AUTONOMOUS SYSTEMS IN EXTREME ENVIRONMENTS

Executive Summary

Antarctica and the Arctic are expensive and difficult places to do research because of their remote nature and harsh environmental conditions. They are the most isolated places on Earth and also experience the most extreme weather conditions. Antarctica and its special challenges is the driver for this workshop; it is the prototype extreme environment. In some regions of Antarctica, temperatures have been recorded as low as - 90°C, wind gusts at nearly 90 m/sec, and absolute humidity lower than in the Sahara desert. The polar regions are among the Earth's most sensitive to environmental change and also have exceptionally long natural climate records. Scientists are constantly looking for ways to accomplish research goals at the lowest possible cost and still maintain a high level of scientific value. In 1996, the Committee on Fundamental Science of the National Science and Technology Council (NSTC) recommended that cost savings for the U.S.
Antarctic Programs could be achieved by reducing requirements for on-site supporting staff by developing autonomous data gathering systems utilizing advanced computers and micro-electronics and emerging satellite capabilities.

Numerous investigators are conducting experiments in polar or other extreme environments that require the use of autonomous systems and the number of autonomous systems is expected to increase. Examples of programs that currently use autonomous systems in the Antarctic are the Automated Geophysical Observatories (AGO) program, University of Wisconsin remote weather stations, remote GPS stations deployed by JPL and UCSB, and remote seismic stations deployed by Penn State University. The Arctic division of NSF/OPP sponsors autonomous systems development for environmental monitoring. The goal of the Long-term Observations in the Arctic program is to increase the availability of long-term environmental data in the Arctic. Sites are needed due to the scarcity of observations in the Arctic (compared to most places on Earth), the lack of ready access to many parts of the Arctic, or the necessity to collect new samples because no Arctic sample curatorial facility exists except for ice cores. Ocean engineers have a long history of dealing with remote stations on the sea floor. Our emphasis for this workshop will be on sub-aerial systems.

While these systems may vary in size and power requirements, they have similar problems that must be overcome in order for them to function properly. These problems include, but are not limited to, issues related to power, thermal environment, data storage, communications, and packaging. A workshop was convened August 31 - September 2, 1999 at the Jet Propulsion Laboratory in Pasadena, California to discuss these issues.

An integrated systems approach must be used to design a successful autonomous station. For example thermal systems impact power systems and these systems may have feedbacks on themselves. Changes in one aspect of the system may impact another component. The workshop sought to promote discussion between investigators so that lessons learned could be efficiently communicated and successful systems developed that maximize scientific output. Scientists, engineers, and industry partners participated in the workshop. The goals of the workshop are as follows:

1. Promote dialogue between scientists and engineers on autonomous system design.

2. Make recommendations on power, thermal, data, communications, and packaging systems.

3. Discuss whether standardization is recommended for future systems.

4. Discuss and recommend whether design and testing criteria should be met before systems are deployed in polar regions.