COMPUTER SCIENCE TRIPOS Part IB – 2025 – Paper 5

4 Concurrent and Distributed Systems (mk428)

You have been hired to create a supervision room booking system for Old Hall College, Cambridge. The system should allow supervisors to reserve rooms for particular time slots, and it needs to ensure that there are no two bookings for overlapping time periods for the same room, even when desperate supervisors are frantically and concurrently trying to book the last available room.

To ensure fault tolerance the system is required to have multiple replicas. It must work in a partially synchronous system model with crash-recovery faults.

- (a) Your first thought is to represent each hourly time slot for each supervision room as a separate register, with the value of the register indicating the supervisor who has booked it (if any), and to use the algorithm by Attiya, Bar-Noy, and Dolev (ABD algorithm) to replicate those registers. Assume that every time slot begins on the hour and lasts for an hour, so there are no overlapping slots. Explain briefly how the ABD algorithm works, and which consistency properties such a room booking system would have. Pseudocode is not needed. [6 marks]
- (b) Your second idea is to instead use state machine replication (SMR). Give pseudocode for a SMR-based supervision room database, and explain the pros and cons of this approach compared to using ABD. You may assume that you already have an implementation of total order broadcast. [6 marks]
- (c) Your third idea is to use two-phase commit (2PC) to coordinate writes to the replicas. Explain how 2PC works, and how it compares to the previous two approaches in the context of the room booking system.
- (d) Which of the three approaches (ABD, SMR, 2PC) is best for this system? Briefly explain why. [2 marks]