Part II

Logical Time and Global States in Distributed Systems

This part of the book, which consists of four chapters (Chap. 6 to Chap. 9), is devoted to the concepts of event, local state, and global state of a distributed computation and associated notions of logical time. These are fundamental notions that provide application designers with sane foundations on the nature of asynchronous distributed computing in reliable distributed systems.

Chapter 6 shows how a distributed computation can be represented as a partial order on the set of events produced by the processes. It also introduces the notion of a consistent global state and presents two algorithms that compute such global states on the fly. The notion of a lattice of global states and its interest are also discussed.

Chapter 7 introduces distinct notions of logical time encountered in distributed systems, namely, linear time (also called scalar time, or Lamport’s time), vector time, and matrix time. Each type of time is defined, its main properties are stated, and examples of its uses are given.

Chapter 8 addresses distributed checkpointing in asynchronous message-passing systems. It introduces the notion of communication and checkpoint pattern, and presents two consistency conditions which can be associated with such an abstraction of a distributed computation. The first one (called z-cycle-freedom) captures the absence of cycles among local checkpoints, while the second one (called rollback-dependency trackability) allows us to associate, without additional computation, a global checkpoint with each local checkpoint. Checkpointing algorithms that ensure these properties are presented.

Finally, Chap. 9, which is the last chapter of this part, presents general techniques (called synchronizers) to simulate a synchronous system on top of an asynchronous distributed system.