Distributed systems I
Winter Term 2019/20

G2T1 – Assignment 5 (theoretical part)

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10/10 1 - Two-Phase Locking

a) 5/5

See figure 1

b) 2/2

The transactions 2 and 3 need to be aborted / rolled back. This is because the abort of transaction 1 does not happen until after the locks for reading uncommitted data have been acquired, resulting in incorrect reads. To enforce consistency, the transactions must be aborted when transaction 1 is aborted.

c) 3/3

See figure 2

Cascading abort does not happen with strict two phase locking because updated information from one transaction is only available for other transactions to read after the transaction either aborted or committed.

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T_1	T_2	T_3	T_4
$rL_1[v]$	$wL_2[z]$	$rL_3[s]$	$rL_4[u]$
$r_1[v]$	$w_2[z]$	$r_3[s]$	$r_4[u]$
$wL_1[v]$			$rL_4[o]$
$w_1[v]$			$r_4[o]$
$wL_1[x]$			$wL_4[y]$
$rU_1[v]$			$rU_4[u]$
$wU_1[v]$		$rL_3[v]$	$rU_4[o]$
$w_1[x]$		$r_3[v]$	$w_4[y]$
$wU_1[x]$		$wL_3[s]$	$wU_4[y]$
a_1	$rL_2[x]$	$rU_3[v]$	c_4
	$wU_2[z]$	$rU_3[s]$	
	$r_2[x]$	$w_3[s]$	
	$rU_2[x]$	$wU_3[s]$	
	c_2	c_3	

