A Study on the Multi-Frequency Time Division Multiple Access Transmission Method + Single Channel per Carrier Application to Ship satellite systems

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Abstract. The ships have been using satellite as a major communication tool both in ground as well as maritime command units. There are various kind of information, such as sign, voice, message, picture and video, that should be shared between vessels and ground units. Although the ships utilized FDMA in the initial stage of the satellite procurement, MF/TDMA method is recently applied as means to transmit information. Both FDMA and MF/TDMA, however, are not the best means of data transmission as the number of bandwidth is limited for both methods. Thus, in order to provide a solution for this problem, a research on applying MF-TDMA + SCPC has been conducted for the Navy’s satellite communication system. When this technology is to be applied, the efficiency of the satellite network within the original frequency bandwidth will be maximized and eventually bringing networking flexibility, expandability, dependability as well as economic feasibility.

Keywords: Satellite communications, multi-frequency time division multiple access, the network, reliability, scalability

1 Introduction

In a satellite system, there is used the technology that multi earth stations connect simultaneously in order that a lot of users can efficiently use a communication channel at the same time, and this technology is called as the multiple access. However, this transmission method is not enough for reliably communicating substantial information in short time within limited frequency bands, so it is the situation that needs researches about somewhat more efficient transmission methods as well as guarantees the reliability of transmission. As an improvement plan, this study carried out a research about a method applying the SCPC (Single Channel per Carrier) technology to the MF-TDMA in the shipboard satellite communication

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system so as to guarantee the data transmission’s reliability and continual communication of substantial information in the special situation of marine.

2 Relevant Research

2.1 Satellite Communication System’s Data Transmission Method

FDMA. The FDMA is the method continually using a channel in a frequency band without any time limit by dividing the frequency’s band width and using them [1]. As representative FDMA methods, there are the SCPC method which is suitable for a satellite communication network having low traffic and numerous earth stations, and the MCPC (Multiple Channel per Carrier) transmitting many channels with only one carrier wave.

MF-TDMA. MF-TDMA is the method enabling several earth stations to share one satellite repeater by inserting the same frequency into each different time zone being assigned to each earth station in order to avoid from overlapping several earth stations’ frequencies on the satellite repeater [1]. This transmission method has the disadvantages like that it needs to be synchronized for avoiding from any interference, and its signal processing is complex [4].

MF-TDMA + SCPC. MF-TDMA + SCPC method assigning channels to multi operators by applying the SCPC to the MF-TDMA enables to support a network structure where terminals having various frequency bandwidth lengths are mixed by using the technique of resource assignment. The method of MF-TDMA+SCPC can set a specific frequency hopping pattern and operate it, keep its efficiency for resource assignment even in a network where terminals having various frequency bandwidth’s lengths are mixed by applying the technique primarily assigning the time assignment depending on a mission’s characteristic or data type and the method assigning frequencies at the same time, and also secure the reliability of data transmission with more important continual data transmission as well as responding against the consecutive jamming of control channel at the same time and finally improve the transmission speed and increase the traffic [5]-[8].
3 Application of Transmission Method of MF-TDMA + SCPC

3.1 Review about Applying the MF-TDMA + SCPC to a Marine Ship Satellite Communication System

As seen the above, the FDMA method has the limit that it sends a RF carrier wave and occupies a repeater even in a time not using a repeater, that is, not calling and the MF/TDMA method has some limits like that it should make its bit rate higher than that of FDMA and also requires bigger EIRP (Equivalent Isotropic Radiated Power), and even it is limited in operating in case of failing the synchronization. Therefore this study applied the MF-TDMA + SCPC method to a Satellite Communication System in order to overcome the both methods’ disadvantages and maximizing their advantages, and consequently in order to secure the reliability of a satellite communication system, to increase the traffic and improve the transmission speed.

3.2 Advantages & Disadvantages by Transmission Method

The [Table 1] shows the results comparing the above mentioned communication methods in terms of reliability, frequency efficiency, countermeasure against any radio disturbance and the net operability as the most important factors in a satellite communication system

Table 1. Comparison of the Transmission Methods: FDMA, the MF-TDMA & the MF-TDMA+SCPC.

<table>
<thead>
<tr>
<th>Classification</th>
<th>FDMA</th>
<th>MF/TDMA</th>
<th>MF/TDMA+SCPC</th>
<th>Remark (Importance Degree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunk Reliability</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Frequency Traffic</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Countermeasure against Electric Wave Interference</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Network Operability/Management</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

In the aspect of trunk’s reliability, the both transmission methods of FDMA and MF/TDMA+SCPC showed high reliability. For the frequency efficiency comparing the transmission methods according to the frequency traffic, the methods of MF/TDMA, and the MF/TDMA+SCPC showed high efficiency. And in the aspect of countermeasure against a radio disturbance, the MF/TDMA+SCPC method got high point. And in the field of operability managing a satellite communication network, it was analyzed that the both methods of MF/TDMA and the MF/TDMA+SCPC showed high operability.
As seen in the above, the results applying various roll off factors and several digital modulation ways to the MF/TDMA + SCPC and comparing them could demonstrate that the MF/TDMA + SCPC method was the optimal transmission method meeting the both items of trunk’s reliability and the frequency traffic which were more important than other items. Besides, if there are applied additional, various good transmission techniques to the transmission except the MF/TDMA + SCPC method, then it is expected to get better results in terms of traffic in a given, specific frequency band, the transmission speed and the reliability of transmission.

4 Conclusion

This study compared three transmission methods of FDMA, MF-TDMA and the MF/TDMA+SCPC that set their necessary communication routes in several earth stations in use of a communication satellite. As the results from comparing and analyzing them in terms of application concept, characteristics, advantages & disadvantages, it was found that the MF/TDMA+SCPC method had the most numerous advantages in the test items of the trunk’s reliability, the data traffic, the countermeasure against a radio disturbance, the network management, and the operability comparing to the other methods of FDMA and MF/TDMA. The reliability of satellite communication and traffic which are especially more important can be improved at the same time by applying the optimal modulation way and the roll of factors to the MF/TDMA + SCPC, and through such improvement, the MF/TDMA + SCPC method will improve its traffic and its transmission in a same frequency band speed as well as guarantee the reliability of data transmission by overcoming the limits of FDMA and MF/TDMA transmission methods. In order to apply the MF/TDMA + SCPC method to a marine ship satellite communication system, it needs to research considerations like identifying the requisites for changing and adding any H/W and S/W in relation to the application of this method.

References