Introduction

What is Distributed Computing?

In the last few decades, we have experienced an unprecedented growth in the area of distributed systems and networks. Distributed computing now encompasses many of the activities occurring in today’s computer and communications world. Indeed, distributed computing appears in quite diverse application areas: The Internet, wireless communication, cloud or parallel computing, multi-core systems, mobile networks, but also an ant colony, a brain, or even the human society can be modeled as distributed systems.

These applications have in common that many processors or entities (often called nodes) are active in the system at any moment. The nodes have certain degrees of freedom: they have their own hard- and software. Nevertheless, the nodes may share common resources and information, and, in order to solve a problem that concerns several—or maybe even all—nodes, coordination is necessary. Despite these commonalities, a human brain is of course very different from a quadcore processor. Due to such differences, many different models and parameters are studied in the area of distributed computing. In some systems the nodes operate synchronously, in other systems they operate asynchronously. There are simple homogeneous systems, and heterogeneous systems where different types of nodes, potentially with different capabilities, objectives etc., need to interact. There are different communication techniques: nodes may communicate by exchanging messages, or by means of shared memory. Occasionally the communication infrastructure is tailor-made for an application, sometimes one has to work with any given infrastructure. The nodes in a system often work together to solve a global task, occasionally the nodes are autonomous agents that have their own agenda and compete for common resources. Sometimes the nodes can be assumed to work correctly, at times they may exhibit failures. In contrast to a single-node system, distributed systems may still function correctly despite failures as other nodes can take over the work of the failed nodes. There are different kinds of failures that can be considered: nodes may just crash, or they might exhibit an arbitrary, erroneous behavior, maybe even to a degree where it cannot be distinguished from malicious (also known as Byzantine) behavior. It is also possible that the nodes follow the rules indeed, however they tweak the parameters to get the most out of the system; in other words, the nodes act selfishly.

Apparently, there are many models (and even more combinations of models) that can be studied. We will not discuss them in detail now, but simply define
Chapter Notes

Many excellent text books have been written on the subject. The book closest to this course is by David Peleg [Pe0], as it shares about half of the material. A main focus of Peleg’s book are network partitions, covers, decompositions, and spanners – an interesting area that we will only touch in this course. There exist a multitude of other text books that overlap with one or two chapters of this course, e.g., [Lei92, Bar96, Lyn96, Tel01, AW04, HKP+05, CLRS09, Suo12].

Another related course is by James Aspnes [Asp] and one by Jukka Suomela [Suo14].

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Bibliography


