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|  | Distributed Algorithms – Project 1  Winter term 2017/18 | Danh Le Phuoc  & Qian Liu  ODS |
| *Exercise Sheet 1* | | |

**Exercise 1.1 Definitions**

1. **What is the difference between a distributed system and a parallel computer?**

Distributed system is defined as a graph DS = (N, E) ; where N denotes set on nodes and E denotes set of edges in the graph. N corresponds to set of individual processing units and E corresponds to set of links, which enable the communication between different machines. Tasks which are solved by the distributed system are solved on multiple physically remote machines, communicating through message exchange.

On the other hand, parallel computer is tightly bound to one physical machine, which is able to have multiple processing cores, or individual processors. Local memory is the shared resource which is used for mutual communication between processors. The task is distributed to these cores, which solve individual fragments in parallel, with the paradigm much like distributed system.

By taking into account similar approach in “Divide and Conquer” paradigm (Divide et impera), we can conclude that parallel computer is a subset of distributed system. It is limited to one machine whereas, distributed systems are not limited with regards to number of machines. Parallel computer has local communication between processes, while distributed system has network enabling the machines to be physically remote. Finally, as a result of unlimited number of nodes and the possibility of introducing new, and excluding non-functional nodes, distributed systems have higher processing power, are more modular, and scalable and are more immune to individual failures.

1. **Why do we use distributed systems although they are complicated? Give examples?**

Processing power

Modularity

Scalibility

1. **What are the differences between the synchronous model, the asynchronous model and the atom model?**

Synchronousmodel of a distributed system defines the upper and lower bounds for all the processes on individual nodes. This means that the information about the specific tasks (start time and end time) is available. The communication between nodes is also bounded, meaning that the delay time, needed for a message to be received is known in advance. Clock rates of individual nodes are known. Taking this into account, we are able to use timeouts as detecting failures. The expectancy of knowing all the time parameters of such complicated system is a long shot, so this model is mostly used in modeling and simulation.

Asynchronous model of a distributed system is contrary to Synchronousmodel. The delay in processing individual tasks is mutually independent and unknown. Most importantly, the messages, which carry information between nodes and enable parallelism and distribution, have nondeterministic delays, as a result of network traffic. Timeouts have no secure information. Reason for timeout may be one of the following:

* The message is delayed longer than usual (traffic overflow on the network)
* The message got lost (packet is dropped in the network or corrupoted)
* The sending process has send the message later than usual (congestion control)
* The sending process has crashed before it could send the message

Asynchronous models make no assumptions on process execution speed, communication delays or clock drift rates.

Atom Model makes assumptions that Processing is synchronous and communication is asynchronous.

[add more info]

**Exercise 1.2: Topologies**

**Consider a hypercube with dimension d.**

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

Len of shortest path in binary

1. **How many different node pairs are there, that are connected with shortest path of length k?**

\* num of nodes / 2 \* note – shortest path exactly k!

1. **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?**
2. **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**

1. **Implement the Flooding algorithm with acknowledgments 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.**
2. **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.**
3. **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:**
   * + 1. **Bidiredtional ring with n nodes**
       2. **Binary X-tree of height h (with 2h+1 -1 nodes, cf. lecture 2, slide 29)**

**Additional notes and assessment:**

* **important parts of the implementation have to be annotated with comments**
* **each exercise has to be completed handled in teams of 3-4 students**
* **the exercise sheet is successfully completed, if exercise 1 was presented and the solution was explained satisfactorily**