Sum-Rate Maximisation Comparison using Incremental Approaches with Different Constraints

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Overview

1. Aim
2. Greedy Approaches
3. Simulation Results
4. Conclusions

Aim

- Exploring greedy approaches for both bit and power allocation
- Show the effect of constraints on system performance

Problem Statement

Sum-rate maximisation of a MIMO system of N subchannels

$$\max \sum_{i=1}^{N} b_i, \tag{1}$$

subjected to the constraints

$$\sum_{i=1}^{N} P_i \leq P_{\text{budget}} \quad \text{and} \quad \overline{\mathcal{P}}_b = \mathcal{P}_b^{\text{target}} \qquad \rightarrow \text{GPA} \tag{1a}$$

or

$$\sum_{i=1}^{N} P_i = P_{\text{budget}} \quad \text{and} \quad \overline{\mathcal{P}}_b \leq \mathcal{P}_b^{\text{target}} \qquad \rightarrow \text{GBA} \tag{1b}$$

and

$$M_k = \begin{cases} 2^{b_k}, & 1 \leq k \leq K \\ 0, & k = 0 \end{cases}, \tag{1c}$$

where $M_K = 2^{b^{\max}}$ is the maximum permissible constellation size

GPA algorithm

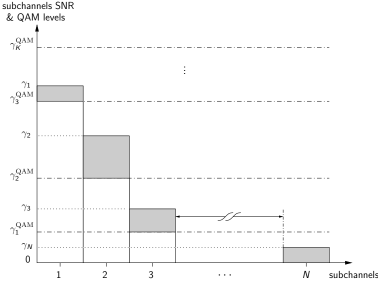
algorithm

1. Uniformly distribute transmit power budget among all subchannels
2. Reside all subchannels into QAM groups according to their SNRs

$$\gamma_k^{\mathrm{QAM}} = \frac{M_k - 1}{3}\left[Q^{-1}\left(\frac{1-\sqrt{1-\mathcal{P}_b \log_2 M_k}}{2\left(1-1/\sqrt{M_k}\right)}\right)\right]^2 \quad (2)$$

3. Iteratively allocate excess power among all subchannels using the greedy approach (as outlined in the previuos talk)

subchannels with UPA:



GBA algorithm

algorithm

1. Equally allocate power among all subchannels
2. Load all subchannels with the highest QAM level $M_K = 2^{b^{\max}}$
3. Compute subchannels BERs and avarage BER

$$\overline{\mathcal{P}}_b = \frac{\sum_{i=1}^{N} b_i \mathcal{P}_{b,i}}{\sum_{i=1}^{N} b_i} \tag{3}$$

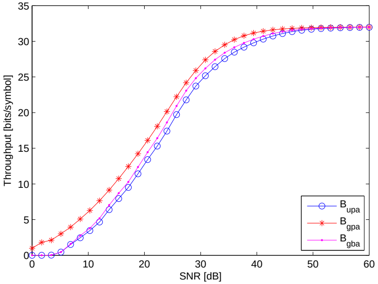
where

$$\mathcal{P}_{b,i} \approx \frac{1 - \left[1 - 2\left(1 - \frac{1}{\sqrt{M_k}}\right) Q\left(\sqrt{\frac{3\gamma_i}{M_k - 1}}\right)\right]^2}{\log_2 M_k} \tag{4}$$

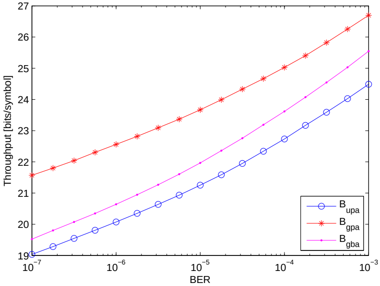
4. **If** $\overline{\mathcal{P}}_b \leq \mathcal{P}_b^{\text{target}}$ **end**
5. **Else** search for the subchannel with worst BER and re-allocate to the next less QAM level
6. **Repeat** (3)-(5) **Until** $\overline{\mathcal{P}}_b \leq \mathcal{P}_b^{\text{target}}$

Performance Evaluation

rate vs. SNR



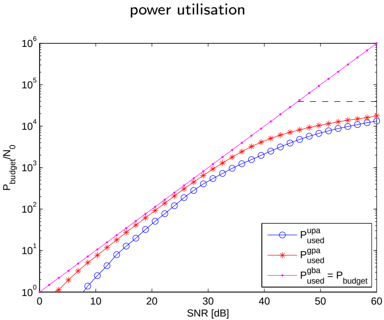
rate vs. target BER

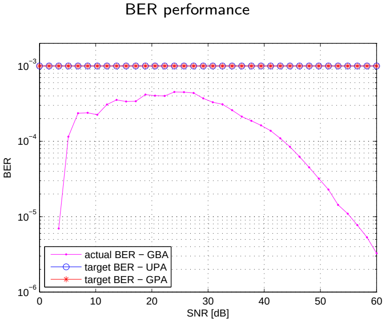


sum-rate performance

- A 4x4 frequency-flat MIMO system is considered
- System throughput is shown for UPA, GPA and GBA loading schemes against SNR and target BER

Performance Evaluation (Contd.)





constraints effect

- The effect of transmit power budget and target BER constraints is shown for UPA, GPA and GBA loading schemes

Conclusions

- Rate maximisation using greedy power GPA and bit GBA allocation schemes with different constraints is considered.
- Both algorithms share the main target of optimising the overall system throughput.
- GPA algorithm tackles this from the efficient power utilisation point of view keeping the target BER to its maximum requirements.
- GBA algorithm guarantees less average BER than target BER.
- This can be thought, respectively, as a conversion between achieving higher system throughput with target BER or attaining higher quality of service in terms of BER with some degradation in throughput, which is useful in design selection of systems with particular interests.

Questions

- Thank You — Any Questions