ATM-Sat
ATM Communication via LEO-Satellites

ATM-Sat

ATM-Sat develops methods for new ATM-based communication technologies for Low-Earth-Orbit (LEO) satellite systems. This is a technically challenging and strategically important R&D topic aimed at the Integrated German Space Program with an estimated market volume of US-$60 billion for the satellite communications market in the year 2000.

Fixed and portable multimedia communication everywhere

Multimedia services of the future have enormous demands in terms of bandwidth, availability and quality. The envisioned services will have to provide video and audio communication with high quality. They should enable the user to browse through the world-wide-web and use e-mail and other Internet services. The user expects to get these services everywhere with the same good quality: at home, at work, during business trips and vacations, even while in the car or in the airplane. Low-Earth-Orbit (LEO) satellites with on-board ATM switches are able to provide a scalable solution that can fulfill these demands. In LEO constellations a large number of satellites (typically 48-840) are placed at low altitude (below 3000 km).

Because of the low altitude the round trip time is below 30 milliseconds thus preventing the large communication delay of today's GEO satellites. On the other side is the short time during which a given satellite can be observed - typically between 10 and 20 minutes. Therefore an efficient handover technology must be developed to switch communication from satellite to satellite while preserving communication quality.

A key point in the LEO constellation is the inter-satellite links (ISL). Handover on ISLs and efficient routing algorithms ensure global communication with low delay and constant quality. To enable real-time services like audio and video as well as bulk data services like e-mail and WWW, ATM switching technology is used throughout the entire satellite network.

The satellites are equipped with ATM switches, containing signalling stacks and connection admission control algorithms. Placing the signalling completely on-board eliminates the additional delays and performance bottlenecks that occur when this functionality is placed in earth-based network control centers.

Integration with fixed networks

The use of ATM inside the satellite network enables seamless integration with fixed, earth-based networks. Gateways in the form of standard ATM switches, equipped with high bandwidth links to the satellite system provide connectivity to the telephone and ISDN networks, as well as to the Internet and to Intranets. This enables communication between ATM-Sat users and users on all other networks.

Intelligent Antennas

The Medium Access (MAC) Protocol is a key aspect of wireless systems. Especially for ATM, where the user can request a given Quality of Service (QoS) which the network has to guarantee, the MAC layer plays a major role. To meet the requirements of ATM a tight interaction between signalling, the MAC layer and the physical layer is needed. The unique MAC protocol developed for ATM-Sat provides guaranteed QoS for the service categories CBR (constant bit rate), non-realtime VBR (variable bit rate), UBR (unspecified bit rate) and UBR with minimum MCR (mean cell rate), providing at the same time multiple access for a large number of users (up to several thousand per satellite) and intelligent handling of errors introduced by shading and rain or snow. The MAC layer operates on a physical layer, that uses the Ka-band for transmission. The downlink transmission scheme provides support to use the inherent multicast capabilities of wireless satellite links that avoids cell duplication in the on-board switch.

This allows use of the ATM-Sat system for bulk transmission like radio, television or news distribution. In the Ka-band, directed antennas are used, that provide high gain. Active planar antennas, that are small enough to be portable, will provide two receive and one send beam at the same time, and be able to communicate with one satellite and locate the next satellite for handover operations. These antennas are complemented with a GPS-like positioning system and acceleration detectors, so that end systems can be located in cars, planes and other moving objects. Bigger antennas with higher gain and more beams can be used to connect gateway stations to the satellite system, that provide connectivity to earth-based sub-networks or to the fixed networks like telephone and the internet. This ensures the seamless integration of the ATM-Sat system with existing networks.

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