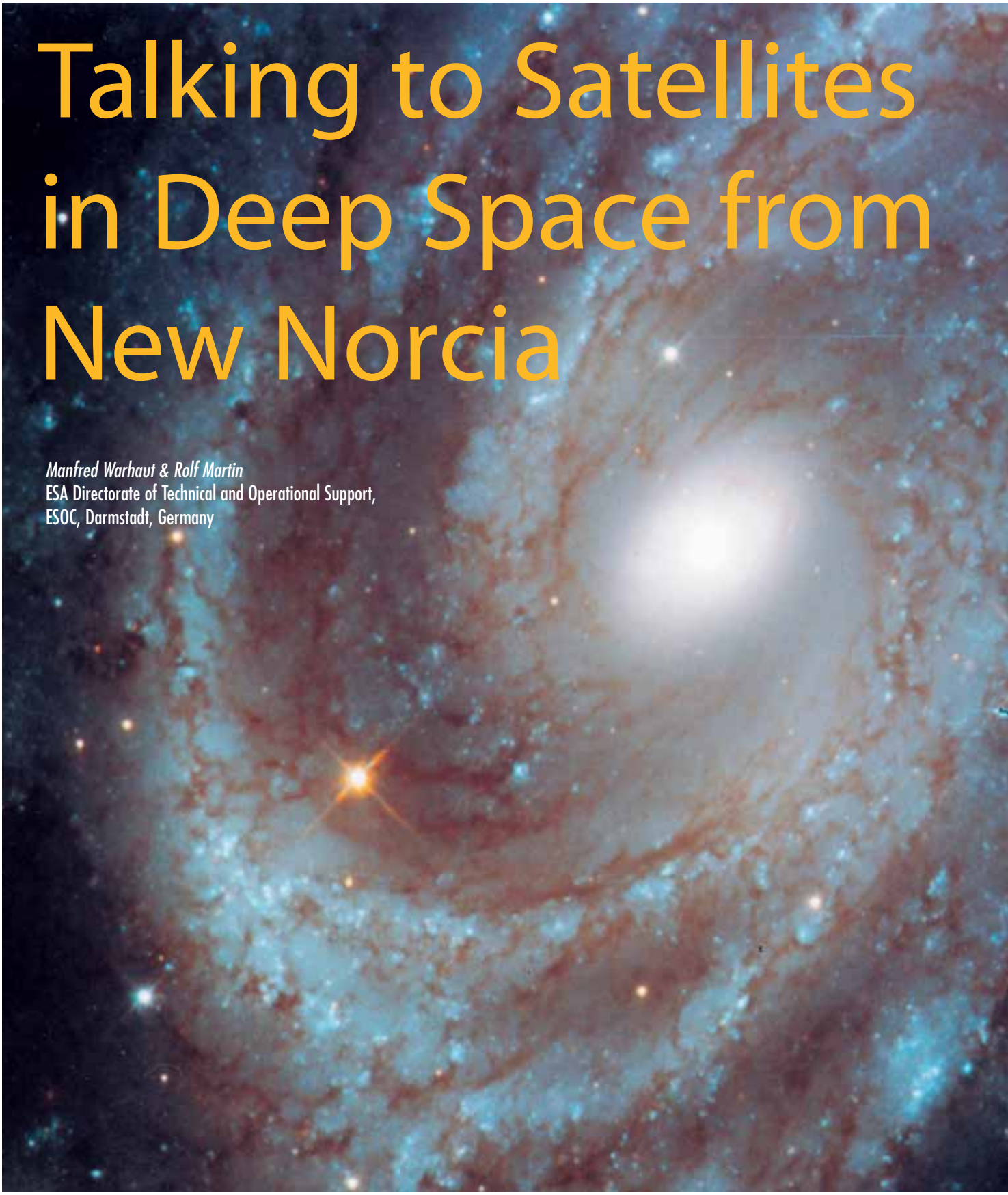
Talking to Satellites in Deep Space from New Norcia

Manfred Warhaut & Rolf Martin
ESA Directorate of Technical and Operational Support,
ESOC, Darmstadt, Germany



To control and operate its spacecraft, ESA maintains a network of ground stations, which consists of several stations with 15 metre antennas using S-band frequencies for telemetry, command and tracking. This network has recently been augmented, in November 2002, with a ground station with a 35 metre-diameter antenna at New Norcia in Western Australia. The new station can transmit and receive at both S-band (2 GHz) and X-band (8 GHz) frequencies, and its mechanical structure will allow later upgrading for data reception in the Ka-band (32 GHz), which become the future international standard for deep-space missions.

