

Design of a New Multiuser Code

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Abstract

In this paper we give a design for a new multiuser line coding scheme that achieves some advantages over quadrature amplitude modulation (QAM). The 4-user code illustrated here gives 2 bits/channel user. A constellation diagram is given for the new scheme, which looks similar to the 16-point QAM, but it is different in two aspects. First this scheme allows multiple users. Secondly it employs simple scalar addition of the users' signals in each time slot. This line code does not need phase information, and hence has smaller synchronization requirements. U communication channel users each independently select one of M symbols coded as B bits (binary) from his independent alphabet A_u , of M symbols as shown in Figure 1. The M symbols might be added decimally either a) in the transmitter or b) at the receiver. We specifically are concerned with a), addition in the transmitter, as in cable or point-to-point radio. The vector V whose B elements are the individual bit sums must uniquely specify each user's symbol that contributed to the sum.

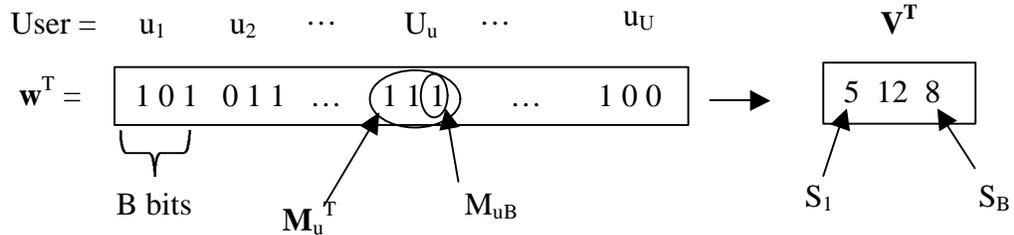


Figure 1. Makeup of U users' B -bit binary symbols m_j constituting their concatenated source symbol word, w , along with the associated sum vector V composed of B bit sums S_b from the U symbols.

We answer the questions,

1. How many sum vectors V can there be?
2. What are the maximum number U of users that can use B bits; alternately, given U users, what is the minimum number B of bits that is required.
3. How can we uniquely determine the user symbols associated with each V ?

A communication scheme can be designed in such a way that for any combination of the U -users data, a unique point from a constellation diagram is sent. Tables present the limits on U and M , and the resulting code rate $R = \log_2 M * (U / B)$ information bits/dimension. A comparison between QAM and the new code and detailed examples of a 4-user code, with 2 bits/channel user are given. The advantage of the new scheme is that it can introduce higher rates by using more than two time slots (i.e. higher dimensional space) using the same type of carrier. The scheme utilizes lookup tables to ease implementation. It employs one type of carrier (cosine only) and does not require perfect phase synchronization – an advantage over QAM.