Small satellite mission for providing communication and imaging services tailored to the Antarctic and other user needs

A joint project in implementation by the Cluster for Aero Space Technologies, Research and Applications (CASTRA) and the Bulgarian Antarctic Institute (BAI)

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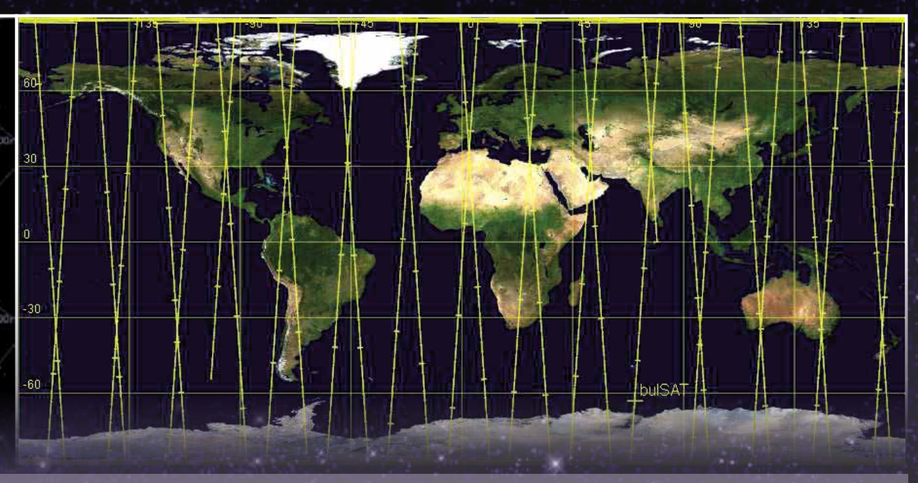
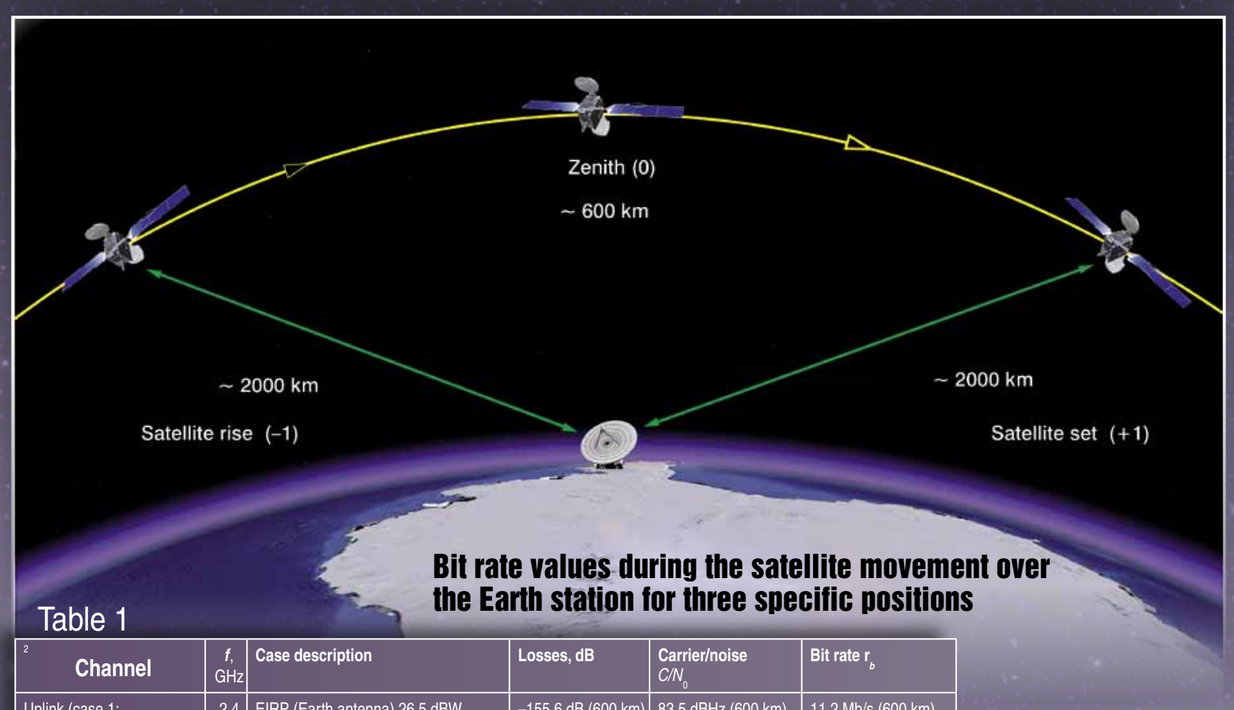
Small satellites (stand-alone or in a constellation) can provide critically important services and data for human activities in the areas across Antarctica such as: high speed two-way data transfer (e.g. between the various ground sensor networks needed for scientific, safety and other applications, and the rest of the world), two-way communication services (e.g. file transfer, e-mail, multi-media communication offline, etc.) for professional, personal or rescue needs; permanent (full year) Antarctic surface monitoring to study biological and other natural phenomena on the continent; weather monitoring and forecasts, permanent collection of data and information about the location and trajectory of the ships sailing in the Antarctic region servicing Antarctic expeditions logistics, staff security, etc.



