G has a clique of size at least k. The clique number is an obvious lower bound on the chromatic number of a graph, since all vertices in a clique must be colored differently (this bound is not tight as there are graphs G for which the gap between $\omega(G)$ and $\chi(G)$ becomes arbitrarily large [7]). It is well-known that both the coloring and the clique problem are NP-complete. Moreover, both problems are also difficult to *approximate:* the problem to determine a coloring using at most $|V|^{1/7-\varepsilon}\chi(G)$ colors, and the problem to find a clique of size at least $|V|^{\varepsilon-1/4}\omega(G)$, are NP-hard for each $\varepsilon > 0$ [5]. This implies, in particular, that it is not possible to approximate the optimization versions of these problems within constant performance ratio in polynomial time, unless P = NP.

Another type of NP-complete problem we deal with in this paper is the *bin packing problem.* Given a set X with positive element sizes μ_x, $x \in X$, and $M > 0$, an *M-packing* of X is a set $\mathcal{B}$ of mutually disjoint subsets of X s.t. $X = \bigcup_{B\in\mathcal{B}} B$ and the total size $\mu_B = \sum_{x\in B} \mu_x$ of each "bin" $B \in \mathcal{B}$ is at most M. The bin packing problem is, given X, μ, M and a nonnegative integer k, to decide whether X has an M-packing $\mathcal{B}$ of size at most k. We also let $p_M(X)$ denote the minimum size of an M-packing of X, called the *M-packing number* of X. In contrast to the chromatic and clique numbers, the packing number can be approximated with good performance quite easily, using a simple kind of "greedy" procedure known as the *first-fit* packing algorithm [6]; we discuss this algorithm in Section 5.

2 Background

Some background information about DAB will help to motivate the problem we consider. The main features of the DAB system are the following:

- "almost-CD" audio quality while retaining reasonable bandwidth requirements using the "MUSICAM" (a.k.a. MPEG 1 Audio Layer 2) encoding;
- transmission of additional "data services" such as traffic information, HTML pages and even digital video;
- a special coding method ("COFDM" = "coded orthogonal frequency division multiplex") allows to transmit multiple radio programs and data services on a wideband channel, and provides for effective error protection and reliable reception even in mobile environments (cars, trains, etc.).

A DAB channel or "block" generally has a width of 1.536 MHz, which corresponds to a gross bit rate of 2.432 Mbit/s. This bandwidth is split up into several components: 32 Kbit/s for synchronization purposes; 96 Kbit/s for the so-called "Fast Information Channel" (FIC) which contains configuration information (contents of the transmitted ensemble and such); and finally 2.304 Mbit/s for the "Main Service Channel" (MSC) which contains the actual data (the ensemble of radio programs and other services) to be transmitted. The net transmission rate on the MSC depends on the error protection level and ranges up to 1.824 Mbit/s. As already mentioned, audio data is compressed using