Selected Paper

Architecture of Group MODEM with Timesharing Processing for Satellite Communication

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Satellite Telecommunication Technical Group of IEICE, Japan and Korean Society of Space Technology held Joint Conference on Satellite Communications 2002 (JCSAT 2002) at Daejeon, Korea on Oct 10-11.

Numbers of papers were presented and active discussions were seen for each presentation. The following is abridgment of the paper entitled “Architecture of Group MODEM with Timesharing Processing for Satellite Communication Networks” presented at the conference. NTT has developed the Multicarrier/Multirate Group MODEM for satellite communication network that support up to 256 carriers simultaneously. The bandwidth of each communication channel can be set individually.

1. Multicarrier/Multirate Group MODEM Features

The proposed Multicarrier/Multirate Group MODEM can handle multiple connections. The features of this modem are listed below.

A) The number of carriers and the bandwidth of each carrier are variable, as shown in Fig.1.

B) The developed modem supports channel assemble/de-assemble function. This feature allows the modem to transmit the required bandwidth over dispersed frequency bands as shown in Fig. 2.

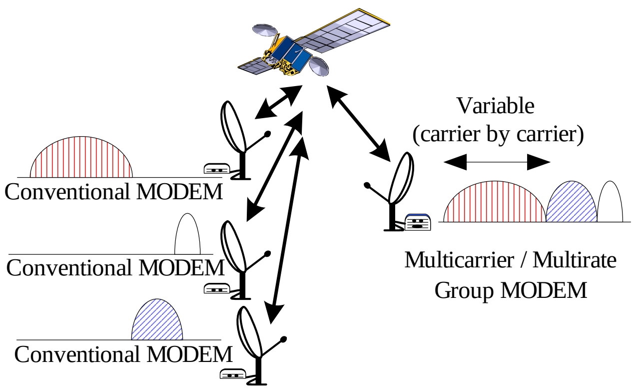

Fig. 1 Simultaneous communication

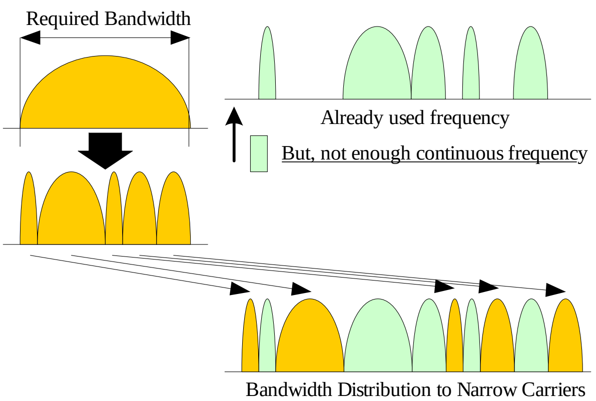

Fig. 2 Allocation of required bandwidth over dispersed frequency bands

2. Composition of the modem

The architecture of the modem is shown in Fig. 3. This modem is comprised of a control module, interface modules, and modem modules. The modules are connected via a local bus. The control module supplies the master clock and internal timeslot index to interface modules and modem modules. The interface modules provide the functions of user interface driver, and framing /de-framing, and encoding/decoding.

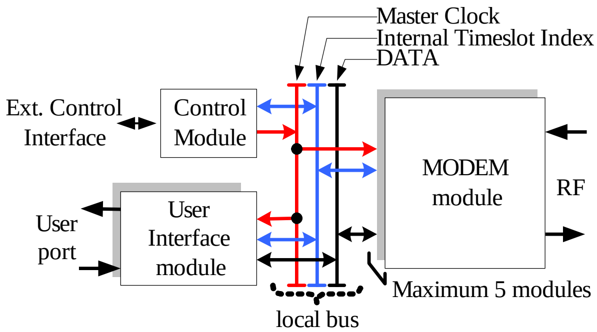

Fig. 3 Block diagram of Multicarrier/Multirate MODEM

2.1. Structure of modem module

The modem module, the main component of the modem, is composed of five function blocks that are implemented on one LSI chip. They are a group modulator block, a group demodulator block, two multirate filter banks for multiplexing/demultiplexing blocks, and single modem as shown in Fig. 4. An important point to emphasize is that the group modulator/demodulator and multiplexer/demultiplexer are operated in a timesharing manner under the control of common clock and algorithm.

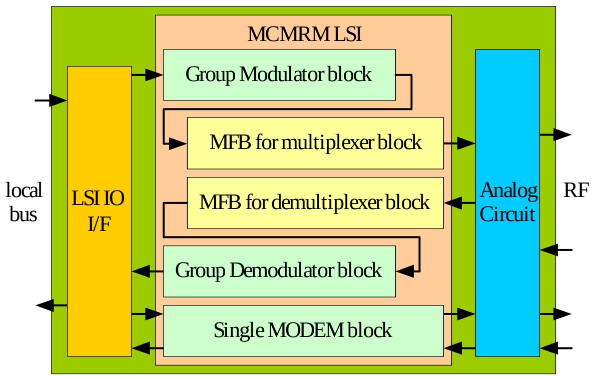

Fig. 4 Block diagram of MODEM module

2.1.1. Multiplexer/Demultiplexer blocks

The conventional multiplexer/demultiplexer block employing multirate filter bank has two problems. First is performance degradation. The 2-channel filter bank in that multiplexer/demultiplexer uses Quadrature Mirror Filters. This, unfortunately, suffers interference by aliasing signals created by decimation to overlap the channel being multiplexed/demultiplexed. The decimated signals are distorted by this overlap effect. Moreover, if the channel to be multiplexed/demultiplexed is not in the flat portion of the pass band of the selected filter, it suffers amplitude distortion. To solve this problem, we use four half-band filters. Because the pass band of these filter are flat, the signal does not experience amplitude distortion. And from the relation between decimation rate and bandwidth of pass band, the aliasing that created by decimation were not overlapped this pass band.

