Assignment 1
Distributed Algorithms

Group 11
Dan Drewes
Manuela Hop
John Mercouris
Malte Siemers

Exercise 1.1: Warming Up

a) A distributed system is a system of independent machines that work together and communicate with each other by exchanging messages. Parallel computing is more along the lines of a single 'machine' executing a task. Additionally, the processors of a parallel computer can access shared memory.

b) We use distributed systems because they are cheap, can be very quick, are reliable, and can grow in a linear fashion. This makes it very attractive for several economic reasons.

c) In a synchronous model, the length of actions and the maximum delay of messages is restricted and known. In an asynchronous model, actions and messages can take arbitrarily long or the limits are unknown. The atom model is a partially synchronized model where the delay of messages is unknown and the length of an action is assumed to be timeless.

Exercise 1.2: Topologies

a) If the distance between u and v is δ, then there are $\delta!$ shortest paths between u and v as we can correct the bits that differ between u and v in an arbitrary order.

b) For each of the 2^d nodes there are $\binom{d}{k}$ nodes with distance k. Thus, there are $\frac{1}{2} \cdot 2^d \cdot \binom{d}{k} = 2^{d-1}\binom{d}{k}$ pairs of nodes that are connected with shortest path of length k.

c) Each dimension must be used exactly once but the order is arbitrary. Therefore, on a d-dimensional hypercube, $d!$ different spanning trees could be created from one start node.

d)

Exercise 1.3: Distribution of Information

a) Flooding in a bidirectional ring sends $n+2$ messages more than broadcast in a unidirectional ring. Since the number of nodes and edges in a ring a equal, we have $4e-2n+2 = 2n+2$ messages compared to n in the broadcast case.

Exercise 1.4: Election

b)

a)

b)