Multi-Threading

Introduction to Multi-Threading

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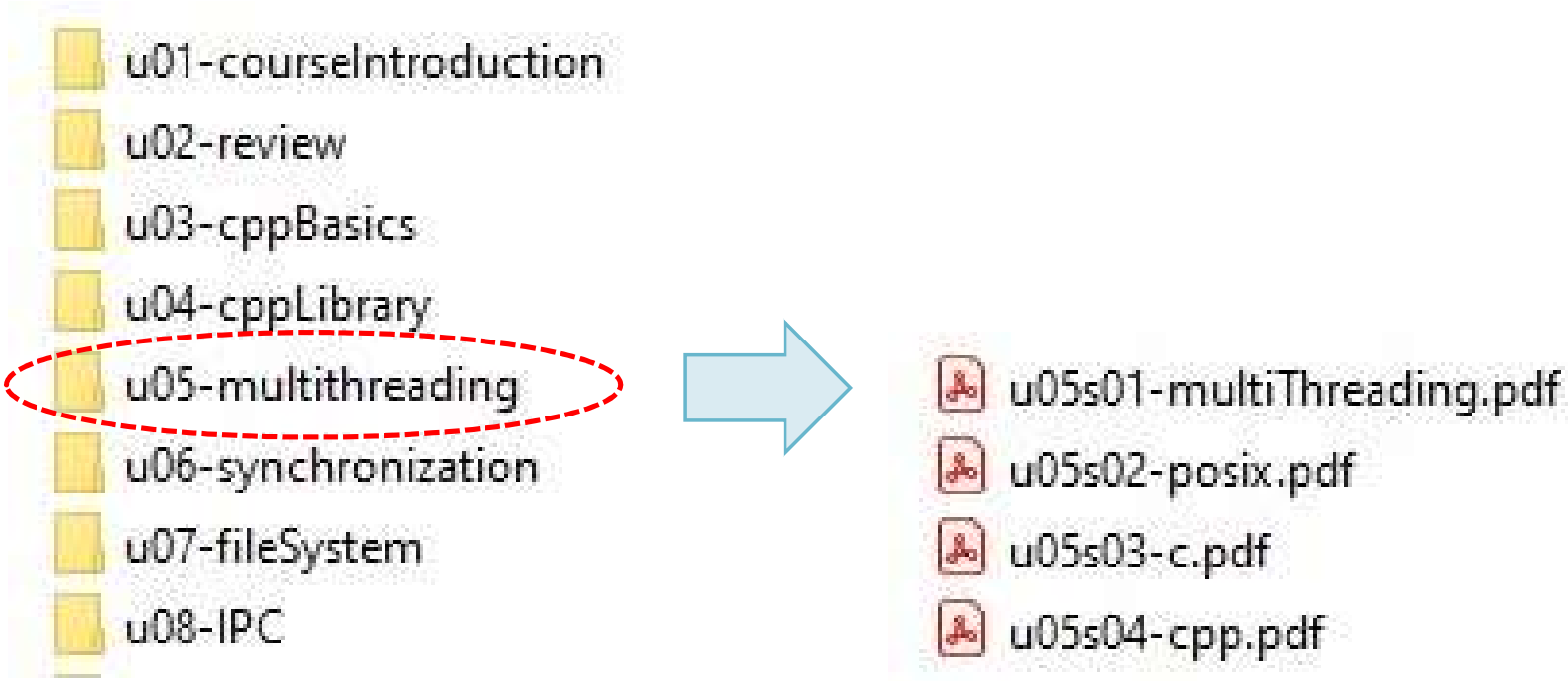
Premises

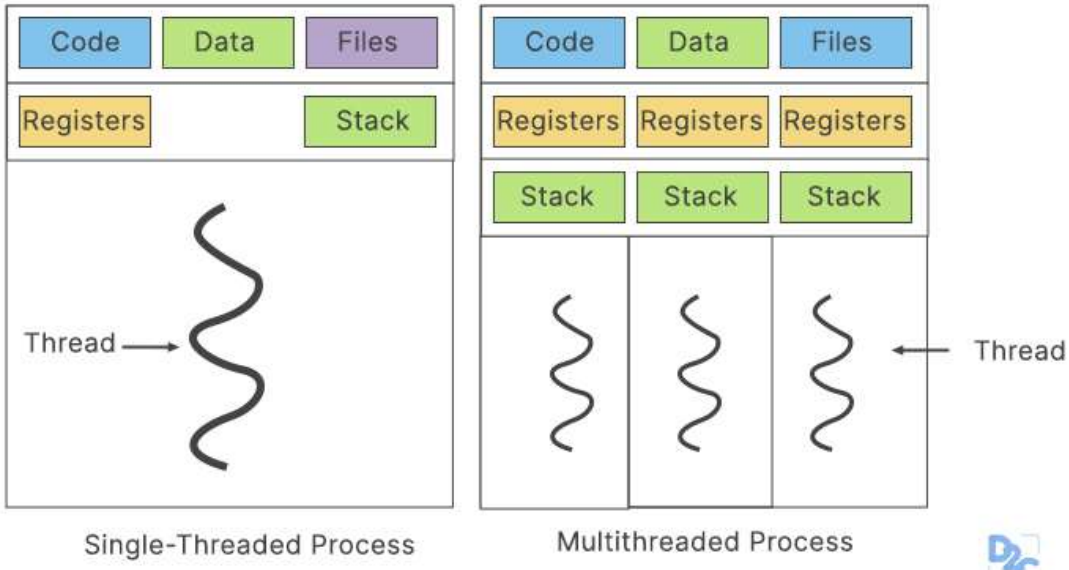
- Where are we?



Introduction

- C and C++ can run multiple threads in a program
  - The thread model allows a program to control multiple different flows of operations (**scheduled and executed independently**) that overlap in time
  - Each flow of operations is referred to as a **thread**

Processes group resources
Threads are units for the scheduling of the CPU



Introduction

- A thread can share its address space with other threads
  - Shared data
    - Code section
    - Data section (variables, file descriptors, etc.)
    - Operating system resources (e.g., signals)
  - Private data
    - Program counter and hardware registers
    - Stack, i.e., local variables and execution history

Obvious, since a thread implies its own flow of execution (within the same process)

Introduction

- Threads allows
  - Shorter response time
  - Shared resources
  - Lower costs for resource management
  - Increased scalability
- Threads have no implicit data protection
  - They are executed in the same address space and the operating system protection is impossible
  - If the threads are not synchronized, access to shared data is **not thread safe**

Thread libraries

- A thread library provides the programmer with the interface to use threads
- The management can be done
  - At user-level (by functions)
  - At kernel-level (by system calls)
- The most used thread libraries are
  - POSIX threads (Pthreads)
  - C and C++
  - Windows 32/64
  - Java

Implemented at user and kernel level

Implemented at kernel-level

Implemented through the thread library of the system hosting Java