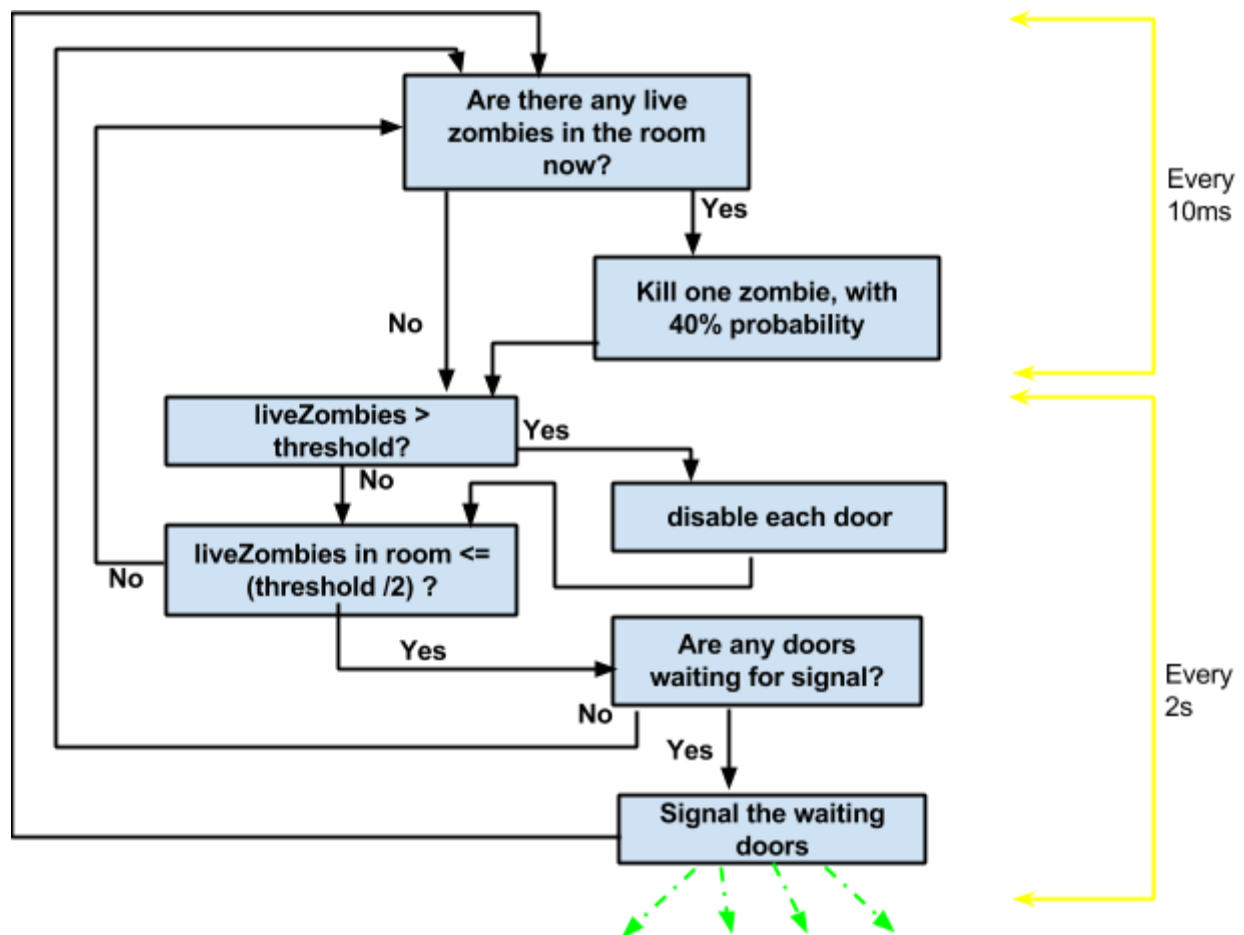## Question no 2 : Zombie Invasion Problem

Synchronization Using PThreads

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Solution :

At the 'hero' thread -

The 'hero' thread is the thread which manages the killing of zombies when the hero's friends stands at the control of each door. Killing a zombie is done by decrementing the number of live zombies, after acquiring a mutex lock on the variable.