Figure 1: Operation timeline for History H_1 using non-strict two-phase locking

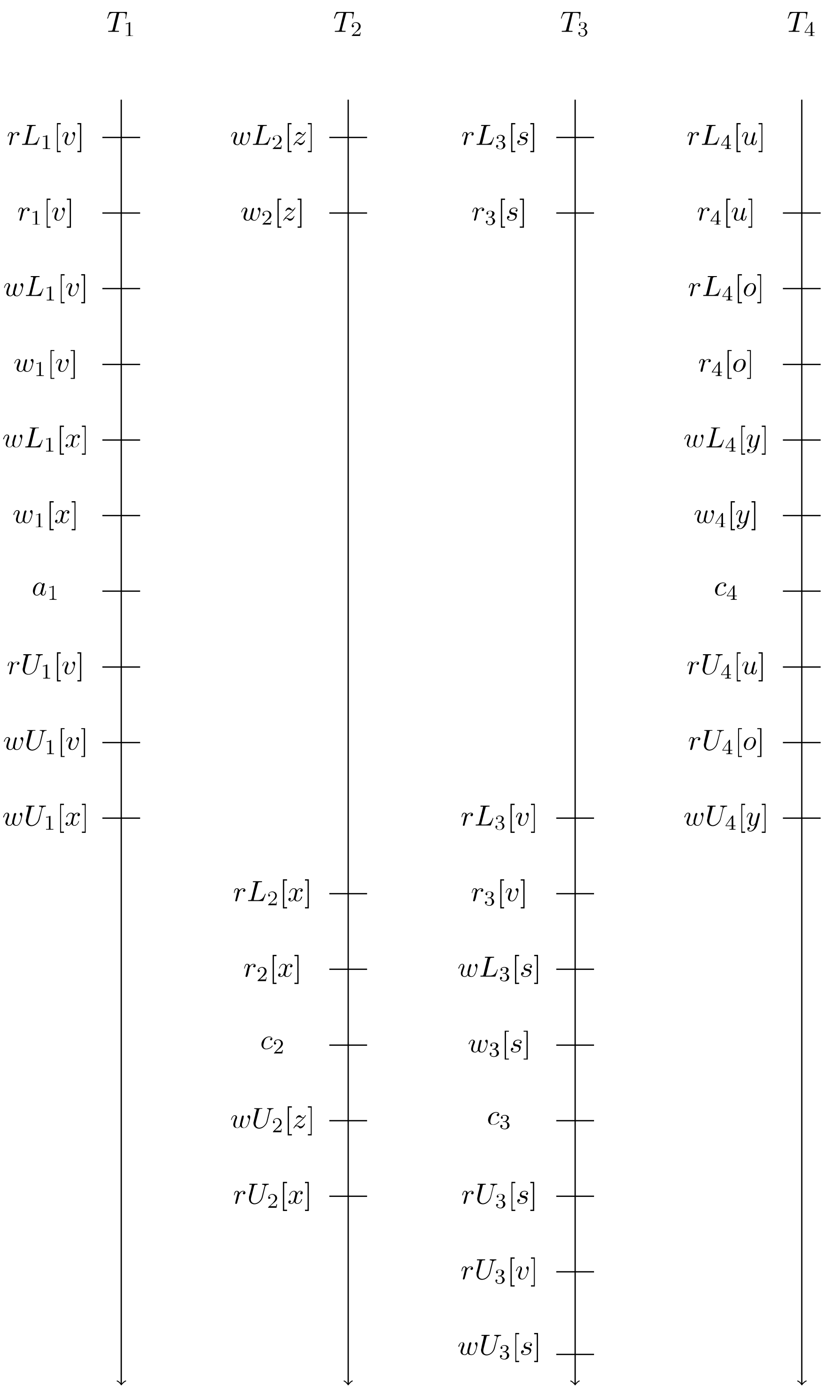

Figure 2: Operation timeline for History H_1 using strict two-phase locking

7.5/9 2 - Two-Phase Commit

a) 3/3

