

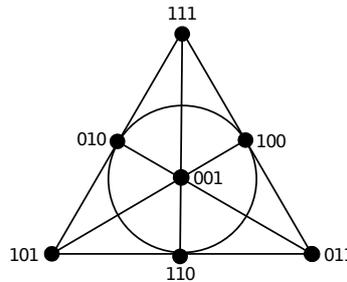


Distributed Systems Part II

Exercise Sheet 7

1 A Quorum System

Consider a Quorum System with 7 nodes numbered from 001 to 111, where each three nodes fulfilling $x \oplus y = z$ constitute a quorum. In the following picture this quorum system is represented: All nodes on a line (such as 111, 010, 101) and the nodes on the circle (010, 100, 110) form a quorum.



- a) Of how many different quorums does this system consist and what are its work and its load?
- b) Calculate its resilience f . Give an example where this quorum system does not work anymore with $f + 1$ faulty nodes.
- c) Calculate its failure probability if each node fails independently with a probability p .

2 The Resilience of a Quorum System

Does a quorum system exist, which still works although all nodes of a specific quorum fail? Give an example or prove its nonexistence.

3 S-Uniform Quorum Systems

Definitions:

S-uniform: A quorum system Q is *s-uniform* if every quorum in Q has exactly s elements.

Balanced access strategy: An access strategy W for a quorum system Q is *balanced* if it satisfies $l_W(i) = L$ for all $P_i \in P$.

Claim: An s -uniform quorum system Q reaches an optimal load with a balanced access strategy.

- a) Describe in your own words, why this claim is true.
- b) Prove the optimality of a balanced access strategy on an s -uniform quorum system.

4 Chubby

Chubby is a distributed lock management system, which is used in different settings, such as to provide locks for the Google File System (GFS).

- a) You have learned that Chubby provides coarse grained locking. What does this mean? Why did the designers of Chubby choose this approach?
- b) Chubby can manage multiple locks, and it is able to store meta-data to each lock. Describe how these properties can be used to implement a reliable name-service.
- c) A Chubby cell typically contains 5 servers. What would be the effect of using a smaller or larger number of servers per cell?