

Small Communication Satellite Mission for Enhancement of Antarctic Investigations

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Category 1: Mission Idea and Satellite Design

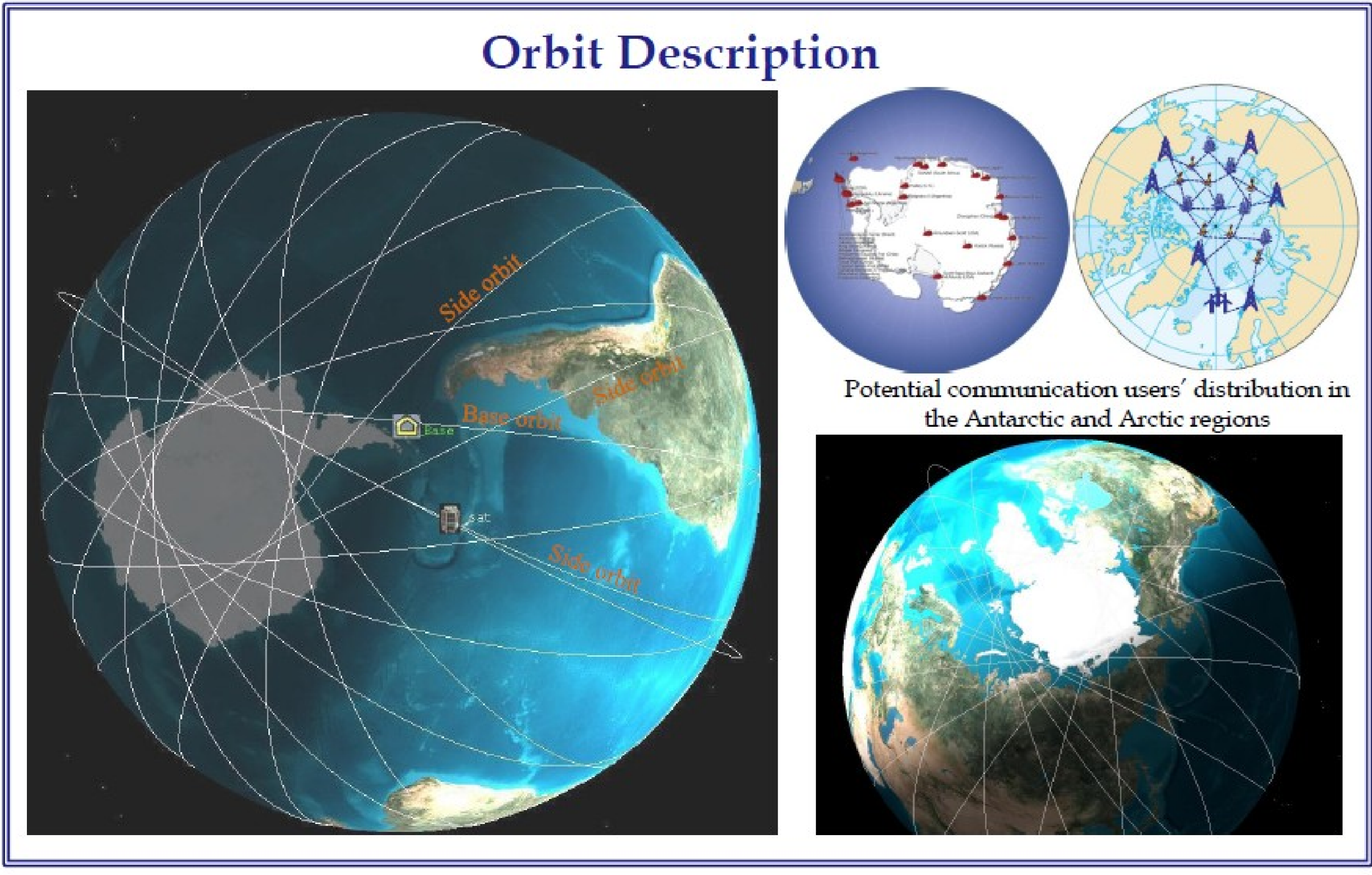
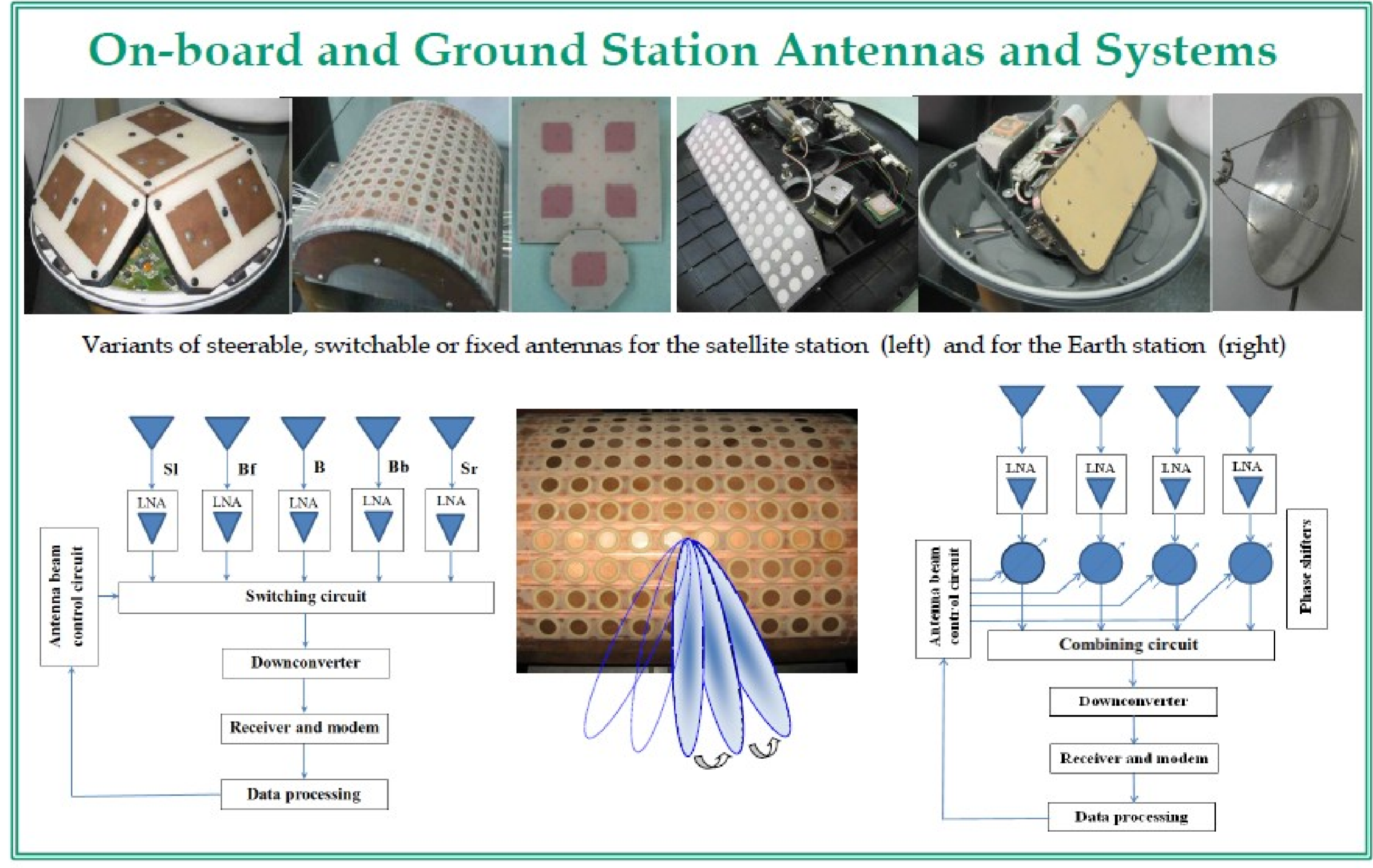
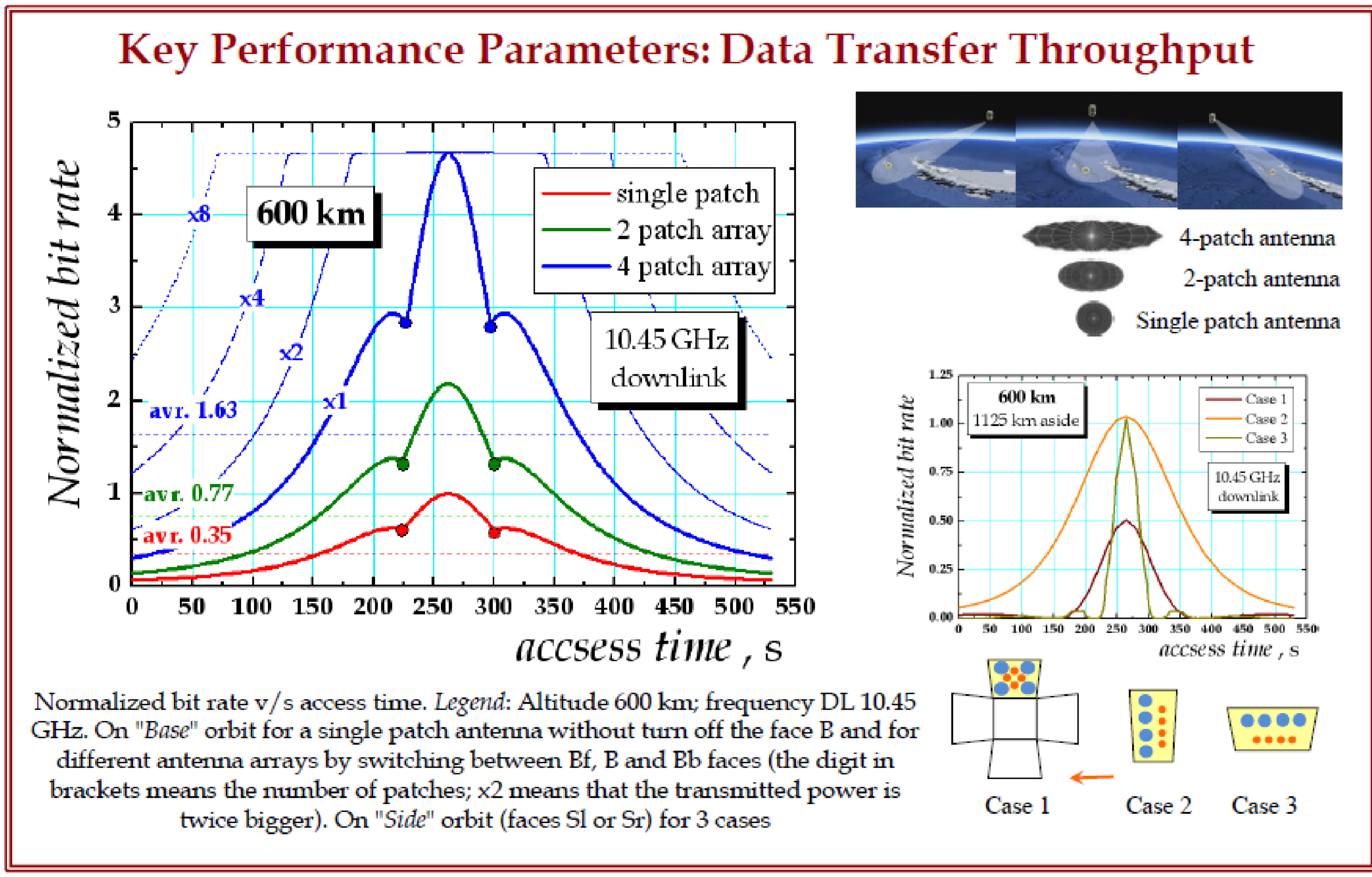