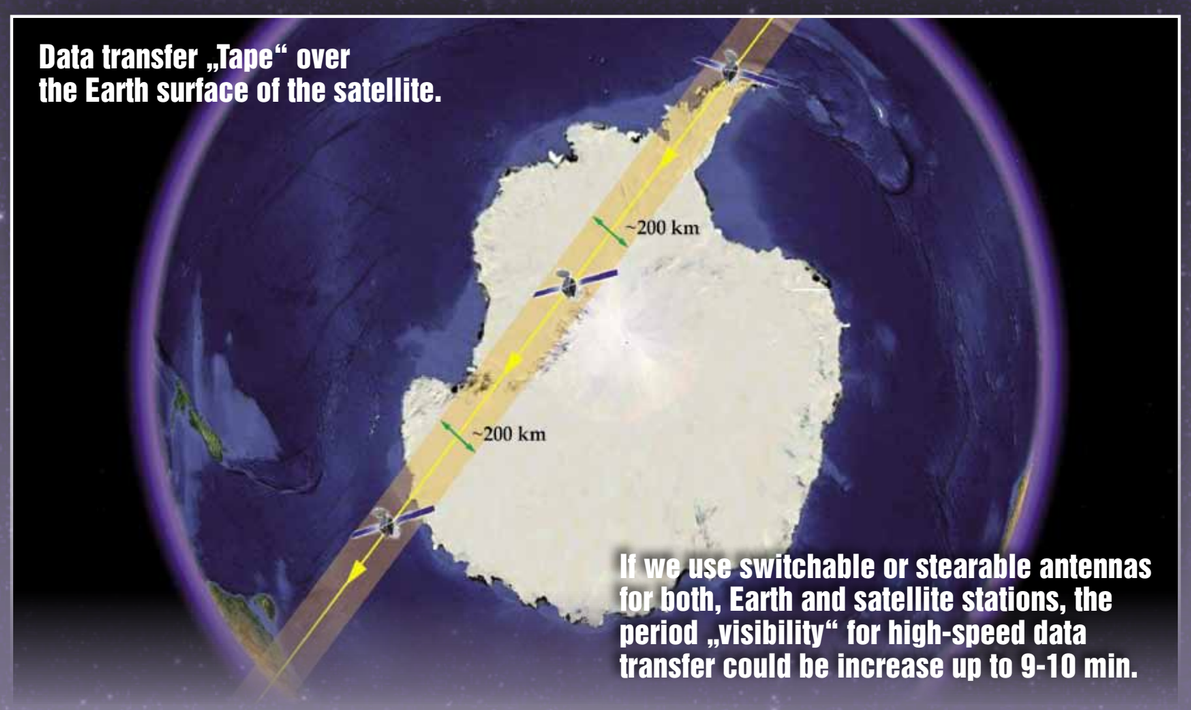
The simplified orbit analysis shows that our satellite would pass over the Bulgarian base on the Livingston Island ~2 times daily, and over Bulgaria – ~1 times per day.