The New Norcia antenna is one of the largest in the world for telemetry, tracking and command (TT&C) applications and represents the jewel in the crown for the ground-station network operated by the European Space Operations Centre (ESOC). This new antenna is essential for high-performance communications with spacecraft in far out in space and missions in highly elliptical orbits which take them far from Earth. ESA's Rosetta and Mars Express scientific missions fall squarely into that category.

Reliable 'long-distance communications' between the New Norcia ground station and the Rosetta spacecraft, now due for launch in early 2004, will be essential to acquire the scientific data being collected by its instruments and to allow ESOC to remotely control both the spacecraft and its payload when it is up to 900 million kilometres away from Earth – more than six times the distance from the Earth to the Sun.

Communicating with spacecraft over these huge distances puts very stringent radio-frequency (RF) requirements on the ground station's antenna system, as weight and energy constraints limit the size and transmitting power of the antenna onboard the spacecraft. The ground station therefore needs very sensitive receivers and powerful transmitters, coupled to a high-gain antenna of its own, in order to ensure reliable communication with the spacecraft. This in turn means a large antenna with a narrow beam width, and hence a high pointing accuracy also. The provision of smooth motion by the antenna's servo subsystem and high stiffness of the antenna's mechanical structure under the prevailing local weather conditions are also required to achieve optimal overall performance (i.e. a main-reflector surface accuracy of 0.3 mm, and a tracking error of no more that 0.006 deg in the Ka-band).

Like all of ESA's other outlying ground stations, the New Norcia antenna will be remotely controlled and operated from ESOC in Darmstadt. This avoids the needed for permanent manning of the station and limits the need for maintenance staff to visits on a weekly basis. The

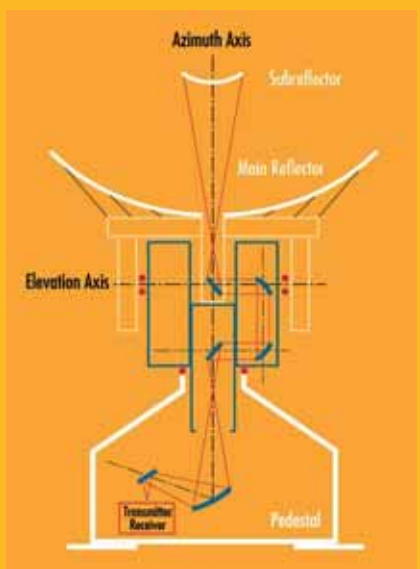
ESA's new 35 metre deep-space antenna at New Norcia in Western Australia

Technical Features of the Station

The New Norcia deep-space ground station consists of the antenna front-end, the site infrastructure facilities, the antenna back-end, and a high-precision frequency and timing system based on hydrogen masers. The 35 m antenna is mounted on a full-motion, turning-head pedestal. There is a beam waveguide feed system, cryogenically cooled S-and X-band low-noise amplifiers, and 20 kW S- and X-band transmitters, together with all of the other typical support equipment for an antenna front-end. The overall height of the antenna is around 40 m, and the structure and equipment above the antenna pedestal weigh approximately 630 tons.

The antenna is complemented by standard ESA ground-station back-end equipment, installed in a separate building. Advanced digital technology has been used in the receivers, the demodulators and the ranging equipment used to determine the position and orbit of the spacecraft being operated.

The project to build the station began in 1998 and the industrial team contracted for the work involved several companies from European countries, Canada, the United States and Australia. The prime contractor was SED Systems of Canada. Major subcontractors were: Bovis Lend Lease of Australia (site infrastructure), Nortel DASA SatCom of Germany (back-end equipment), Vertex Antennentechnik of Germany (mechanical and servo system), and Vertex Antenna Systems of the USA (passive radio-frequency system).



Incoming signals are collected by the main 35 m dish and guided via the sub-reflector and various mirrors down to the receiver

station's location has been carefully chosen to provide the necessary satellite visibility, the required radio-frequency clearance for data transmission and reception, the best-available weather conditions, which influence station performance (rain attenuation, wind speed), and to satisfy the need for cost-efficient operation and maintenance.

New Norcia is a small historic town about one and a half hours north of Perth, where the new ground station provides a 'bridge' between the 150 year old traditions of its Benedictine Monastery and the high-tech world of operations in deep space! esa

The geographical location of the New Norcia ground station