Conflicting Operations

1. T_1 and T_2 (diff trans.)
2. $T_1(x)$ and $T_2(x)$ (same var)
3. Write (at least 1)

RW, WR, WW

$S_1 = W_2(x), W_1(x), R_3(x), R_1(x), W_2(y), R_3(y), R_3(z), R_2(z),$ Serializable

Conflict: $W_2W_1(x), W_2R_3(x), W_2R_1(x), W_1R_3(x), W_2R_3(y)$

$S_2 = R_3(z), R_2(y), W_2(y), R_2(z), W_1(x), R_3(x), W_2(x), R_1(x)$ Non-serializable

Conflict: $R_2W_2(y), W_1R_3(x), W_1W_2(x), R_3W_2(x), W_2R_1(x)$

$S_3 = R_3(z), W_2(x), W_2(y), R_1(x), R_3(x), R_2(z), R_3(y), W_1(x)$ Serializable

Conflict: $W_2R_1(x), W_2R_3(x), W_2W_1(x), R_3W_1(x), W_2R_3(y)$

$S_4 = R_2(z), W_2(x), W_2(y), W_1(x), R_1(x), R_3(x), R_3(z), R_3(y)$ Serializable

Conflict: $W_2W_1(x), W_2R_1(x), W_2R_3(x), W_2R_3(y), W_1R_3(x)$

Schedules S_1 and S_4 are conflict equivalent, that is, the order of any two conflicting operations is the same in both schedules.

$T_1 T_2 T_3$: $W_1(x)$, $R_1(x)$, $W_2(x)$, $W_2(y)$, $R_3(z)$, $R_3(x)$, $R_3(y)$, $R_3(z)$

Conflict: $W_1 W_2(x)$, $R_1 W_2(x)$, $W_1 R_3(x)$, $W_2(x) R_3(x)$, $W_2 R_3(y)$

$T_1 T_3 T_2$:

Conflict: $W_1 W_2(x)$, $R_1 W_2(x)$, $W_1 R_3(x)$, $R_3 W_2(x)$, $R_3 W_2(y)$

$T_2 T_1 T_3$:

Conflict: $W_2 W_1(x)$, $W_2 R_1(x)$, $W_1 R_3(x)$, $W_2 R_3(x)$, $W_2 R_3(y)$

$T_2 T_3 T_1$:

Conflict: $W_2 W_1(x)$, $W_2 R_1(x)$, $R_3 W_1(x)$, $W_2 R_3(x)$, $W_2 R_3(y)$

$T_3 T_1 T_2$:

Conflict: $W_1 W_2(x)$, $R_1 W_2(x)$, $R_3 W_1(x)$, $R_3 W_2(x)$, $R_3 W_2(y)$

$T_3 T_2 T_1$:

Conflict: $W_2 W_1(x)$, $W_2 R_1(x)$, $R_3 W_1(x)$, $R_3 W_2(x)$, $R_3 W_2(y)$

S_1 and S_4 are conflict serializable with $T_2 T_1 T_3$, and S_3 is conflict serializable with $T_2 T_3 T_1$. Hence, S_1, S_3 and S_4 are serializable.

Q2 Answer
Centralized deadlock detection methods involve a deadlock detector located designated in one site for the entire system. In contrast, the hierarchical deadlock detection method employs a hierarchy of deadlock detectors, where each site detects deadlocks locally and deadlocks accross sites are detected by the lowest next level deadlock detector that has control over the sites.

Centralized deadlock detection mechanisms present a trade-off between delay time and communication overhead. The smaller the lenght of the interval for transmitting information concerning graph changes, the smaller the daly due to undetected deadlocks, but the larger the communication overhead. In turn, it is argued that large communication overhead might be required to ensure efficiency. In addition, because the deadlock detector lies in a single site, it is highly vulnerable to failure.

Hierarchical deadlock detection mechanisms, in contrast, have therefore no dependence on the central site, considerably reducing communication costs and is also less vulnerable to failure. Notwithstanding, it is significantly more complicated to implemnet and would involve non-trivial modifications to the lock and transaction manager algorithms.

Q3 Answer
It can be concluded that there is a deadlock located locally at the current site (no external site) involving transactions T_i.

It can be concluded that there is a deadlock located globally across sites (global deadlock), since T_i -> T_ex and T_ex -> T_i

Q4 Anwer
Not necessarily. The proposed method aims to detect the existance of a global deadlock. However, according to description, it only tests whether a deadlock exists across two sites at a time. That is, transactions in the current site and that site it is being transferred to (2 sites). However, a global lock might exist involving more than two sites, requiring to form a graph consisting of the combination of the transactions between three or more sites. This case, for instance, is covered by hierarchical structures, but is not covered according to the description of the proposed method in the question. Hence, it is argued that the proposed scheme won’t necessarily find all global deadlock if it exists should it involve transactions occurring in 3 or more sites.