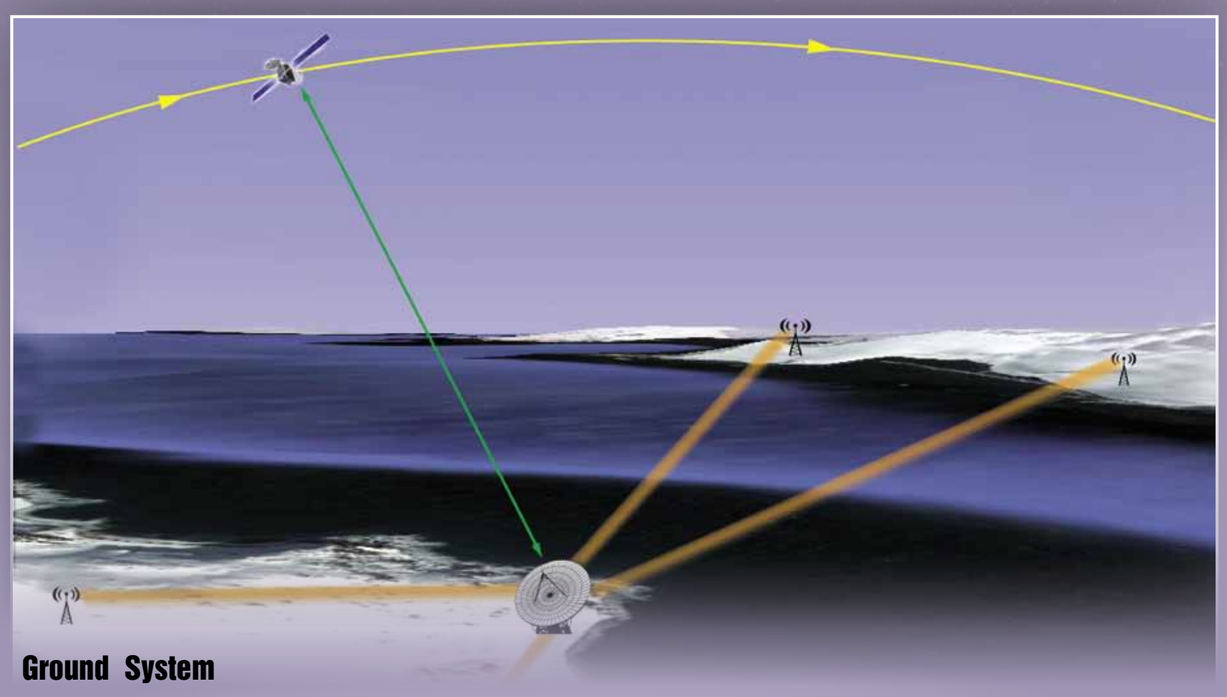
Bit rate values during the satellite movement over the Earth station for three specific positions

Table 1

[2] Channel	*f*, GHz	Case description	Losses, dB	Carrier/noise C/N_0	Bit rate r_b
Uplink (case 1; narrow-beam Earth antenna 1.2 m; steerable)	2.4	EIRP (Earth antenna) 26.5 dBW (50 % efficiency; standard power 1 W); Satellite antenna *G/T* = -16 dBK; *EM* = 9.5 dB; margin 3.5 dB	–155.6 dB (600 km) –160 dB (2000 km)	83.5 dBHz (600 km) 73.1 dBHz (2000 km)	11.2 Mb/s (600 km) 1.023 Mb/s (2000 km)
Uplink (case 2; wide-beam Earth antenna)	2.4	EIRP (Earth antenna) 9.5 dBW Satellite antenna *G/T* = -16 dBK	–"–	66.5 dBHz (600 km) 56.1 dBHz (2000 km)	223.8 kb/s (600 km) 20.4 kb/s (2000 km)
Downlink (case 1; narrow-beam Earth antenna 1.2 m; steerable)	8.2	Gain (satellite antenna) 7.5 dB; power 4 W; Earth antenna *G/T* = 14.2 dBK; E_bM_0 = 9.5 dB; margin 3.5 dB	–155.6 dB (600 km) –160 dB (2000 km)	98.7 dBHz (600 km) 88.3 dBHz (2000 km)	37.15 Mb/s (600 km) 33.8 Mb/s (2000 km)
Downlink (case 2; wide-beam Earth antenna)	8.2	Gain (satellite antenna) 7.5 dB; power 4 W; Earth antenna *G/T* = -13.5 dBK	–"–	71.5 dBHz (600 km) 60.9 dBHz (2000 km)	708 kb/s (600 km) 61.6 kb/s (2000 km)

