Terminal Architectures and Protocols

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ABSTRACT:

We consider a broadband satellite communications system supporting a number of service groups using a flexible Multiple-Frequency Time Division Multiple Access (MF-TDMA) system with re-configurable frequency-time plans. The advantage of MF-TDMA over pure FDMA is its flexibility and ease of implementation. Each terminal transmits at its assigned rate and not at the aggregate rate. This results in reduced power requirement and, therefore, smaller antennas and power amplifiers.

The supported service groups can be classified into two main categories: broadband satellite access (BSA) for two-way interactive multimedia services, and private business network (PBN).

The first category, BSA, provides two-way broadband access for residential interactive multimedia services such as video-on-demand, news-on-demand, webcasting. The satellite communications system supports a number of service-provider groups. Each group has one service-provider station connected to many user-terminals in a star topology. The satellite bandwidth/capacity is shared by the service-provider groups to provide both upstream (from user-terminals to service-provider station) and downstream (from service-provider station to user-terminals) connections.

The second category, PBN, provides interconnections of various remote plants of the same company in a mesh topology to form a business private network (BPN). Such a BPN consists of several user-terminals; each connected to the router of a LAN in a given plant. A satellite system can support a number of BPN's by sharing the satellite bandwidth/capacity. The inter-LAN services over broadband satellite systems should satisfy the end-to-end QoS requirements and efficiently utilize satellite resources. We have considered interconnection of IP-based LAN's using IPv6 and RSVP to support both real-time services of varying degrees of QoS such as videoconferencing, web browsing, and non-realtime, best-effort services such as FTP.

In order to maximize the utility of satellite resources in a bursty traffic environment, dynamic capacity allocation (DCA) approach based on the combined free/demand-assignment multiple-access (CFDAMA) scheme is adopted. Capacity allocation to different service groups and to user-terminals in each group is controlled by the scheduler located in the Master Control Station (MCS) or on board (in case of satellite communications system with on-board processing capability).

In the BSA category, the service-provider station in consultation with the MCS performs connection admission control in each group. During a connection, the scheduler based on the instantaneous needs allocates capacity required by the user-terminal and service-provider station. Traffic in the downstream has relatively high load and is less bursty. A constant, steady capacity allocated to the service-provider station may be adequate. On the other hand, traffic from a user-terminal has a low load and bursty. For example, during a video-on-demand connection, the user-terminal may need infrequent transmission of short commands. Therefore, capacity allocation in the upstream requires a dynamic scheduling to efficiently share the uplink bandwidth among a large number of user-terminals.

In the BPN category, traffic from different user-terminals has a relatively equal load. Connection admission control is negotiated between two involved user-terminals in consultation with the MCS. The scheduler performs capacity allocated to the user-terminals during a connection.

The main objectives of this research work are to develop terminal structures and air-interface protocols with special emphasis on the medium access control (MAC) sub-layer suitable to support the above mentioned services while maintaining the required quality of service (QoS) of various services and high utility of satellite resources. In developing the protocol, we examined the related systems/protocols such as DAVIC, DOCSIS 1.1, BWA (Broadband Wireless Access), BRAN.

We have considered the feasibility in using both traffic parameters for each connection available in the RSVP and on-line monitored traffic indicators from the user-terminal such as the incoming traffic load and queue length to derive estimated and predicted indicators used in the DCA and traffic control algorithms. Formal techniques are used to specify and validate the proposed air-interface protocols and terminal structures. SDL models of the functional blocks of the user-terminal, service-provider station and master control station, and the signaling scheme to support the traffic control, capacity request and allocation mechanism will be described.