5. Exercise sheet: Distributed Concurrency Control and Recovery

Exercise 1
Consider the following local schedules:

- $S_1: R_1 A \ W_1 A \ R_2 A \ W_2 A$
- $S_2: R_2 B \ W_2 B \ R_1 B \ W_1 B$
- $S_1: R_1 A \ W_2 A$
- $S_2: R_3 B \ W_1 B \ R_2 C \ W_3 C$
- $S_1: R_1 A \ R_3 A \ R_3 B \ W_3 A \ W_3 B \ R_2 B$
- $S_2: R_4 D \ W_4 D \ R_1 D \ R_2 C \ R_4 C \ W_4 C$
- $S_1: W_1 A \ c_1 \ R_3 A \ R_3 B \ c_3 \ W_2 B \ c_2$
- $S_2: W_2 C \ c_2 \ R_4 C \ R_4 D \ c_4 \ W_1 D \ c_1$

(1) Verify whether or not the schedules are serializable.

(2) Demonstrate that by applying Distributed 2PL (Timestamp Protocol) the non-serializable schedules could not have occurred.

(3) Check whether or not the schedules are rigorous and commit-deferred.

(4) Demonstrate that by applying a Ticket-based concurrency control the not serializable schedules could not have occurred.

Exercise 2
Think about a distributed database management system that runs 2PC and how it deals with failures

(a) What happens when a participant votes abort in phase 1? Use the state transition graphs shown in the slides to explain your answer.

(b) What happens when a participant fails in phase 2 without sending anything to the coordinator (e.g. a kernel freeze)? Again use the state transition graphs to further explain your answer.

(c) How would using 3PC change the situation of b)

Exercise 3
(a) Describe the communication topology of centralized, decentralized and linear 2PC.

(b) Give the state diagrams of decentralized 2PC, in analogy to the state diagramm of centralized 2PC.

Exercise 4
Characterize centralized 2PC and linear 2PC with respect to

(1) message and time complexity,

(2) possibilities of processes to become uncertain.