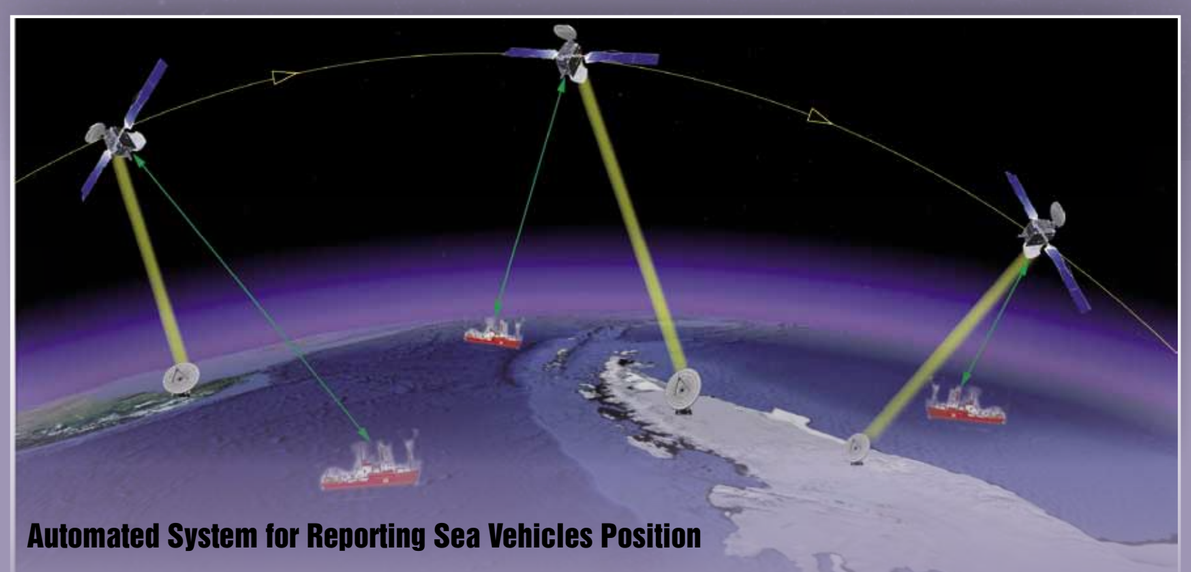


Total data volume for a single communication session is evaluated at ~100 MB for the uplink channel and ~300 MB for the downlink channel. In general, this is enough for online transfer of meteorological data and the daily satellite images.More than 1-2 communication sessions per day could be established using more than 2 ground stations. In case of a need to transmit more data through the downlink channel (for example: high-resolution satellite images), data-transfer speed increase of ~50% from the rates given in *Table 1* could be achieved if simple unidirectional data-transfer protocols are used.



Ground System

Automated system of sensors located on ground in the area of a research project.
The data registered by the sensors is transmitted to the main ground station and archived with a specific algorithm . The compressed data is transmitted to the satellite when the latter is in the range of the ground station antenna. Sensor network control data/commands can be sent back to the ground station as well.



Automated System for Reporting Sea Vehicles Position

The data for latitude, longitude, heading and UTC time shall be taken automatically from the ship's navigation system. If this is not allowed, such data will be obtained through a dedicated GPS receiver, additionally installed aboard the ship .The data will be processed and stored in a dedicated satellite communication module, also independently installed aboard the vessel. Upon establishing the communication channel with the small satellite, the stored data is to be automatically transmitted with an appropriate protocols with enhanced security. The satellite will transmit back the data from all vessels to a dedicated server on ground to help the logistics planning for the Antarctic expeditions.

CASTRA - Cluster AERO-SPACE TECHNOLOGIES, RESEARCH AND APPLICATIONS is anon-government organization in public benefit whose members represent business organizations, academic institutions and non-government organizations with activities and capacity to develop aero-space technologies and their application in innovative products and services.

CASTRA's vision is to promote the research, innovation and technology development in the aero-space domain,the applications in industry and in all spheres of public activities and private life.

CASTRA's mission is to stimulate the public interest and positive disposition to the field of aero-space technologies and research, to increase the public awareness about the importance of space technology applications and spin-offs in various areas of life on Earth and to the activities of the organizations - members of the cluster.

BAI - Bulgarian Antarctic Institute is The National Operator of Bulgarian Antarctic Activities.

The **BAI** organizes annual Antarctic campaigns and operates the Bulgarian Antarctic base "St. Kliment Ohridski", Livingston Island, South Shetland Islands. **BAI** is in contact with the Antarctic Programs of Spain, Great Britain, Russia, Germany, Argentina, Brazil, Chile, South Korea, Japan and etc.

The Republic of Bulgaria joined to the Antarctic Treaty in 1978, and afterwards - SCAR (Scientific Committee on Antarctic Research) and COMNAP (Council of Managers of National Antarctic Programs) in 1994, became the twenty-27th Consultative Party in 1998 and is Member of the EPB (European Polar Board). The development of a long-term National Antarctic Program is a result of the sustainable policy of the Republic of Bulgaria aimed at more active and more efficient scientific participation in the European cooperation in Polar Regions, as a worthy partner in all efforts exerted for the sake of both scientific progress and peacekeeping.