Second, the tree structured conventional MFB has an inherent problem in terms of circuit scale, because the circuit scale increases with the number of the carriers to be handled. This problem is solved by the introduction of a MFB with timesharing. A block diagram of the proposed multiplexer/demultiplexer block is shown in Fig. 5.

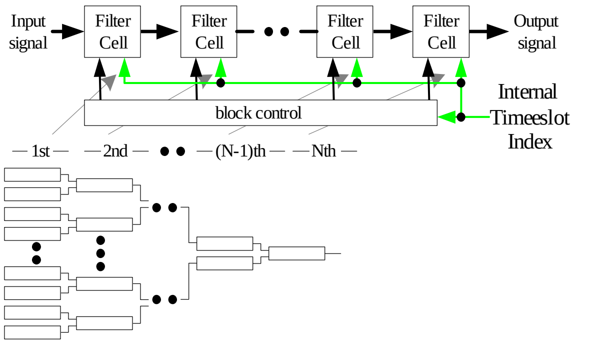

Fig. 5 Block diagram of proposed multiplexer/demultiplexer

2.1.2. Modulator/Demodulator blocks

Also, timesharing was applied to the modulator/demodulator to reduce the circuit size. The modulator is composed of Binary Transfer Filter (B.T.F.) for mapper and pulse shaping filter, re-sampler, RAM for timesharing processing, and ROM to hold the common parameters. The block of timesharing demodulator is composed of pulse shaping filter, re-sampler, carrier and clock recovery block, de-mapper, RAM, and ROM. In the proposed modulator/demodulator, the size of I/O buffers is minimized by batch processing the input signal while controlling the processing timing assigned to each channel.

3. Performance Evaluation

A prototype multicarrier/multirate modem module was developed and its performance was evaluated. The main circuit of the prototype module was implemented within a single LSI as shown in Fig. 6. Major prototype module parameters are listed in Table 1. The output spectrum shown in Fig. 7 demonstrates that the bandwidth can be freely varied. Bit Error Rate performance versus E_b/N_0 is shown in Fig. 8. The overall BER performance as measured in bench tests was very close to predicted by QPSK theory.

4. Conclusion

This paper has described the principle and the structure of a highly efficient Multicarrier/Multirate group MODEM for satellite communication systems. The basic characteristics of a developed modem were clarified.

Table 1 Major Prototype MODEM module parameters

No. of carriers	0～256
Modulation rate per carrier	32 kHz ～25.6 MHz
Modulation schemes	QPSK, OQPSK, π/4QPSK, BPSK
Roll-off factor	0.2, 0.35, 0.4, 0.5
Demodulator function	Coherent detection AFC : (±12.5 kHz with minimum carrier rate) AGC : 10 dBp-p

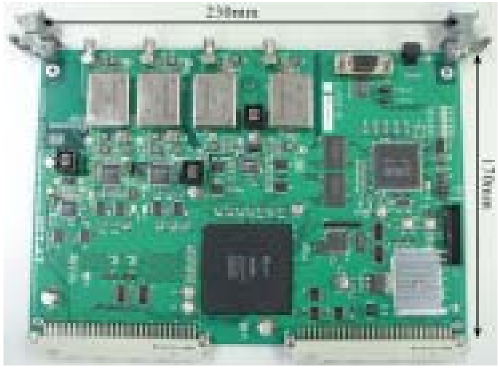

Fig. 6 MODEM module

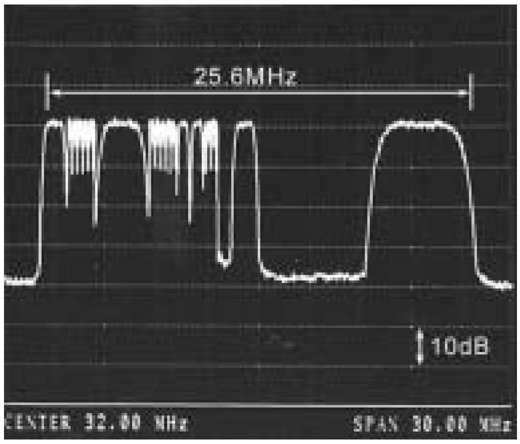

Fig. 7 Output spectrum

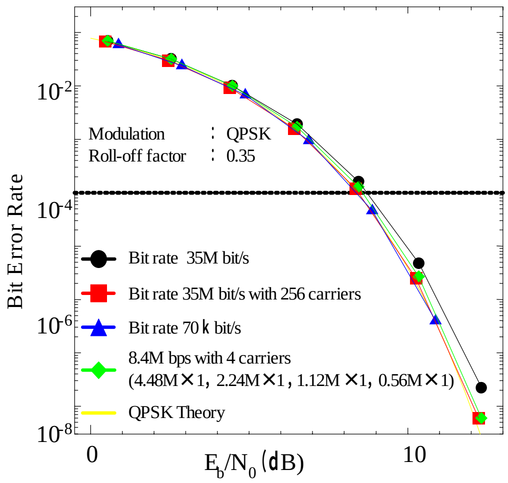

Fig. 8 The bit error rate of the developed modem