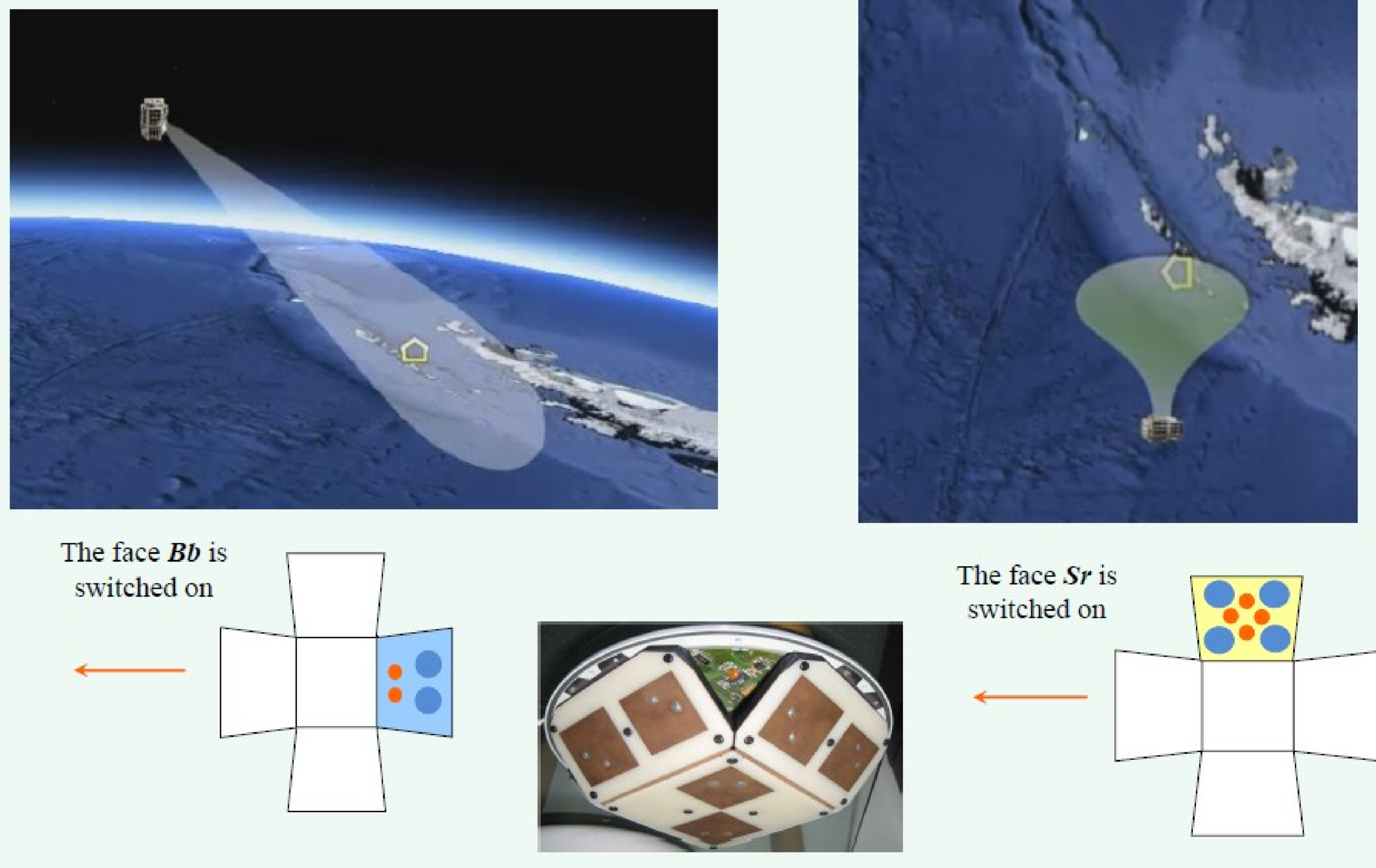
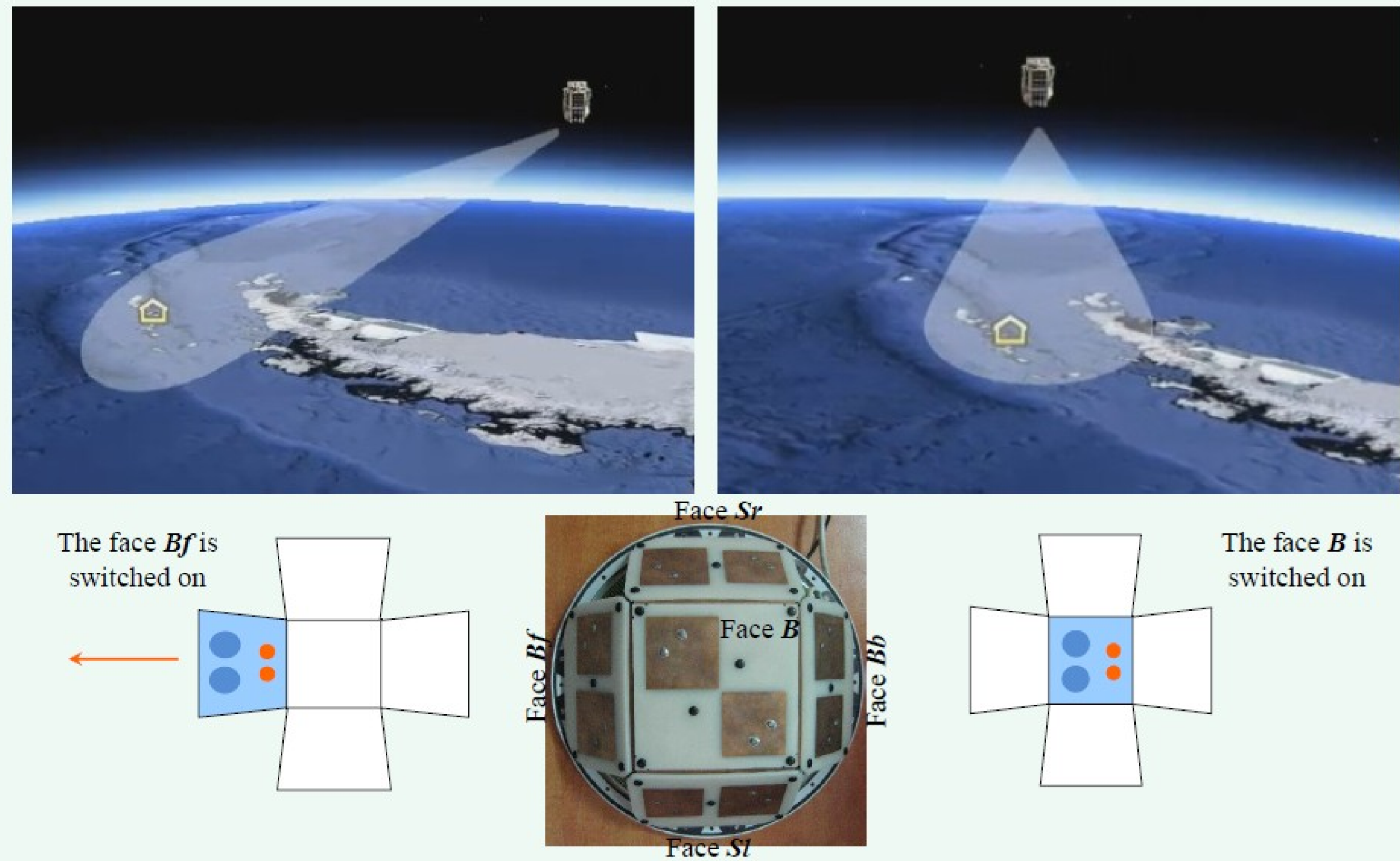
Conclusions

