

CLAIMS

1. A method for dynamic high-frequency (HF) frequency allocation management in a broadband communication network containing a plurality of users, a set of N_0 frequencies $S = \{f_i\}_{i=1}^{N_0}$, N_0 being allocated to each user, N_0 being a positive integer, each frequency in the set S having one or more authorised service level agreements (SLAs) services, a maximum power level $P_{\max}$ for each SLA service and an associated usage type, the method comprising the following steps:
 - 5 determining a sub-set S' formed as an intersection of a range of passing frequencies for a user for a given link in the broadband communication network and SLA service of the set S ,
 - 10 establishing a set of eligible frequencies S'' in a transmission range of the user with the different power and modulation configurations for said each frequency, the set S'' including an intersection between the set S and the range of passing frequencies in the sub-set S' ,
 - 15 analysing a received spectrum in order to determine the frequency or frequencies already used and deciding, on the basis of an associated usage type of said frequency or frequencies, whether said frequency or frequencies must be excluded in order to form a set S''' of N possible frequencies f_l ,
 - 20 for each frequency f_l of the set S''' , determining a necessary power $\widetilde{P}_l^j, i=1..N, j=1..m$ with N being a number of frequencies in the set S''' , m being one of a plurality of rate/waveform configurations, for each of the m possible rate/waveform configurations, taking into account a power limit on said each frequency f_l ,
 - 25 allocating the frequencies f_l of the set S''' to different users, respective modulation and power of the frequencies f_l , by taking account of multi-carrier constraints including a maximum total band, a total power, a conformity of the transmitted spectrum resulting from a simultaneous use of the frequencies f_l with an eligible power frequency pattern.
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2. The method according to claim 1, wherein, for a user and a particular SLA concerned, the list of the m possible rate/waveform configurations for the particular SLA is determined during an operation of the method.

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3. The method according to claim 1, wherein the necessary power $\widetilde{P}_i^j, i=1..N, j=1..m$ is determined by applying the following rule:

$$\begin{aligned} \text{if } \widetilde{P}_i^j > P_{tot} \text{ then } P_i^j &= P_{tot} + 1 \\ \text{if } \widetilde{P}_i^j \leq P_{tot} \text{ then } P_i^j &= \widetilde{P}_i^j \end{aligned}$$

where P_{tot} denotes a total overall transmit power level of a transmitter in the broadband communication network, $i=1, \dots, N$, and $j=1, \dots, m$ with m being the number of the rate/waveform configurations.

4. The method according to claim 1, wherein a rate/power cost function is used to determine the different power and modulation configurations for said each frequency.

5. The method according to claim 1, wherein a cost function

$$\zeta = \frac{\text{rate}}{\text{power}}$$

and the costs

$$\zeta_i^j = \frac{d^j - d^{j-1}}{P_i^j - P_i^{j-1}}$$

are defined in different increments arranged in ascending order, wherein d^j is the rate for the configuration j , d^{j-1} is a rate for a configuration $(j-1)$, P_i^j is a power for a configuration j and a frequency i of the set S , P_i^{j-1} is a power for the configuration $j-1$ and the frequency i of the set S .

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6. The method according to claim 1, wherein a step of resolution under said allocating is carried out according to a required criterion by using one of the following criteria:

determining a target rate D using a minimum overall power

$$\min \sum_{i=1}^N \sum_{j=1}^m x_i^j P_i^j \left| \sum_{i=1}^N \sum_{j=1}^m x_i^j d^j \geq D \right.$$

where D is a target rate, d^j is a rate for a j^{th} configuration, P_i^j is a power for a configuration j and a frequency i of the set S , x_i^j is an assignment variable, or

determining a maximum rate under the constraint of a total overall transmit power level

$$P_{\text{tot}} \max \sum_{i=1}^N \sum_{j=1}^m x_i^j d^j \left| \sum_{i=1}^N \sum_{j=1}^m x_i^j P_i^j < P_{\text{tot}} \right.,$$

where n is a maximum number of 3 kHz channels concerned P_{tot} is a total overall transmit power of a transmitter in the broadband communication network.

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7. The method according to claim 6, wherein an integrity constraint of a frequency modulation choice of the frequencies is used, represented by the integral variable x_i^j :

$$\forall i=1..N, j=1..m \ x_i^j \in \mathbb{N}$$

$$\forall i=1..N, \sum_{j=1}^m x_i^j \leq 1$$

$$\sum_{i=1}^N \sum_{j=1}^m x_i^j \leq n$$

20 a set of x_i^j values ($i=1$ to N , $j=1$ to m) satisfying the following integrity constraints, where x_i^j is an assignment variable, with $i=1$ to N , $j=1$ to m , m being a number of the rate/waveform configurations.

8. The method according to claim 7, wherein the integral variable has the value 1 when the frequency f_i is used with the rate d^j of the j^{th} configuration.

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9. The method according to one claim 1, wherein said steps are carried out for fourth-generation or 4G high-frequency transmissions.

5 10. A system for dynamic high frequency (HF) frequency allocation management in a broadband communication network including a plurality of users, a set of N_0 frequencies $S = \{f_i\}_{i=1}^{N_0}$, N_0 being allocated to each user, N_0 being a positive integer, each frequency in the set S having one or more authorised service level agreements (SLAs), a maximum power level $P_{\max}$ for
10 each SLA in the one or more authorized SLAs and an associated usage type, each user comprises a frequency plan storage memory for the SLA and at least a processor adapted for carrying out:

determining a sub-set S' formed as an intersection of a range of passing frequencies for a user for a given link in the broadband communication network
15 and SLA service of the set S ,

establishing a set of eligible frequencies S'' in a transmission range of the user with the different power and modulation configurations for said each frequency, the set S'' including an intersection between the set S and the range of passing frequencies in the sub-set S' ,

20 analysing a received spectrum in order to determine the frequency or frequencies already used and deciding, on the basis of an associated usage type of said frequency or frequencies, whether said frequency or frequencies must be excluded in order to form a set S''' of N possible frequencies f_l ,

for each frequency f_l of the set S''' , determining a necessary power
25 $\widetilde{P}_l^j, i=1..N, j=1..m$ with N being a number of frequencies in the set S''' , m being one of a plurality of rate/waveform configurations, for each of the m possible rate/waveform configurations, taking into account a power limit on said each frequency f_l ,

30 allocating the frequencies f_l of the set S''' to different users, respective modulation and power of the frequencies f_l , by taking account of multi-carrier constraints including a maximum total band, a total power, a conformity of the

transmitted spectrum resulting from a simultaneous use of the frequencies fl
with an eligible power frequency pattern.

11. The system according to one claim 10, wherein said system is
5 implemented for fourth-generation or 4G high-frequency transmissions.