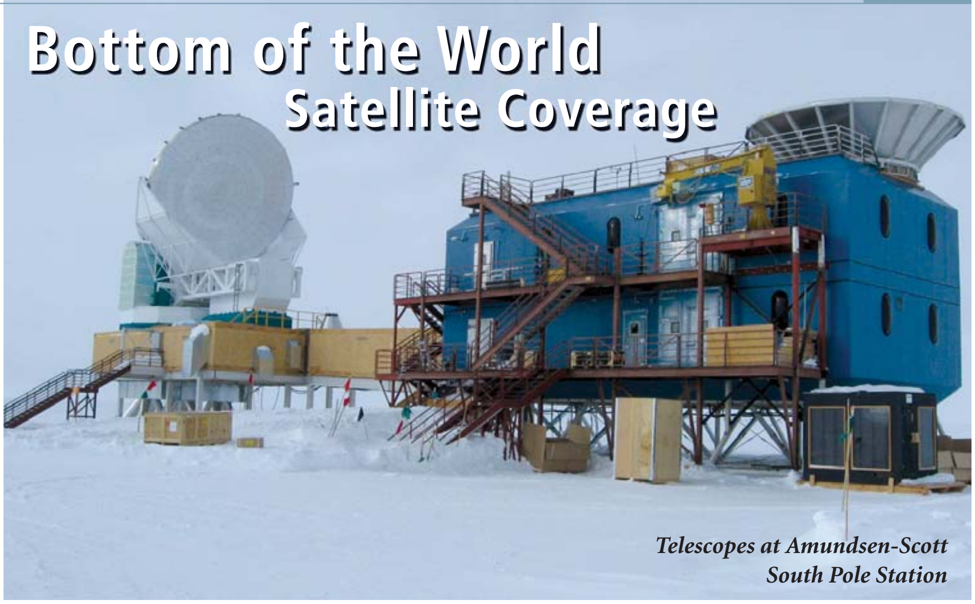
Bottom of the World
Satellite Coverage



Telescopes at Amundsen-Scott South Pole Station

With just six hours of satellite coverage for high-speed data transmission, researchers at the South Pole have had a limited window of opportunity for transmitting their data. With more advanced technologies comes a need for increased functionality and more data capacity. During the past two years, Raytheon Polar Services and its partners have been building a new South Pole satellite communications system to meet this need.

With the enormous data sets created by ongoing expansion of the IceCube neutrino detector and increasing data from the South Pole Telescope, the current intercontinental satellite communications pipeline is full. The new system's science data link transmission rate was increased to 150 megabits per second or about 100 times faster than most home high-speed Internet connections. The South Pole also has greater flexibility in using NASA's Tracking Data and Relay Satellite (TDRS) system. The station can now schedule time on any TDRS satellite simultaneously visible at the South Pole and NASA's White Sands Complex in New Mexico. The aggregate daily connect time through all satellites will vary daily and may be more or less than the fixed six hours currently provided by NASA's TDRS Flight 1 (TDRS F1). The daily pass schedule depends on many things, including: queued data volume, TDRS mission taskings such as the space shuttle or Hubble Space Telescope, satellite visibility at the Pole, and equipment status.

The Current State

Most communications satellites are in geosynchronous orbits (GEO) parked in a fixed location over the equator. Their position and the Earth's curvature hide them from the North and South Poles. Low earth orbiting (LEO) satellites can cover the Poles, but only for brief periods of time, and they require more satellites (like the Iridium constellation, which has 66 satellites). Currently, there is no LEO satellite constellation with the bandwidth that the South Pole needs for off-continent science data transmissions.

In 24 hours, a GEO satellite traverses a ground trace that looks like a big Figure 8. When the bottom of the Figure 8 has an angle greater than 8.5 degrees below the equatorial plane, the satellite becomes visible at the South Pole for several hours of its orbit. This orbital characteristic provides the station access to communication systems that support Internet and telephone service access for the few hours a day that the satellite can be "seen."

When satellites get old, they begin to stray outside of their normal orbit patterns, moving farther north and south. Since 1999, the South Pole has used NASA's TDRS F1, which is now nearing the end of its life. It could fail tomorrow or last a few more years; no one knows for sure. However, everyone seems to agree that it is operating well beyond its design life.

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ENGINEERING PROFILE

Steven Fox

Technical Director and Director of Field Operations

Raytheon Technical Services Company

As director of Field Operations and technical director for RTSC's worldwide field support operators, Steve Fox is responsible for leading a qualified workforce of 1,400 people — certainly no small task. But if you ask Fox, he feels well prepared for the job.

Before Raytheon, Fox spent 28 years in the U.S. Army in a variety of leadership positions. "I designed and managed ground- and space-based intelligence and communications systems," said Fox, who holds three master's degrees in electrical engineering, national security and strategic studies. "Years of having to quickly solve problems — both engineering and operational — prepared me for finding solutions to RTSC's diverse portfolio."

The Army also honed Fox's people skills, a valuable asset for someone who leads as many engineers as Fox does. "When I worked in the classified world — as the project manager of the Tactical Exploitation of National Capabilities program office — I learned to gently lead a disparate group of stakeholders toward a common goal."