The main conclusion from the detailed analysis in this presentation is that the proposed development of so-called "communication functions" of university low-cost small satellites is completely feasible and 10-60 Mbps data-transfer bit rate in the S, C and X band is achievable at 1500-600-km orbit altitude. The main benefit appears when this communication function is combined with the primary "imaging function" (remote sensing) of Earth-exploration small satellites on lower-altitude orbits (400-800 km). In such a case, the improved downlink channel combined with the proposed time-extended communication sessions can easily carry out backhaul transfer of recorded data from the on-board computer with relatively small delay. In addition, at higher-altitude orbits (~1500 km), communication functions (not loaded with large data transfer from the satellite cameras) can easily carry out backhaul and off-line operational communications with remote Earth locations like the Antarctic and Arctic regions. In particular, the combination between communication and educational functions transforms university small satellites served by low-cost university ground stations into perfect high-performance scientific, communication and educational tools which will be continuously developed in the next few years. The proposed communication mode will be designed on a 50-kg small satellite similar to the Russian spacecraft "Yubileiny-1/2" at a 1500-km altitude near-to-polar orbit providing 11 Mbps in the C-band downlink channel during 15 min. long sessions.

Abstract

The proposed mission "SofiaUniversitySAT" is focused on development of the "communication function" of small university satellites for support and enhancement of science research and human activities in Antarctica. This function can provide a range of critically important services for Antarctic stations and expeditions, such as: high-speed two-way backhaul data transfer for scientific, safety and other applications using "store-and-forward" technology, off-line two-way operational communication services for professional, personal or rescue purposes, continental surface measurements of biological and natural phenomena; weather monitoring and forecasting, etc. Extensive preliminary investigation has been done: selection of suitable frequency bands for university satellites, optimization of on-board planar antenna arrays with adequate gain and directivity, link budget, etc. A concept of time-extended communication sessions between satellite and Antarctic ground station is developed, based on a switchable 5-face on-board antenna panels and steerable ground-station planar antenna panels. Three line-of-sight directions can be switched during a single session in "base" orbit (with trace over the ground station or max ±200 km away): forward, bottom and backward, and two additional lateral directions in two "side" orbits (±1500 km aside the ground station). Link budget in the X band shows that 30-60 Mbps bit rate for 3 min. or ~20 Mbps average bit rate for 9-10 min. in base orbit can be achieved in downlink direction using switchable on-board panels (~10 GB throughput).

Concept for Time-Extended Communication Sessions between the Small Satellite and the Ground Station



Implementation Plan

Future implementation of the proposed ideas is supported by several organizations in Bulgaria: Sofia University as a host of the unique Bulgarian Antarctic base "St. Kliment Ohridski" on the Livingston Island; CASTRA – Bulgarian Cluster for Aero-Space Technology, Research and Applications, Bulgarian Academy of Science, and the Bulgarian Antarctic Institute (BAI), member of several Antarctic organizations (COMNAP, SCALOP, EPB and SCAR), which support for realization of the proposed project is crucial.

For the practical assembly of the first Bulgarian university small satellite with well-developed communication function we have already started collaboration with the Siberian Aerospace University "Academician M. F. Reshetnev" in Krasnoyarsk, the Russian Federation. Our idea is to apply the currently developing new Russian universal small-satellite platform for incorporation of sufficiently universal communication equipment which will be implemented through our efforts in Bulgaria.