Shown in figure 3. N_2 and N_4 are blocked until the 'COMMIT'-Message is received. N_3 will try to resend the 'COMMIT'-Message until it receives the 'ACK'-Message.

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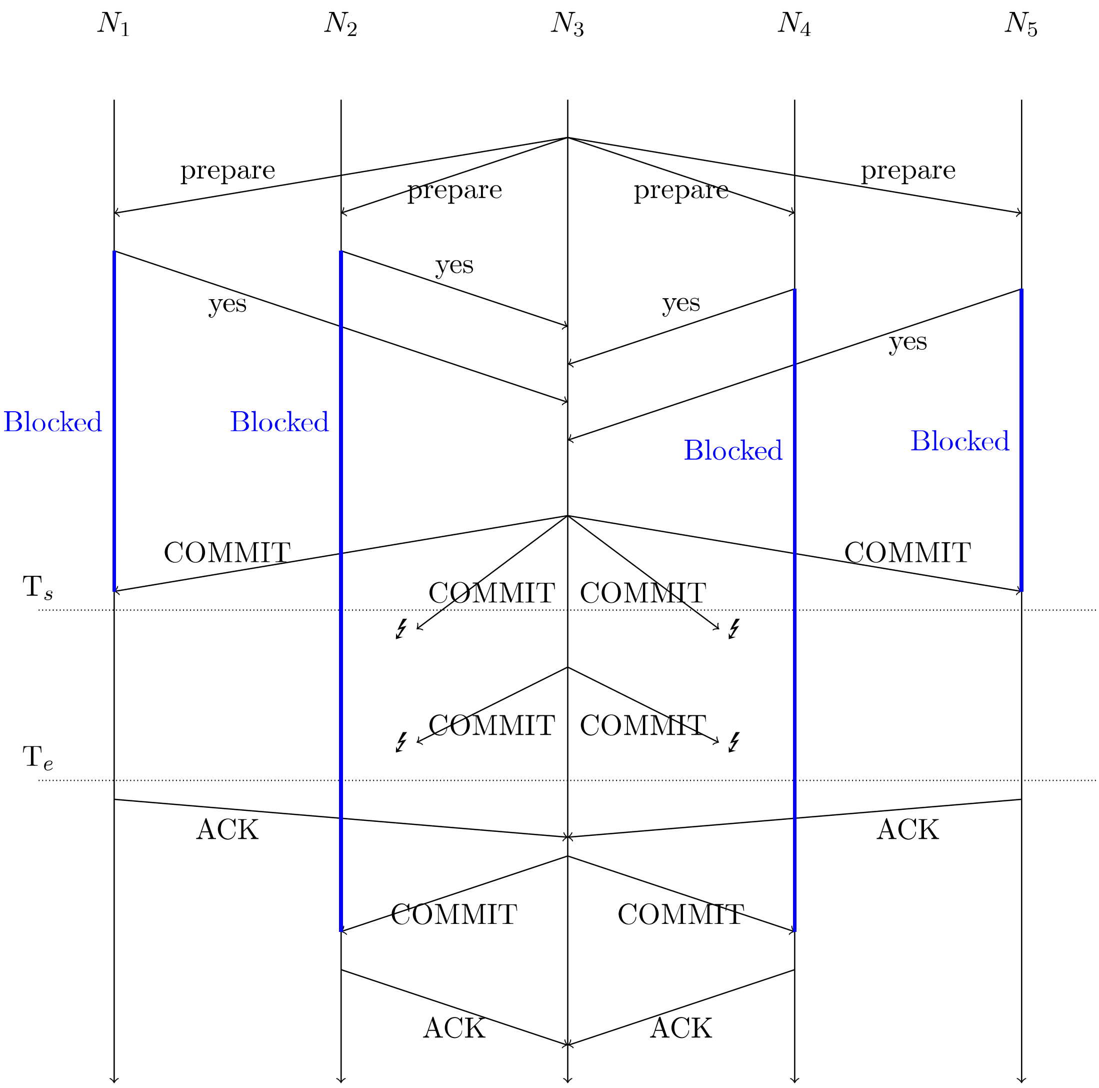

