

### T-Question 3.1: Threads and Thread Models

a. What is the difference between a PCB and a TCB?

1 T-pt

**Solution:**

**Process control block (PCB)** *The PCB contains all information to implement a process as container of resources for threads (address space, open files, pending signals, etc.).*

**Thread control block (TCB)** *The TCB holds thread-local management information such as (the pointer to) the stack of the thread and possibly the register set, when the thread is not running. There exists a TCB for each thread in a process.*

b. The lecture and tutorials introduced two fundamental types of threads, depending on where the thread is implemented and where it executes. What are these two types? Give a short explanation for each.

2 T-pt

**Solution:**

**Kernel-level Threads (KLT)** *The TCB is implemented in the OS kernel. The kernel is thus fully aware of the threads and responsible for managing them.*

**User-level Threads (ULT)** *The thread is fully implemented in a user-space program or library (TCB, dispatching, scheduling, synchronization, etc.). The kernel is not aware of the threads.*

c. Give two disadvantages of the many-to-one thread model.

1 T-pt

**Solution:**

- *Blocking system calls block the entire application*
- *Cannot benefit from multiple CPUs/cores*
- *High implementation work (e.g., need to re-implement thread context, thread dispatching and scheduling, etc.)*

d. Explain the basic concept of a hybrid thread model.

2 T-pt

**Solution:**

*In a hybrid thread model (m-to-n model), m user-level threads are mapped to n kernel-level threads. The hybrid thread model combines the flexibility of a user-space thread library with the benefits of kernel-level threads (true parallelism, individual thread blocking).*

e. Why does a switch to a thread of a different process normally take longer than a switch to a thread in the same process?

1 T-pt

**Solution:**

*When switching to a thread in a different process, the OS needs to perform a full context switch, which includes switching to a different PCB and address space. For a thread switch in the same process, most state can remain the same. Primarily, the current kernel stack and register state needs to be exchanged.*

**Total:  
7 T-pt**