The engineers and field operators in Fox's charge are always on his mind. According to Fox, one of his biggest challenges is taking the creative ideas of his people and quickly applying them to develop solutions to meet pressing customer needs.

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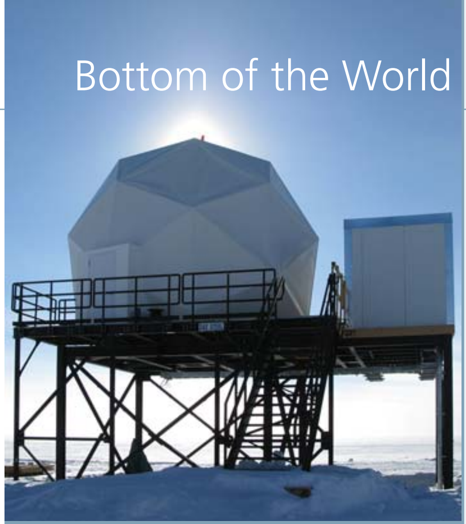
The original South Pole TDRS Relay satellite ground station (SPTR-1, pronounced spitter-one) uses TDRS F1, fixed pointing antennae, and an electronics suite incompatible with the rest of NASA's TDRS satellite constellation and ground station network. The fixed pointing antennae limit the number of hours during which data can be transmitted off station. When TDRS F1 reaches end-of-service life, SPTR-1 will become obsolete.

Enter SPTR-2

A team comprising managers, engineers and technicians from the National Science Foundation (NSF); Raytheon Polar Services; Space and Naval Warfare Systems Center Charleston, S.C.; LJT & Associates; NASA White Sands, N.M.; Goddard Space Flight Center, Md.; and L-3 Datron designed, engineered, installed and now operate a new South Pole satellite communications system called South Pole TDRS Relay-2 (SPTR-2). The system encompasses new electronics at White Sands and the South Pole as well as a new tracking 4-meter-diameter antenna that permits expanded communications over NASA's Space Network. The new antenna is currently being used with SPTR-1 electronics while TDRS F1 is still operational, providing the station complete TDRS F1 pass coverage and the maximum data rate possible. Operating in this configuration also provides valuable data and experience that will be useful when full SPTR-2 operations turn to using the TDRS F4, F5 and F6 satellites.

SPTR is not just a satellite communications system. It also incorporates a science data store-and-forward system; interfaces with station communications infrastructure for Internet service, telephone service and video teleconferencing; and White Sands-to-Denver network upgrades. Raytheon Polar Services designed and implemented these critical data communications and network components during a SPTR-1 upgrade at the South Pole, White Sands and Denver during the last two years. These subsystems will continue operating in the SPTR-2 architecture.

Raytheon Polar Services' role in the SPTR-2 project was full-circle: from planning, design, management, engineering, procurement and transportation, through actual construction of the site, antenna platform, equipment shelter, radome, data networks and utility tie-ins at the South Pole. It also played a key role in upgrading the NSF data network at White Sands to enhance performance, redundancy and security. It will continue to provide the glue to keep the technical and operational aspects working together for the unique Antarctic environment.



The South Pole Tracking Relay-2 (SPTR-2) satellite communications ground station with radome around the antenna

While SPTR-2 will give the station access to more TDRS satellites, its use will be different than that of TDRS F1. The South Pole will not have exclusive access to the satellites when they are above the local horizon. Instead, the South Pole will submit scheduling requests to NASA every week. NASA will then assess all requests and develop a daily contact time schedule for all users, including the South Pole, based on system status, operations needs and mission priorities.

Change comes to all things, including the South Pole. SPTR-2, like many aspects of the new station, represents a change for the South Pole community. However, it will provide a reliable path for science data and station communications between the continent and outside world well into the 21st century. Also, SPTR-2 has application beyond South Pole communications. Raytheon is using the project's engineering and operations lessons learned in its efforts to field National Polar-orbiting Operational Satellite System (NPOESS) ground stations that use similar equipment. •

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Supporting Science at the Bottom of the World

Contracted to the National Science Foundation, Raytheon Polar Services provides operations, construction, maintenance and staff to sustain and support research programs at three year-round U.S. locations, numerous field camps, and on two research vessels in the Antarctic region.

Working in Antarctica — on average the highest, driest, coldest and emptiest continent — means dealing with extreme weather conditions and extremely limited logistics. Missions require maximizing limited resupply options, relying on integrated long-term schedules, providing specialized training, working closely with the client and other related agencies, and adapting quickly to changing circumstances.

Polar Services recently finished building a new elevated research station at the South Pole, where it tests systems that NASA may use in missions to the moon and Mars, collect critical data on climate change, and built premier telescopes and the largest-ever neutrino detector. They must withstand extreme temperatures, a short operating season, a 10,000-mile logistics chain, and a six-month day and night — all while operating one of the largest and geographically dispersed and technically complex 24x7 communications infrastructures in the world. •

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The elevated research station at Amundsen-Scott South Pole Station sits on 9,000 feet (2,700 meters) of snow at 90 degrees south.