Figure 3: simple termination protocol

4/4 **b)**

Shown in figure 4. N_1 is getting sent a 'DECISION-REQ'-Message to send the 'COMMIT'-Message to N_2. Same for N_5 because N_4 is not reachable.

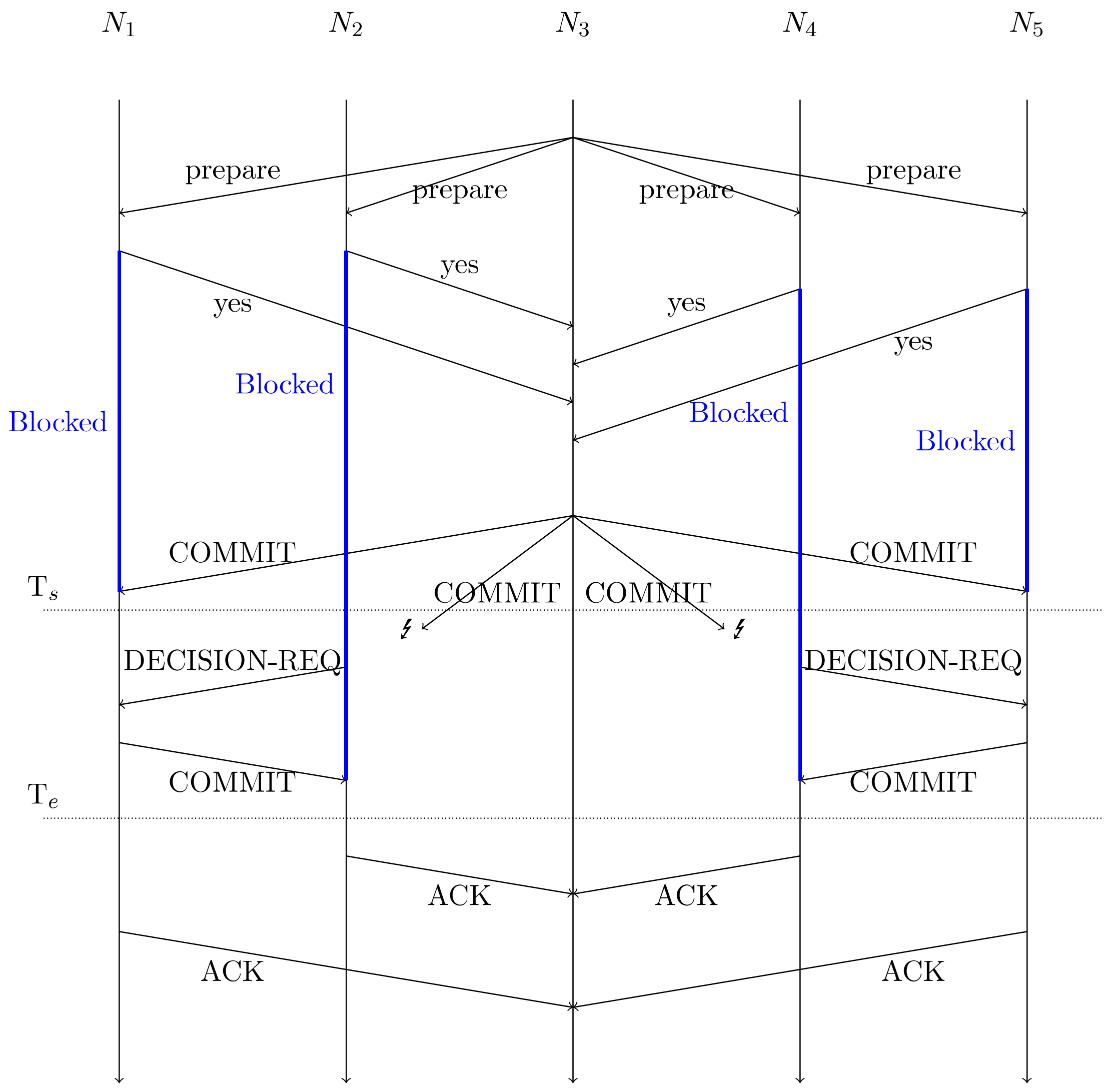

Figure 4: cooperative termination protocol

c) 0.5/2

Shown in figure 5.

