Technische Universität Berlin Fachgebiet Kommunikations- und Betriebssysteme	**Assignment 1** Distributed Algorithms
Winter Term 2015/16	Prof. Dr.-Ing. Reinhardt Karnapke, Mohannad Nabelsee
Deadline of submission:	November 10th, 2015 (per ISIS)
Discussion:	starting from November 11th, 2015

HINT:
Every group has to submit the solution for the assignment online at ISIS before the deadline expires. Please, only one submission per group!

Exercise 1.1: Warming Up

a) What is the difference between a distributed system and a parallel computer?

b) Why do we use distributed systems although they are complicated? Give examples.

c) What are the differences between the synchronous model, the asynchronous model and the atom model?

Exercise 1.2: Topologies

Consider a hybercube with dimension d.

a) Given two arbitrary nodes u and v from the hypercube. How many shortest paths are there between u and v?

b) How many different node pairs are there, that are connected with shortest path of length k?

c) Given the broadcast algorithm from the lecture to produce spanning trees on the hypercube. How many different spanning trees could be generated from the same start node by varying the dimension used for sending?

d) Would it be possible to do multiple broadcasts in parallel with the previous algorithm from the same start node? i.e. in the unit time model there exist at most one message on an edge.

Exercise 1.3: Distribution of Information

a) Implement the Flooding algorithm with acknowledgements using the simulation framework *teachnet* (provided at the ISIS course website). After finishing the implementation, test your algorithm on a ring topology and compare the amount of messages sent with the "Broadcast on Unidirectional Rings" using the same topology.

b) Implement the Echo algorithm using *teachnet* and evaluate the correctness of the amount of messages sent to be (2e) on various topologies. Highlight all edges that are part of the spanning tree.

c) An improvement of the Echo algorithm has been introduced (see lecture) that sends a set of tabu node IDs together with an explorer. Examine the behavior of the algorithm compared to the classical Echo algorithm in terms of message reduction under the assumption of the following topologies:

   (a) Bidiredtional ring with n nodes

   (b) Binary X-tree of height h (with 2^{h+1}-1 nodes)
   $\rightarrow$ *cf. lecture 2, slide 29*

Exercise 1.4: Election

a) Implement the algorithm of Chang and Roberts that have been introduced in the lecture. Afterwards evaluate the message complexity of your implementation compared to the formulas provided in the lecture given the following scenarios:

   (a) **Worst-Case:** Configure your topology that it reflects the worst-case scenario.

   (b) **Best-Case:** Configure your topology that it reflects the best-case scenario.

   (c) **Average-Case:** Configure your topology that it randomly assigns node IDs and examine the average message complexity calculated over several runs.

b) There is a precondition for the algorithm of Chang and Roberts that all node IDs have to be unique (no duplicate IDs). Assume, we drop this precondition and allow multiple nodes to have the same ID.

   (a) Does the algorithm still work properly? Please provide a reasonable answer.

   (b) In which cases does the algorithm still deliver a proper result? Explain at least two cases.