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ABSTRACT - The multi-frequency time-division multiple access (MF-TDMA) has become general in satellite communications. In this paper, we developed a simulation model for MF-TDMA-based satellite networks using OPNET simulator. With the simulator, we evaluated the efficient use of DAMA schemes using MF-TDMA compared to PAMA based on FDMA.

Key Words: Satellite Communications, MF-TDMA, OPNET, Simulation Study, DAMA, PAMA

1. INTRODUCTION

Evaluating performances of a satellite communication system is often costly, even impossible for systems in development phase. M&S (Modeling and Simulation) is most important tools at this phase to inspect a suitable requirements and solutions.

The multi-frequency time-division multiple access (MF-TDMA) has become general in satellite communications. The access method used for the NCW (Network Centric Warfare) is MF-TDMA which is an excellent choice when a mixed network with different terminal capabilities are to be supported[1]. It has great promises in multimedia networks such as commercial broadcasting, long-range military communication and emergency rescue. MF-TDMA allows a large number of users to dynamically share satellite resources efficiently.

In DVB-RCS standard[2][3], a return channel satellite terminal (RCST) sends a message, capacity request (CR), to the Network Control Center (NCC), after it has scheduled how to request timeslots needed. An RCST may explicitly requests the needed capacity to the NCC in a Demand Assignment Multiple Access (DAMA) scheme. The NCC then allocates return channel timeslots based on each CRs.

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terminals or users, are capable of buffering the traffics arriving from the user applications, before transmitting CRs to the satellite link. In a RCST, there can be heterogeneous services, and these are requested to be supported the Service Level Agreements (SLAs).

Fig. 1. MF-TDMA procedure

In this paper, we develop a military satellite network simulator based on MF-TDMA, and evaluate its performances compared with FDMA-based PAMA networks. For the simulator, OPNET simulation software is used.

2. IMPLEMENTATION OF MF-TDMA SIMULATION MODELS

To evaluate the performances of the MF-TDMA operation, we implemented simulation models using OPNET [4] as shown in Fig. 2. The model consists of three OPNET node models such as SAT (Satellite), NC (Network Controller) as NCC, and NM (Network Member) as RCST and terminals as shown in Fig.3.

TBTP and C2P are all implemented on NC_MAC, user traffic scheduling mechanism is implemented on NM_MAC, and user traffic is delivered through NM_Eth_Intf. Satellite propagation link (SAT_Link) is modeled as a simple pipe to covert from uplink signal to downlink signal. We set the propagation delay as 250ms with varying BER (Bit Error Rate) characteristics.

For traffic generations, self-similar traffic model is considered according to the self-similarity phenomenon study on the aggregate IP traffic in [5].

Fig. 2. OPNET Simulation Model for MF-TDMA Satellite Networks

3. EXPERIMENTAL RESULTS

The delay for different traffic classes are compared through the MF-TDMA-based satellite networks. For the traffic differentiation, DiffServ (differentiated services) mechanism is utilized.

As shown in Fig. 4, with the DiffServ operation, EF traffic delay can be guaranteed below a specified
delay requirement even the high traffic intensity environments. On the other hand, the delay of BE class traffic increases as the traffic intensity increases.

The efficiency of MF-TDMA is compared to that of FDMA-based PAMA (Pre-Assigned Multiple Access) scheme. Resources are constantly assigned to each user in PAMA scheme, while MF-TDMA assigns the resources on demand by considering the condition of the resources’ usages.

In Fig. 5, number of acceptable terminals when traffic burst ratio varies. The traffic burst ratio is defined as the ratio of peak rate to average rate. As shown in Fig. 5, as the burst ratio increases, i.e. the traffic variation becomes larger, the number of acceptable terminals significantly improved compared to PAMA.

4. CONCLUSION

Modeling and Simulation (M&S) work is a very cost effective and efficient method to perform performances evaluation and to validate network protocols. In this paper, we developed a simulation model for MF-TDMA-based satellite networks using OPNET simulator. With the high utilization feature of MF-TDMA scheme, MF-TDMA scheme is expected to be one of the promising resource management schemes for next generation satellite systems. Our study on developing the MF-TDMA-based satellite simulation model can contribute to the construction of those next generation satellite systems.

REFERENCES