At the door / At the friend's side who controls the door -
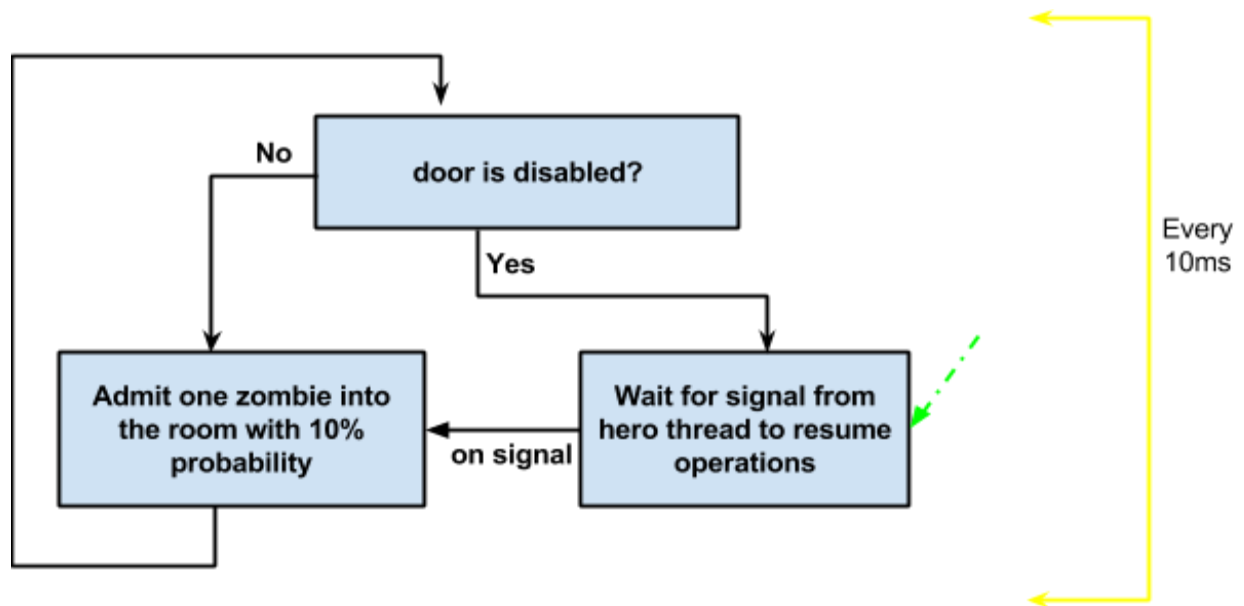
Admitting one zombie is done by incrementing the live zombie count by one, after acquiring a mutex lock on the variable. *signal-wait* mechanism is implemented using conditional variables in PThreads. Mutexes has been used wherever required.

Parallelism : All the threads are executing in parallel. Once the threshold is crossed, ie, there are too many live zombies in the room, the threads representing the doors will wait until a signal is given from the 'hero' thread. This can't be stated as decreased parallelism since that is what the problem statement demands.

Observations :

Threshold n	Time of execution (in mins) x	Throughput after x mins (kills per second)
10	1	29
15	1	36
20	1	38

25	1	38
30	1	38
35	1	37
40	1	39
50	1	39

Observations were made with the help of messages printed on screen at various stages of execution (as seen in the below given Sample Output). Threshold was output once every 2 seconds.

Sample output : (Excerpts from output of an execution with threshold value = 10)

    Hero thread created successfully
    Friend thread 1 created successfully
    Friend thread 2 created successfully
    Friend thread 3 created successfully
    Friend thread 4 created successfully
    Thread 1 has let in a zombie
    Thread 2 has let in a zombie
    Total no of live zombies now = 2
    Killed one zombie
    Total no of live zombies now = 1
    Killed one zombie
    Thread 1 has let in a zombie
    Thread 4 has let in a zombie
    Total no of live zombies now = 2
    Killed one zombie
    Thread 3 has let in a zombie
    Total no of live zombies now = 2
    Killed one zombie
    Total no of live zombies now = 1

Killed one zombie

Thread 1 has let in a zombie

Thread 3 has let in a zombie

Thread 2 has let in a zombie

Total no of live zombies now = 3

Killed one zombie

Thread 4 has let in a zombie

Total no of live zombies now = 3

Killed one zombie

Thread 2 has let in a zombie

Total no of live zombies now = 3

Killed one zombie

Total no of live zombies now = 2

Killed one zombie

...

...

...

Thread 4 is waiting for signal to let in more zombies

Total no of live zombies now = 10

Killed one zombie

Thread 1 is waiting for signal to let in more zombies

Thread 3 has let in a zombie

Thread 2 is waiting for signal to let in more zombies

Total no of live zombies now = 10

Killed one zombie

...

...

...

Total no of live zombies now = 1

Killed one zombie

2 seconds checkpoint

Live zombies less than threshold / 2

Signalling door 1 to let in more zombies

Signalling door 2 to let in more zombies

Thread 1 is resuming operation

Thread 2 is resuming operation

Signalling door 4 to let in more zombies

Throughput : 24 kills per second

Thread 4 is resuming operation

Thread 4 has let in a zombie

...

...

...