a visionary and his development of the Syncom communications satellite would change the world.

The National Inventors Hall of Fame announced today that Harold Rosen would be inducted in to the Hall of Fame in recognition of his contributions to the development of geo-synchronous satellite communications. In 1903, the Wright Brothers changed the world forever with their first successful powered flight. To commemorate this historic milestone, this year's 31st annual class of inductees are being recognized for their remarkable contributions to the advancement of aviation and aerospace with a special induction ceremony in May celebrating this one-hundredth year of flight.

In 1957, the United States was facing a problem. The Russians had successfully launched Sputnik and effectively beat them into space. As a result, Harold Rosen, an engineer at Hughes Aircraft Company, found himself heading in a completely new direction from the airborne radar project on which he was working.

The need to develop global communications was clear. Global telephone calls were expensive, relying on cables to transmit signals, and global television transmission was nonexistent. Technology available at the time provided limited international communication with the use of numerous aluminum-coated balloons in a low-orbit above the Earth.

Given the demand for better international communication and new opportunities in aerospace, Harold Rosen began to pursue work on a new communications satellite.

Rosen knew that to provide consistent 24-hour communication, he would need to develop an active communications satellite that remained in orbit with the Earth. To do this required a simple and lightweight design with a spin-stabilized control system to keep the satellite in synchronous orbit. While the physics were always there, a spin-stabilized control system was not developed until the 1950's and even then it was considered impractical, as the system required a crew of people to change transistor tubes every day.

The ultimate solution for a satellite that would maintain an orbit above a fixed point on earth came with "spin-stabilized configuration." One of the challenges of maintaining a satellite in this fixed orbit came from the heavy weight of its stabilizing devices. Rosen's ingenious solution was for a lightweight satellite that stabilized itself by continuous spinning.

Rosen's team, including Don Williams, an engineer with previous work on the development of a navigation satellite that became the predecessor to GPS, along with Tom Hudspeth and John Mendel, began work on creating a lightweight transmitter and receiver for use in the satellite. The team began building a ground model of the satellite for Hughes Aircraft in 1958 and received additional funding in 1960 to build a prototype. The team took their satellite to the Paris Air Show in 1961 and demonstrated the satellite's capabilities by taking pictures of the crowd, relaying them through the transmitter and receiver to beam the images back to the crowd. When they returned from Europe, the team received a contract from the government to build a flight model.

The government project, titled Syncom (Synchronous Communication) continued for another two years before the satellite launched in 1963. Syncom 1, a model of the satellite only intended for a few voice channels never made it off the ground, exploding at launch in February 1963. A few months later the team successfully launched Syncom 2 and the next year launched Syncom 3. With a wider band receiver, Syncom 3 could accommodate television signals and was used during the Tokyo Olympics to deliver the first continuous transoceanic television broadcast.

With the launch of Syncom 1, CommCast Corporation was formed by an act of Congress, charging it with a charter to provide commercial communications via satellite. With the success of Syncom 2 and Syncom 3, Hughes Aircraft was selected to build a satellite based on its previously demonstrated technology but with commercial frequencies. This new satellite was first launched in 1965.

CommCast worked with European affiliates to form an international communications satellite organization, IntelSat, thus leading the way to international commercial communications via satellite.

Harold Rosen has received such honors as the Lloyd V. Berkner Award from the American Astronautical Society in 1976 and Presidential Medal of Technology in 1985. He was also inducted into the Society of Satellite Professionals International Hall of Fame in 1987, and during his lifetime he has been the recipient of more than fifty patents.

Born in 1926 in New Orleans, Louisiana to Isidore and Anne Vera Rosen, Harold Rosen graduated from Tulane University in 1947 with a degree in Engineering and went on to receive degrees from the California Institute of Technology. Always interested in math and science while growing up, Rosen built a crystal radio, became a radio amateur in high school and was a transmitter engineer at a radio station in college. He has two children from his first marriage and currently lives in Santa Monica, California with his wife Deborah Castleman.

The not-for-profit National Inventors Hall of Fame® is the premier organization in America dedicated to honoring and fostering creativity and invention. Each year a new class of inventors is inducted into the Hall of Fame in recognition of their patented inventions that make human, social and economic progress possible. Founded in 1973 by the U.S. Patent & Trademark Office and the National Council of Intellectual Property Law Associations, the Hall's permanent home is Akron, Ohio, and serves as both a museum and an educational programming resource. For information on the National Inventors Hall of Fame, you can visit the organization's web site at www.invent.org.

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