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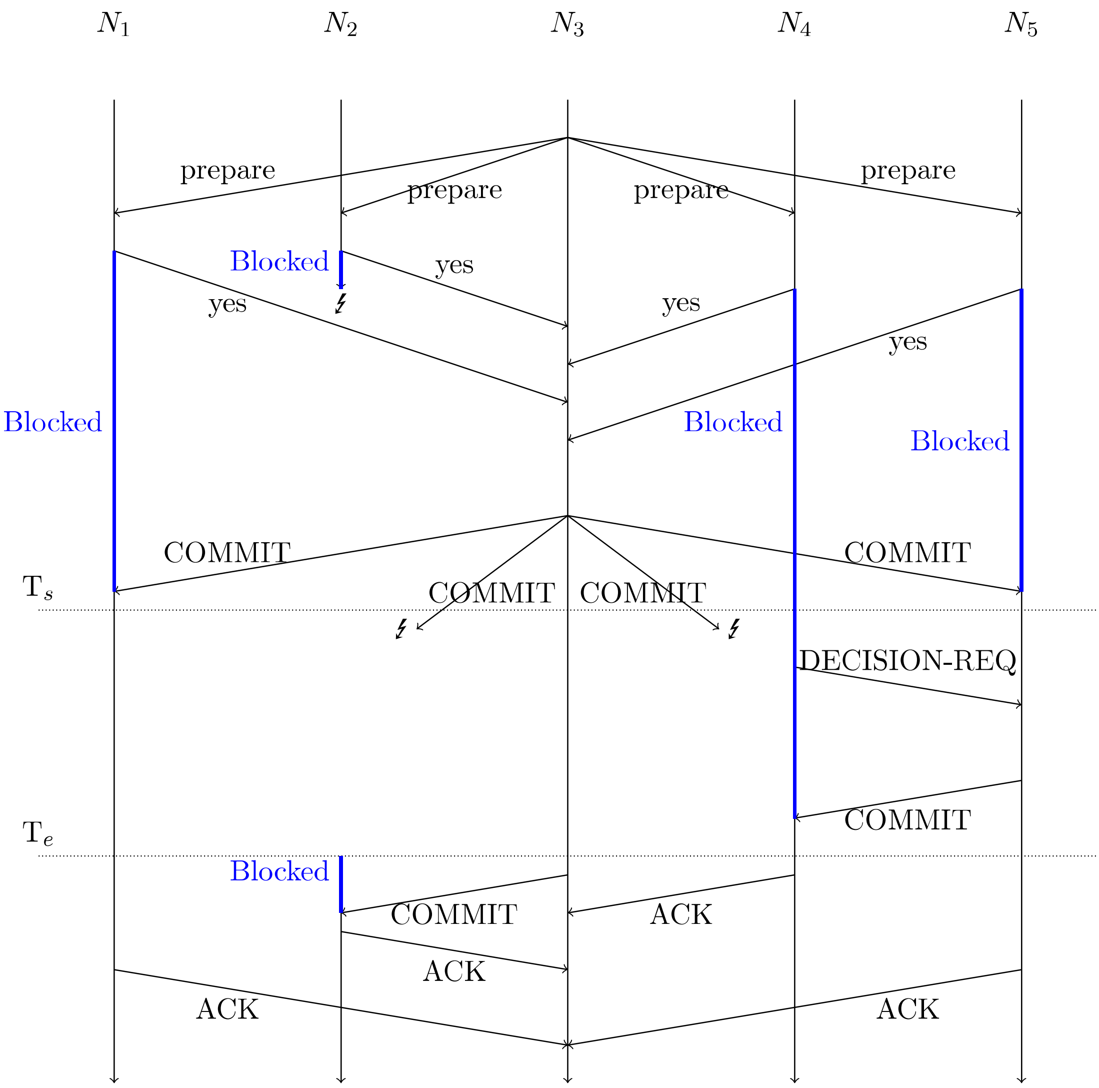

Figure 5: cooperative termination protocol with node failure

9.5/11 3 - Data Replication

4.5/6 a)

$q[X_A] = 1$
$q[X_B] = 1$
$q[X_C] = 3$
$q[X_D] = 1$

$q_w[X]$ 1: X_C, X_A
$q_w[X]$ 2: X_C, X_B
$q_w[X]$ 3: X_C, X_D
$q_w[X]$ 4: X_C, X_A, X_B
$q_w[X]$ 5: X_C, X_A, X_D
$q_w[X]$ 6: X_C, X_B, X_D

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q_w[X] 7: X_C, X_A, X_B, X_D

q_r[X] 1: X_A, X_B, X_D
q_r[X] 2: X_C
q_r[X] 3: X_C, X_A
q_r[X] 4: X_C, X_B
q_r[X] 5: X_C, X_D
q_r[X] 6: X_C, X_A, X_B
q_r[X] 7: X_C, X_A, X_D
q_r[X] 8: X_C, X_B, X_D
q_r[X] 9: X_C, X_A, X_B, X_D No justification

3/3 **b)**

q_w[X] = 6
q_w[x] 1: X_C, X_D, X_A
q_w[x] 2: X_C, X_D, X_B
q_w[x] 3: X_C, X_D, X_A, X_B

2/2 **c)**

$p_r(Y) = 1-((1-p_K)*(1-p_L))-((1-p_L)*(1-p_M))-((1-p_M)*(1-p_K))-((1-p_K)*(1-p_L)*(1-p_M))$ To be readable a majority of nodes have to be available, which is 2 in this case. That means that 1-p_r(Y) is the probability that more than 1 node fails.